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Austrian Research and Technology Report 2019

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Preface

A look back at the FTI Strategy 2020, which was adopted by the federal government in 2011, shows an impressive catching-up process in the areas of research, technology and innovation. The outstanding result of the review, which was prepared as part of this year's Austrian Research and Technology Report with the involvement of relevant experts, is the high number of successfully implemented measures, even though an overriding objective, namely to advance into the group of 'Innovation Leader' countries, has not yet been achieved. The individual sub-strategies, which have been adopted since 2011 on new, current topics such as open innovation, life sciences, creative industries, digitisation and many others, supplemented the RTI Strategy 2020 from an overall systemic perspective. Overall, the coordinated approach of policymakers, research-relevant ministries and actors in the RTI system can be regarded as a success within the framework of the RTI Strategy.

Progress has been made in all RTI-relevant areas of science, industry and the public sector. Austria's position in international rankings has largely improved or stabilised since 2011. Austria is one of the leading nations with regard to its research and development expenditures and ranks second in Europe behind Sweden and ahead of such innovative countries as the USA and China worldwide; Austria ranks second in Europe behind Finland when it comes to cooperation between universities and industry. Austria is leading in Europe when it comes to science – industry cooperation as a whole, as well as in measurable achievements of its science system such as public-private co-publications, citations or in the development of international patent applications. Austria is thus well equipped to meet the increasing technical challenges in a globally networked science and economy. The analyses of Austria's competitiveness and innovative capacity based on the Global Competitiveness Report and the Innovation Capability Indicator of the German Institute for Innovation and Technology (iit) also show an above-average (compared to the EU-28) positioning of Austria with regard to technological maturity, political and economic framework conditions and the qualification of individuals.

In addition to the well-known weaknesses in venture capital, there is a need to catch up in knowledge-intensive service exports, employment in fast-growing companies and tertiary education in the field of digitisation. In addition to the review of the RTI Strategy 2020, another focus chapter is therefore devoted to the state of digital change in Austria in all RTI, social, educational and administrative policy areas and provides a comprehensive overview of the numerous initiatives and measures. With the creation of a lead ministry, a task force and the establishment of the Digitalisation Agency, efforts to improve the framework conditions for the development of digital technologies have been considerably expanded.

In August 2018 the federal government agreed on an "Action plan for the future of research, technology and innovation", and the preparations for its implementation show how we will progress towards becoming an "Innovation Leader". A new RTI strategy, and the interlinking of all elements of the innovation system – from the education system and academic research institutes to SMEs and large enterprises – will ensure the maximum possible output, and social and economic impact for the long term.

With an estimated €12.8 billion and a nominal increase of €554 million compared to 2018, Austria will reach a new record level of R&D expenditure in 2019. At 4.5%, the increase in R&D expenditure was thus higher than the 3.8% increase in gross domestic product. Austria's R&D intensity of 3.19% will be slightly above that of the previous year, which was revised to 3.17%. The financing share of companies is expected to be 49% at €6.3 billion, followed by the

public sector at €4.5 billion and a share of around 35%, the foreign sector at €2 billion and a share of around 16% and the private, non-profit sector at €0.08 billion and a share of around 0.6%.

Overall the Austrian funding system is well developed and has a variety of instruments and priorities to cover the broad range of funded researchers. The latest analysis of the strategic funding trends of the three major research funding agencies, the Austrian Science Fund (FWF), the Austrian Research Promotion Agency (FFG), and the Austria Wirtschaftsservice (aws) is a fixed component of the Research and Technology Report and is presented annually.

Additional sections address European RTI policy, including the activities conducted in the context of Austria's Presidency of the Council of the European Union in the second half of 2018, selected evaluations and an analysis of federal research funding and contracts in 2018, as recorded in the federal government's research database. As usual, a comprehensive annex with tables completes the picture of Austria's RTI activities.

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Executive Summary

The Austrian Research and Technology Report is the status report on the country's federally funded research, technology, and innovation. It was commissioned by the Federal Ministry of Education, Science and Research (BMBWF), the Federal Ministry for Transport, Innovation and Technology (BMVIT), and the Federal Ministry for Digital and Economic Affairs (BMDW). The report includes an analysis of data and findings in its various forms and in its international context, as well as development trends and selected special topics.

The Austrian Research and Technology Report 2019 presents **the latest global estimate of R&D expenditure in Austria**, the **performance of the Austrian innovation system compared to international standards** and an **analysis of the system with regard to progress in digitalisation**. The report also provides a **description of various initiatives and strategic measures in research, technology and innovation**. In preparation for the new RTI strategy, this report focuses particularly on the **implementation and goal achievement of the RTI strategy 2020**, which was adopted by the federal government in 2011. The RTI strategy 2020 is subjected to a *review* involving external experts, providing an analysis and a closer examination of the developments between 2011 until today. Emphasis is also placed on **digital transformation**, which is of increasingly affecting the business, education and public sectors. New developments as well as current measures and initiatives are also shown here for the respective sector. An essential component of the Austrian innovation system is its well developed **research funding**, which is presented according to the current key indicators and the approaches to strategic further development at federal level on the basis of the three major funding agencies, the Austrian Science Fund (FWF), the Austrian Research Promotion Agency (FFG), and the Austria Wirtschaftsservice (aws). Austrian RTI policy is marked by a broadly applied and firmly anchored **evaluation culture**. The report concludes with some insights into this culture and a synopsis of recent evaluations of RTI programmes.

Global estimate of R&D expenditure in 2019

The current global estimate by Statistics Austria, published in April 2019, predicts that **total investment in research and development (R&D) in 2019 in Austria will be €12.8 billion** – 4.5% over the total for 2018 (€12.2 billion). **Estimated R&D intensity** (percentage of gross domestic expenditure on research and development relative to gross domestic product) is expected to total **3.19%** for 2019, which constitutes a slight increase in comparison to last year (2018: 3.17%, revised value in comparison to the global estimate for 2018). This would place Austria **above the European target value of 3% for the sixth consecutive year**. In the past ten years 2009-2019, R&D investments increased nominally by 71.1%, but gross domestic product only by 39.1% – the growth in R&D investment has therefore exceeded economic growth, confirming that the Austrian economy is becoming increasingly research intensive.

Combined federal and state funding, with an **anticipated total of €4.3 billion** in 2019, is expected to make up 33.9% of the financing for all R&D conducted in Austria. While this is €148.4 million more than in the previous year, the proportion of funding from federal and state sources will fall slightly (2018: 34.2%). This is the fourth lowest value in the last ten years. The largest proportion of public investment in R&D, at an anticipated total of €3.8 billion (+ 3.4% or + €123.4 million) will be contributed by the federal government. This also includes investments of €138.7 million for the National Foundation for Research, Technology and Development and €670.0 million (as estimated by the Federal Ministry of Finance (BMF)) for the research tax premium.

The **Austrian companies** will have financed **€6,3 billion or 48,96% almost half of all R&D in 2019**, which corresponds to the second highest value within the last ten years (2015: 49,74%). Austrian firms provide an ever-increasing share of the funding for R&D conducted in this country. In comparison to the previous year, investments rose by €314.1 million, or 5.3%.

Around €2 billion or 15.6% of R&D funding in 2019 will come from outside Austria; the majority of this sum comprises financing from foreign firms for research being carried out in Austria, but it also includes funds from EU research programmes. The category "Other" includes other public funding and the private non-profit sector (non-profit institutions whose status is predominantly private, subject to civil law, confessional or other non-public bodies), which play a relatively minor role at 1.0% and 0.6% respectively.

Major Federal Funding Agencies in Austria

The **Austrian Science Fund** (FWF) is the country's central institution for the funding of basic research. In 2018, 684 projects (2017: 642 projects) were newly approved from the Austrian Science Fund (FWF), amounting to a total of €230.8 million (compared to €217.3 million in 2017). Owing to a significant increase in the application volume to approx. €950 million; (2017: €879.4 million), the total approval rate (by volume) fell slightly, from 22.4% to 22.1%, while the approval rate in terms of standalone projects remained stable, at approx. 28%. In total, the number of individuals who received financing from the FWF in 2018 increased to 4,155. They are mostly PhD students working on projects of the FWF. The proportion of women amongst all researchers financed by the FWF in 2018 increased in all categories of personnel. The FWF also saw numerous ground-breaking developments in 2018. One of these was a commission, as part of the "action plan for the future" formulated in the federal government's legislative programme, for the FWF to draft an excellence initiative for Austria. Another was a strategic plan for the years 2019-2021 (multiyear programme of the FWF) which focuses on three key elements: quality assurance, consolidation of the funding portfolio, and dialogue with civil society. The implementation of project funding through institutions ("PROFI") was continued, and the FWF made a strong commitment to expand measures in the area of scientific ethics and integrity; it also continued its pro-active role in the area of Open Access and Open Science.

The **Austrian Research Promotion Agency (FFG)** is the national funding institution for business-related research and development. It offers a broad portfolio of funding instruments for firms in particular, but also for research and higher education institutions. In addition to financial support, the Austrian Research Promotion Agency (FFG) also provides services and advice – for example, it serves as the national contact point for EU research programmes. In 2018, contractually guaranteed grants (including guarantees and loans) amounted to €617.6 million, corresponding to a present value of €500.8 million. The FFG expanded its portfolio for the development of new funding formats in many directions in 2018. On the one hand, the two pilot projects "Impact Innovation" and "Ideas Lab" passed the test for real-life application and are about to be incorporated into the portfolio of the FFG. On the other, new priorities were set within the field of digitalisation: qualification and diffusion. A Digitalisation Agency was established as a separate division within FFG - with the aim of enhancing Austria's standing as a location for digital excellence and innovation. This brings together projects, skills and different stakeholders from the general population, industry and government bodies for the first time under one roof.

The **Austria Wirtschaftsservice GmbH (aws)** is the federal promotional bank. By providing loans, grants and guarantees with low interest rates, businesses receive support for the implementation of their innovative projects, particularly when other forms of financing are unable to provide the necessary funds. In addition, specific information and consulting services are offered to prospective, existing and expanding companies. At €2,189.5 million, total financing in 2018 was around 91.2% higher than in the previous year, with temporary and broadly effective subsidy programmes (in particular the employment bonus) being the main reason for the high increase in subsidy volume. Adjustments

to the terms and conditions of funding with guarantees and loans, effective from the beginning of 2017 and continued in 2018, also made a significant contribution. Examples of these adjustments include increases in maximum amounts available, increased willingness to take risks as well as a reduction in processing and guarantee fees. They also entail the streamlining of ERP loan guidelines in a new growth and innovation programme whilst maintaining the interest rate at an all-time historical low. These apply equally to innovative investment projects of existing businesses as well as those of new ventures and young firms; the latter continue to benefit from the special conditions offered by the start-up microloan, which has a fixed interest rate of 0.5% over the entire term. Further changes included the strategic orientation as well as the continuous further development of the aws instrument portfolio - among other things with the objectives of increasing the effectiveness of subsidised enterprises, facilitating access to subsidies and reducing the administrative burden.

Austria's position in international comparisons

In an international comparison, Austria has **clearly improved** its **position among key RTI indicators** in recent years. In terms of expenditure on research and development, Austria is one of the leading nations. With an R&D intensity of 3.17% in 2018, Austria achieved the second highest level in the EU-28 - behind Sweden. Austria is thus positioned ahead of Denmark, Germany, Finland and Belgium. In a global comparison, Austria is also ahead of highly innovative countries such as the USA or China.

In terms of the **core quality-oriented parameters**, such as citation rate and international patent applications, Austria has also made **striking progress**. Austria is the European leader in science–industry cooperation on RTI. In cooperation between higher education institutions and companies, Austria ranks second among all European countries. Austria is thus only behind Finland and ahead of the leading innovation nations Sweden, Denmark, the Netherlands and Great Britain. As a result, Austria is also well positioned to ensure a fast and efficient transfer of new processes, technologies and services.

In the area of digitalisation the Digital Economy and Society Index (DESI), commissioned by the European Commission, places **Austria in the mid-range** of the EU-28, at position 11. The leaders in this ranking are the northern European countries of Denmark, Sweden, Finland and the Netherlands. The DESI index confirms that there is still further potential for development in the expansion of the internet and the integration of digital technology. In the area of "human capital", which includes basic skills in the use of the internet, as well as advanced capabilities and development, Austria is well placed by international standards.

As far as Austria's **competitiveness** is concerned, the "Global Competitiveness Report" shows that Austria is performing **better than the EU-28 average in all aspects**. Austria ranks 22nd among 140 countries worldwide. The world leaders are identified as the USA, Singapore, Germany, Switzerland and Japan. Particularly in terms of the maturity of the economic system, innovation activity and the institutional framework conditions, Austria is achieving significantly better values than the average of the EU countries. The level of technological maturity and education in Austria, as well as the EU average, are both at a very high level. Potential for development in Austria and the rest of the EU is considered to lie in the efficiency of the labour and goods markets, and in the development of the financial market.

The successes achieved, the international top position of Austria in R&D intensity, and the positive trends in many of the key performance indicators of innovation together provide evidence that Austria has succeeded in positioning itself well in terms of international competition, particularly when it comes to developing innovations and launching them successfully on the global market.

The Austrian Presidency of the Council of the European Union

In the second half of 2018, Austria assumed the Presidency of the Council of the European Union. In the area of RTI policy, despite challenging circumstances (Brexit and the pending decision on the EU's multi-year budget for the period 2021-2027), agreement was reached in a record time of just five months on the essential elements of the **Horizon Europe Regulation**, i.e. the regulation on the next European Research Framework Programme. This was achieved through the adoption of the so-called "partial political agreement" by the Competitiveness Council on 30 November 2018. On 20 March 2019, the European Commission, the European Parliament and the Council, subject to the anticipated formal resolution, also agreed on a so-called "partial political agreement", and on 15 April 2019, the Council agreed on the key components of the specific programme, setting Europe on course for a constructive resolution. The major changes to the current Horizon 2020 research framework programme concern the continued development of the European Innovation Council, new governance processes and the introduction of so-called "missions", which are to be defined in relation to specific targets yet to be determined (such as for example plastic-free oceans), mostly in RTI clusters that will encompass a number of themes.

After Horizon Europe, the second priority of the Austrian presidency of the European Council in the field of RTI was the further implementation of the European Research Area (ERA). In this respect too, the conclusions successfully negotiated by Austria over several months in the Research working group were accepted and adopted by the Council on 30 November 2018. In the middle of February 2019, the progress report on the implementation of the European Research Area was presented, showing that progress in the implementation process in Europe has slowed, and that major disparities are still evident within the EU. For Austria, positive developments were observed in four of the six priority areas. However, Austria's positioning in priority 4 ("Gender equality and gender mainstreaming in research"), in particular the proportion of female PhD graduates, was still found to be its major weakness in comparison with other countries in the ERA.

In the context of the Austrian Presidency of the Council of the European Union, 40 other events were held, which addressed the organisation of Horizon Europe, and dealt with important policy issues in the European Research Area, and which were focused on the intersection between RTI policy and sectoral policies.

Austria in Horizon 2020

In the period covered by this report, **Austrian RTI organisations reached a total of more than one billion euros in funding acquired from the European Commission, since the beginning of the Horizon 2020 programme in 2014**. This means Austria continues to show a positive return between the total funds acquired, and the imputed total of contributions made to the Horizon 2020 programme. Institutions and researchers based in Austria were involved in 8.82% of all 21,472 projects supported under Horizon 2020. It is particularly pleasing to note that Austria's success rate of 17.87% is significantly higher than the average success rate of 15.32% for Horizon 2020, ranking second amongst the Member States of European Union, behind Belgium. This reflects not only the high level of Austrian research, but also the excellent advisory, support and supervision structures whose professional operation – as confirmed by a recent evaluation – contributes to the successful results achieved in the context of Horizon 2020.

Overall, the **business enterprise sector is responsible for the largest proportion of Austrian participation in Horizon 2020** (38%). Almost two thirds of the firms involved are SMEs. Other main areas of participation are the higher education sector (28%) and non-university research (23%). The rest is spread amongst other institutions (such as funding agencies and other public institutions). In contrast to other European countries, the majority of funding al-

located to Austria from Horizon 2020 was under Pillar 3, "Societal challenges", where the business enterprise sector and non-university sector have been particularly successful, with above-average results. Areas of strength for Austria under Pillar 3, compared to other European countries, include the thematic clusters "Intelligent, environmentally friendly and integrated transport", and "Secure, clean and efficient energy". Within Pillar 2, "Industrial leadership", the thematic clusters "Materials", "ICT" and "Biotechnology" are recognised areas of strength.

Review of the RTI Strategy 2020

Austria has caught up over the last few years in the areas of research, technology and innovation – and this is partly due to the fact that RTI has increasingly become a focus of political interest. This interest is also reflected in the **RTI strategy** adopted by the federal government in 2011. This strategy was a **clear commitment of the Austrian government** to strengthening research, technology and innovation activities in all relevant sectors.

The RTI strategy provided a framework for all **objectives and measures** requiring funding, support, etc. In view of current developments, additional sub-strategies have also been formulated to support and promote certain selected aspects such as the establishment of new ventures or *Open Innovation*. Looking back, it can be stated that the RTI strategy – i.e. the coordinated course of action of policymakers and all other stakeholders in the innovation system – has succeeded. Most of the objectives have been achieved and a large number of measures have been implemented. The grand vision of the RTI strategy 2020, namely to position Austria as an *Innovation Leader* (in the European *Innovation Scoreboard*), was not fully achieved.

In recent years, Austria has made substantial progress in the scientific realm and in the private and public sector. The **RTI Task Force** – the inter-ministerial committee for coordinating the RTI strategy – has also played a key role in pooling and consolidating resources. The task force was set up with the objective of improving coordination between the various ministries responsible for RTI programmes and policies (currently this is the Federal Ministry of Education, Science and Research (BMBWF), the Federal Ministry for Digital and Economic Affairs (BMDW) and the Federal Ministry for Transport, Innovation and Technology (BMVIT)), with additional involvement of the Federal Chancellery (BKA) and the Federal Ministry of Finance (BMF). The *RTI Task Force* has now been commissioned by the federal government to draw up the new "RTI Strategy 2030". For the future, the main focus will be on continuously pursuing and further developing previous efforts - from the perspective of an overall systemic viewpoint - and adapting them accordingly to changed (or new) framework conditions.

In addition, it is crucial that the *policy mix* in Austria remains well coordinated in future – between *bottom-up* and *top-down* and between direct and indirect research funding. Also, as stated by the OECD and the Austrian Council for Research and Technology Development (RFTE), greater efficiency should be sought (in the sense of improving the ratio of input to output). In fact, Austria today has the second-highest research intensity in Europe, but with some output indicators, Austria is still in the midfield. Linked with the question of societal impact, discussions relating to output are taking on a new dimension once again, although this also means that the debate on this issue in future must be more wide-ranging than has previously been the case.

One of the priority objectives is also to strengthen basic research. To this end, the RTI strategy has defined a number of objectives, including a reform of the model for university financing (under the heading of "capacity-oriented university financing"), and increased acquisition of competitive funding, both of which were regarded as central to raising the overall amount invested in basic research. The expansion of third-party funding was embedded into the Austrian National Development Plan for Public Universities, so that universities were also required to develop and define their own strategies for third-party funding.

To ensure sustainability, this objective has also been incorporated into the university development plans for the period to 2024. Furthermore, performance agreements have been concluded with the Austrian Academy of Sciences, and the Institute of Science and Technology Austria (IST Austria). These measures are designed to strengthen basic research in Austria; research funding at higher education institutions is also expected to be more oriented towards competitive funding in future.

Another important aspect of Austria's RTI policies involves the goal of continuously improving and /or adapting the *governance* system. The OECD has made several recommendations in this regard as well, and a new RTI advisory panel will also be set up for the federal government in the near future. Plans also call for *governance* structures in the Austrian research system to be reviewed and optimised through provisions, including also a new *Research Funding Act* , which gives the funding agencies more autonomy in their operational activities.

Digitalisation in the public sector

Digital infrastructures, products and services lead to fundamental changes in our economy, science, society and politics. In particular, technological change and innovation processes are substantially accelerated by digitalisation. The government programme for the years 2017-2022 recognised the **great importance of digitalisation**, with the establishment of a "Digitalisation Agency" to support digitalisation initiatives. A "Chief Digital Officer" (CDO) has been nominated in every federal ministry to take responsibility for digitalisation issues. These CDOs are now developing a unified data strategy for the federal government, amongst other things. A unified strategy will enable citizens' data to be stored securely, and used in accordance with the "once-only" principle, as well as allowing high-quality data to be made available for big data evaluations, predictive analytics and artificial intelligence applications. These and other measures and initiatives have been contributing factors to an increasingly dynamic progress in the implementation of measures set out in the *Digital Roadmap*.

The diffusion of innovative technologies

For the application of innovative technologies, a **modern and efficient digital infrastructure** is extremely important. *5G* will create the basic infrastructure needed for many downstream industries and services; for applications such as Industry 4.0, autonomous vehicles, the extensive use of big data and artificial intelligence (AI) and the Internet of Things, a high-performance IT infrastructure is essential. Consequently, 5G has the potential to function as a disruptive factor in digitalisation, and to ensure further acceleration of the digital transformation processes. With its national *5G strategy* the Austrian federal government has defined a specific work programme for the central fields of activity, together with a schedule, to facilitate upgrading to 5G standard throughout Austria as rapidly as possible.

AI and robotics are areas of future thinking that are growing constantly in significance, and which will result in lasting changes to industry. For this reason the "Austrian Council for Robotics and Artificial Intelligence", which was set up by the Federal Ministry for Transport, Innovation and Technology (BMVIT) in 2017, presented a white paper in November 2018, titled "Shaping a positive future for Austria with robotics and artificial intelligence". This describes the current status of developments, the opportunities and challenges, spheres of activity and recommendations for future action in the field of AI.

Currently no more than 13% of all businesses in Austria actually use AI applications; 29% are only now in the process of developing them. To achieve a broad-based consensus for the use of AI in Austria, it is essential to involve civil society in the process of formulating the strategy, together with as many stakeholders as possible from industry and research institutions; this will ensure that Austria is successful in the competitive arena of AI technology, while also upholding the rights of individuals and of society as

a whole. To this end, the Federal Ministry for Transport, Innovation and Technology (BMVIT) and the Federal Ministry for Digital and Economic Affairs (BMDW) have together developed a preparatory paper, titled "Artificial Intelligence Mission Austria 2030", as the basis for a complete and comprehensive strategy, to be drafted during the course of 2019.

A digital competence framework for Austria

The digital transformation also affects the way work is structured, and the requirements for employee qualification profiles are changing. Digitalisation does not necessarily mean that a high level of formal qualification is needed, but it does demand that **employees have the necessary skills to fulfil these future digital requirements**. Funding for ongoing continuing education, particularly for supporting digital learning, and equipping schools with the appropriate digital infrastructure, is therefore essential to ensuring that targeted support for the digital transformation in Austria also extends to education and training.

The "Digital dossier 2018", published by the Federal Ministry for Digital and Economic Affairs (BMDW), maps the current status of digitalisation in Austria. It includes the "Pact for digital competence", as a cooperation between industry, educational institutions and public administrative bodies, with various sub-programmes. With the comprehensive "**Master plan for digitalisation in education**" drawn up by the Federal Ministry of Education, Science and Research (BMBWF), digital training will be gradually and comprehensively extended into the Austrian education system.

The Federal Ministry for Digital and Economic Affairs (BMDW) has also developed a digital competence framework for Austria, **DigComp 2.2 AT**, with the aim of alignment and comparability of digital skills, providing the basis for lifelong learning, social inclusion and employment in a digitalised society. On the initiative of the Federal Ministry for Digital and Economic Affairs (BMDW), the association "fit4internet" was founded in December 2018, as a platform – in cooperation with firms, institutions and organisations – with the aim of increasing digital skills in Austria, and ensuring that all areas of society are able to participate in the digital transformation.

Culture and practice of evaluation

Evaluations are an **indispensable part of an intelligent, strategically oriented RTI policy**, providing opportunities to reflect, assess and further develop measures, instruments and practices in RTI policy. The practice of evaluations in Austria's RTI sector was positively assessed in an OECD review. During the reporting period, several evaluations were conducted, including a number of major ones. These include an evaluation of the implementation of Horizon 2020, EUREKA, COSME, EEN and ERA in Austria, evaluation of the Frontrunner Initiative, evaluation of the "FIT-IT" and "ICT of the future" programmes, to name just a few. The findings have been reflected in the formulation of measures and in policy development. One example is the evaluation of the implementation of Horizon 2020, EUREKA, COSME, EEN and ERA in Austria, which provides important evidence for the realignment and adaptation of the requirements which will be made of a future advisory, support and supervision structure for Horizon Europe, the forthcoming European research framework programme .

The further development of the Austrian RTI evaluation culture is also manifest in the **new edition of the Austrian evaluation standards for the field of RTI**, which has been adopted by the Austrian Platform for Research and Technology Policy Evaluation. These standards serve to provide commissioning institutions, evaluators, and those affected by evaluations, with a framework for behaviour and instructions on how "good" evaluations should be planned, managed, performed and used. New features pertain, among other things, to a greater emphasis on the gender dimension in RTI policy evaluation processes, the obligatory publishing of evaluation reports, sug-

gesting the introduction of a management response system, as well as numerous ethical and procedural suggestions, particularly with reference to the formulation of *terms of reference*, with the aim of implementing an evaluation process that is as efficient, transparent and effective as possible.

One structural weakness of the Austrian evaluation system, which was also pointed out explicitly in the OECD review, is the limited availability, accessibility and interconnectivity of statistical data in public offices. The Platform for Registry Data Research established in 2018 aims to ensure that academic researchers have easier access to data in public registers. There are still a number of related challenges, however, such as the review of the Federal Statistics Act (Bundesstatistikgesetz), and the regulations to be agreed between the Federal Ministry for Education, Science and Research and the ministries responsible for the relevant registers with respect to individual data holdings, which still need an overall solution on legislative, procedural and instrumental levels.

1. Current Trends

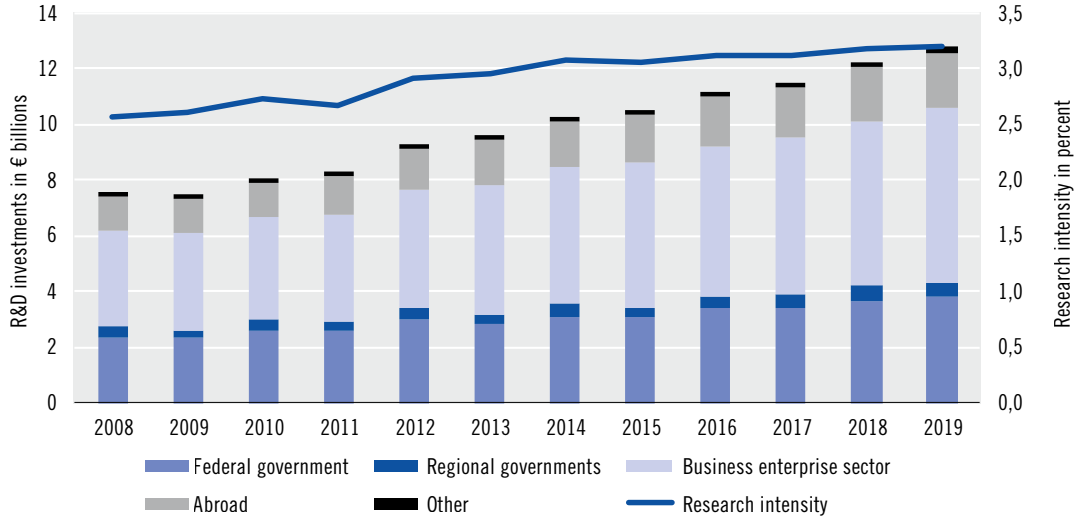
1.1 Funding and R&D performance in Austria

As of April 2019, Statistics Austria is expecting an additional increase in Austrian R&D investments in 2019, both in relative and absolute terms. According to their forecast, €12.8 billion will be spent on research and experimental development in 2019. This corresponds to a research intensity (R&D expenditures as a percentage of GDP) of 3.19%. As the 2018 research intensity was 3.17%, this entails an increase of 0.02 percentage points.[1]

Fig. 1-1 illustrates the development of R&D investments since 2008. The columns depict absolute expenditures at their respective prices; they are divided according to the source of funding, and the solid line represents research intensity. Austria achieved the 3% target defined by the EU for the first time in 2014. In subsequent years, its research intensity continues to be greater than 3%, with a tendency of the value to increase. In the observation period 2008-2019 depicted here, R&D investments have increased nominally by 69.6%; Austria's GDP, however, only increased by 36.4%. Hence, the growth of R&D investments took place over 90% faster than economic growth overall. This shows that Austrian industry is becoming more research-intensive.

In 2019 the public sector will account for over one third of all R&D research funding in Austria, with nearly 35% of the total (Federal government: 33.9%, Regional governments: 4.3%, Other public funding: 1.0%). This is the fourth-lowest value in the 2009-2019 observation period, with the trend decreasing overall. 15.6% of R&D funding in 2019 will come from outside Austria; the majority of this sum comprises financing from foreign enterprises for research being carried out in their subsidiaries in Austria, but it also includes funds from EU research programmes. At a

Fig. 1-1: Funding of research and experimental development carried out in Austria and research intensity, 2008–2019



Source: Statistics Austria, Global Estimate as at 11 April 2019. Graphic: WPZ Research; the category "Other" combines the two categories "Other public funding" and "Private non-profit sector".

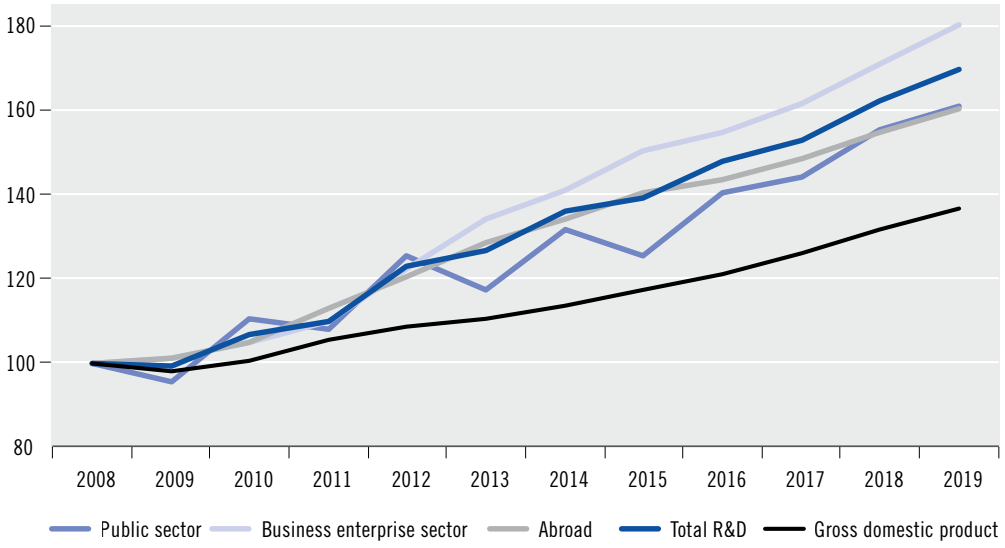
1 Information based on the Statistics Austria press release no. 12.001-067/19. It is noted that the research intensity for 2018 was expected to be 3.19% according to the 2018 Austrian Research and Technology Report. However, this figure was adjusted to 3.17% as of April 2019.

total of 48.96%, Austrian firms will have financed almost half of all R&D – the second highest value, after 2015 (49.74%), in the observation period. The private non-profit sector (private non-profit institutions whose status is predominantly private or under civil law, sectarian, or other non-public) continues to play a relatively minor role in Austrian R&D funding at an anticipated level of 1.0% of total R&D expenditure.[2]

In 2017, the year for which the most current data is available for Member States, Austria placed second within the EU, with a research intensity of 3.16%, behind Sweden (3.40%). In 2015 Austria outranked Denmark, which continues to remain in third place (value for 2017: 3.05%).[3] The only other country within the EU that met its three-percent target in 2017 was Germany, with a research intensity of 3.02%. It is not only interesting that Austria is among the top-ranking countries, but also that, compared to the following Member States, the distance between them is quite large: Finland's research intensity (tendency decreasing) ranks fifth at 2.76%, while Belgium placed sixth with a research intensity of 2.58%. The last country to achieve a research intensity greater than two percent was France, with 2.19%. All other Member States - including Great Britain, Luxembourg and the Netherlands, designated by the European Commission as Innovation Leaders - had a research intensity in 2017 that was less than 2%.

Fig. 1-2 depicts the development of funding percentages, categorised according to the Public sector (i.e. the federal government, regional governments and other in Fig. 1-1), the Business enterprise sector and Abroad. This development is then compared to the development of R&D investments overall as well as GDP. As is the case in Fig. 1-1, the values correspond to the prices depicted. In other words, it is not possible to draw conclusions with regard to real development. However, the index does allow to com-

Fig. 1-2: Development of funding for research and experimental development carried out in Austria, 2008–2019 (index, 2008=100)



Source: Statistics Austria, Global Estimate as at 11 April 2019. Calculation and graphic: WPZ Research; the category "public sector" contains the categories "federal government", "regional governments", "other public funding" and "private non-profit sector".

2 For a more concise overview, the categories "Other public financing" and "PNP" have been classified as "Other" in Fig. 1-1.

3 Eurostat data, accessed on 11.04.2019; Austria's 3.16% deviates from the 3.11% which is based on the most current global estimates used for Fig. 1-1. This is because Eurostat's data has not been updated accordingly.

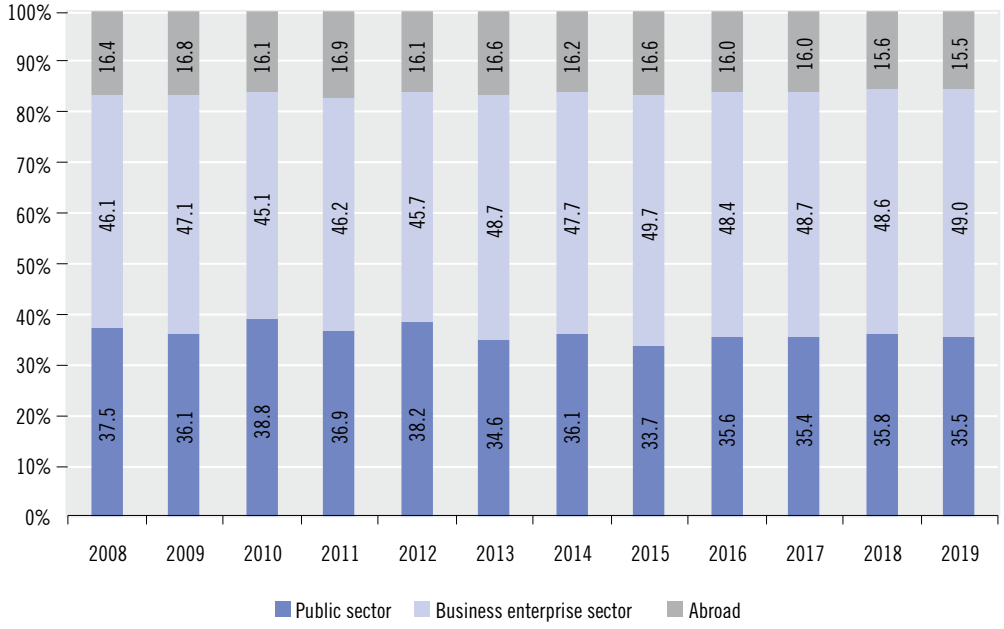
pare development trends: when a category deviates from the sum of R&D investments, either increasingly or decreasingly, this development reveals whether funding contributions increase or decrease.

Indeed, for the observation period depicted in Fig. 1-2, 2008-2019, the only line which exceeds the total sum of R&D investments is that of the business enterprise sector. This means that during this period, firms made an exceptionally high contribution to growth, and hence they ensured that Austria met the three-percent target. As noted above, the category "Abroad" mostly comprises funding from firms. Therefore, it is not firms as a whole; rather, it is *Austrian firms* which have been funding most R&D conducted in Austria, at least since 2012. By contrast, the percentage of funding from the public sector has continued to decrease ever since. However, it is noteworthy that this refers to the Austrian public sector, i.e. it is the percentage of funding from the EU, in particular, which is included in the category "Abroad".

In Fig. 1-3, the percentages of the following three categories are depicted separately for each year (categories defined as in Fig. 1-2): Public sector, Business enterprise sector and Abroad. It becomes particularly clear how the contributions of Austrian firms steadily increased during the observation period. In 2008, it was at 46.1%; in 2019, it is predicted to increase to 49%. This amounts to a *percentage growth* of 6.2% during the observation period. However, it should also be noted that the growth of the business enterprise sector over the past ten years was even higher: in 1998, it accounted for 41.7% of funding. In 2008, this figure went up to 46.1%, which is a percentage growth of 10.5%. Additionally, with a percentage of 48.7%, funding in 2007 was almost at the same level as today.

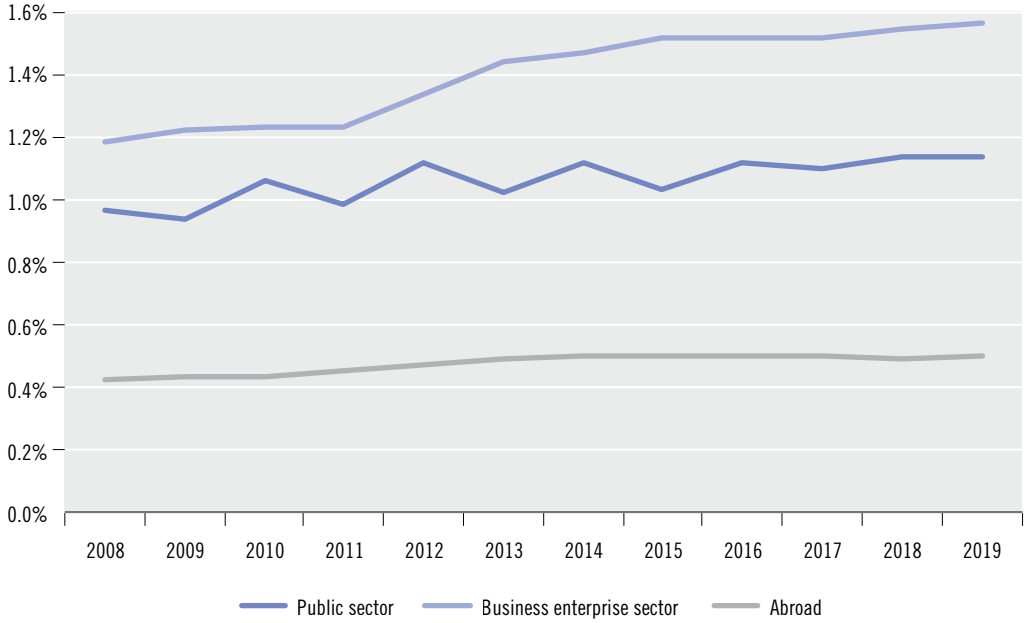
Owing to the strong increase in research intensity and the simultaneous percentage growth of the business enterprise sector with regard to R&D investments, there is nevertheless *a percentage of R&D as part of GDP whose funding by Austrian firms continues to increase significantly as a percentage*. This trend is explained in Fig. 1-4: The business enterprise sector increased its funding for research intensity by 1.18 percentage points in 2008 to 1.56 percentage points predicted for 2019. This corresponds to a per-

Fig. 1-3: Share of funding for research and experimental development carried out in Austria, 2008–2019



Source: Statistics Austria, Global Estimate as at 11 April 2019. Calculation and graphic: WPZ Research; the category "public sector" contains the categories "federal government", "regional governments", "other public funding" and "private non-profit sector".

Fig. 1-4: Research intensity in Austria by type of funding, 2008–2019



Source: Statistics Austria, Global Estimate as at 11 April 2019, Calculation and graphic: WPZ Research; the category "public sector" contains the categories "federal government", "regional governments", "other public funding" and "private non-profit sector".

centage growth of 32%. Although funding from the public sector and abroad have also increased, at 17.8% and 17.6% respectively, this growth is much slower. This indicates that Austria is on the path towards an innovation system which is self-sustainable through privately funded R&D and which can also be characterised as successful, since funding research and experimental development in Austria is becoming more and more appealing. In other words: if, in relation to GDP, the R&D investments of Austrian firms in 2019 were to amount to the 1.18% measured in 2008, rather than 1.56%, then gross domestic expenditures for R&D in 2019 would be €1.52 billion less.

Fig. 1-5 provides an overview of OECD countries in 2016, both with regard to R&D intensity and funding percentages. Sweden's research intensity (3.27%) as the top Member State within the EU is surpassed by that of South Korea (4.23%), Israel (4.39%) and Switzerland (2015: 3.37%). Among OECD countries, Austria ranks sixth (3.13%), behind Japan (3.14%). Fig. 1-5 also shows that the percentage of funding from Austria's public sector (including "Other national funding sources") is slightly below the OECD's weighted average of 31.29%; in Austria it is 30.35%. The percentage of funding from abroad in Austria is 16.01%, which is much higher than the weighted OECD average of 6.63%. At 53.11%, the percentage of funding from (Austrian) firms is lower than the OECD average of 62.08%.

However, a more careful examination of the data shows that, in relation to research intensity, the percentage of funding from Austria's business enterprise sector is relatively low compared to the OECD average, while the percentage of funding from the public sector is high. The correlation coefficient for the percentage of funding from the public sector and the research intensity of the countries ranked by the OECD is -0.7. In other words, when a country's research intensity increases, the percentage of funding from the public sector decreases. Conversely, the correlation coefficient for the percentage of funding from the business enterprise sector and countries' research intensity is clearly positive at 0.6: the greater a country's research intensity is, the greater the percentage of funding from the business enterprise

sector is. These international findings align very well with the national findings in Figures 1-1, 1-2, 1-3 and 1-4. This is also true of Austria: when research intensity increases, the percentage of funding from Austrian businesses continues to increase: There is also a positive correlation between the percentage of funding from domestic firms and research intensity in Austria: for the 2002-2019 observation period it is 0.6; for the period of 2008-2019, which is depicted in Figures 1-1 to 1-4, it is even higher, at 0.8.

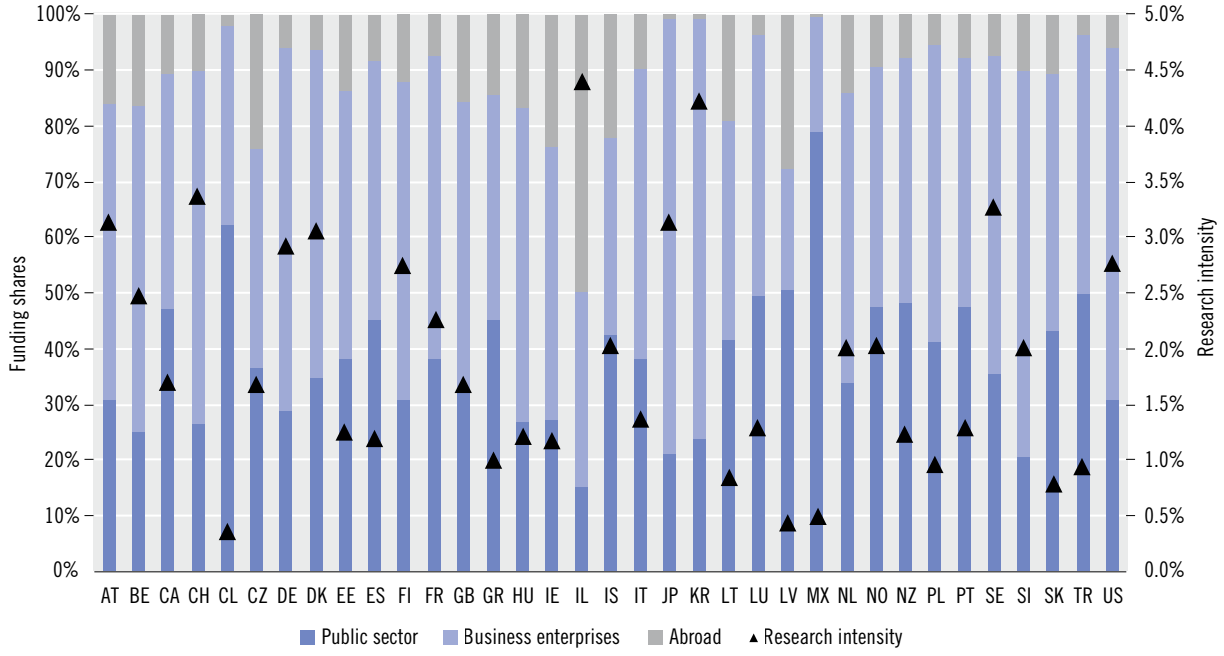
In sum, it can be concluded that Austria's research intensity is growing at a greater rate than the economy as a whole. In addition, Austrian businesses account for an even greater percentage of funding for R&D conducted in Austria. Austria already has one of the highest research intensities globally; however, the percentage of funding for R&D from Austrian firms is comparatively low by international standards.. This is why it is even more important that this percentage continues to grow, so Austria can establish itself as a global leader for research.

Development of R&D investments in 2019 compared to last year

The current global estimate by Statistics Austria, published in April 2019, predicts total expenditure on R&D in 2019 at €12.8 billion – 4.5% over the total for 2018 (€12.2 billion). Estimated R&D intensity is expected to total 3.19% for 2019, which constitutes a slight increase in comparison to last year (2018: 3.17%, revised value in comparison to the global estimate for 2018). This would place Austria above the European target value of 3% for the sixth consecutive year.

Federal and state funding together, with an anticipated total of €4.3 billion in 2019, is expected to make up 33.9% of the financing for all R&D conducted in Austria. While this is €148.4 million more than in the previous year, the proportion of funding from federal and state sources will fall slightly (2018: 34.2%). The largest proportion of public investment in R&D, at an anticipated total

Fig. 1-5: Research intensity and funding in OECD countries, 2017



Source: OECD, Main Science and Technology Indicators, retrieved 11 April 2019; calculation and presentation: WPZ Research; the category "Public sector" contains the categories "government" and "other national sources", no funding data available for Australia a; data for Belgium, Denmark, France, Luxembourg, New Zealand, Sweden and Switzerland for 2015; country code ISO-3166-1.

of €3.8 billion (+ 3.4% or + €123.4 million) will be contributed by the federal government. This also includes investments of €138.7 million for the National Foundation for Research, Technology and Development and €670.0 million (as estimated by the Federal Ministry of Finance (BMF) in April 2019) for the research tax premium.

With a total of €6.3 billion for 2019, or 48.96%, Austrian businesses will have provided almost half of all R&D funding. Austrian firms provide an increasing share of the funding for R&D conducted in this country. In comparison to the previous year, investments rose by €314.1 million, or 5.3%.

€2 billion or 15.6% of R&D funding in 2019 will come from outside Austria; the majority of this sum comprises financing from foreign firms for research being carried out in Austria, but it also includes funds from EU research programmes. This translates into a slight increase of €76.8 million or 4%. The proportion attributable to "Other" includes other public financing and the private non-profit sector (non-profit institutions whose status is predominantly private, or subject to civil law, or denominational or other non-public bodies), and remains low with projections of 1.0% and 0.6% respectively.

1.2 Austria's position in international comparisons

This chapter looks at Austria's position in research, technology and innovation in an international comparison. The analysis comprises three steps: Firstly, indicators on current input and output are used to compare current research and development performance across countries. Secondly, Austria's position with regard to digital penetration in the economy and society is considered. With an ever-increasing digital transformation, these indicators reveal the extent to which national economies and societies are prepared for a working environment that is increasingly digital. Thirdly, various aspects and indicators, which allow to draw conclusions on Austria's capacity for innovation, will be reviewed.

The indicators used are based on the following sources of data[4]:

- **Global Innovation Index 2018**[5]: A total of 80 indicators for 126 countries have been used to compile the Global Innovation Index (GII). With 80 indicators, a ranking list of all examined countries is published which shows the innovative capacity of individual countries. The ranking is published annually by the French business school INSEAD, Cornell University and the United Nations' World International Property Organization (WIPO). This analysis examines the total index as well as information on the use and the access to information and communication technologies.
- **Global Competitiveness Report 2018**[6]: The Global Competitiveness Report (GCR) analyses 140 national economies and compiles a ranking index of the economies with the greatest growth opportunities. This report is published by the World Economic Forum (WEF). The classification is based on the evaluation of publicly available primary data and surveys of business leaders. This study examines the overall index as well as information on human capital and the ability to translate technological developments into innovation.
- **Readiness for the Future of Production Report 2018:** The World Economic Forum's Readiness for the Future of Production Report[7] is a comparative analysis of 100 countries. The publication uses 59 indicators to analyse the basis of production; it also

4 Note: This report does not address the European Innovation Scoreboard as no new data have been available since the previous FTB published in 2018.

5 See https://www.globalinnovationindex.org/Home, last review on 15.01.2019

6 See http://www3.weforum.org/docs/GCR2018/05FullReport/TheGlobalCompetitivenessReport2018.pdf, last reviewed on 2 May 2019

7 See http://www3.weforum.org/docs/FOP_Readiness_Report_2018.pdf, last reviewed on 15.01.2019

conducts a comparative analysis on key technologies and countries' abilities to use them as well as their abilities to transform production systems.

- **OECD – Main Science and Technology Indicators:** The Organisation for Economic Cooperation and Development (OECD) publishes important indicators on a wide range[8] of topics in its database, including industry, education, energy, transport as well as research and development. The database contains data for every OECD country, supplemented with the respective OECD total value. Information from the euro area and the European Union as well as data from Brazil, China, India, Indonesia, the Russian Federation and South Africa, is available too. In particular, this report makes use of data on expenditures in research and development as well as R&D staff.
- **Digital Economy and Society Index (DESI) Report 2018[9]:** In this report the European Commission informs about the findings of the 2018 Digital Economy and Society Index (DESI). It examines the Member States' progress with regard to internet access, the use of digital competences, the digitalisation of firms and digital public services. Individual sub-indicators are assigned to five main categories, with the five indicators in each category being evaluated.
- **Innovation Indicator:** The Innovation Indicator was compiled by the Fraunhofer Institute for System and Innovation Research (ISI) and the Leibnitz Centre for European Economic Research GmbH Mannheim (ZEW) on behalf of the Federation of German Industries (BDI).[10] This composite indicator for the measurement of national innovation potential consists of 38 input and output indicators. In turn, they are divided into the following five sub-indicators: education, research, industry, government and society.[11]

This chapter will evaluate the following indicators on a comparative basis within the 28 EU nations. In addition, provided that comparable data on each of the indicators is available, the following nations will serve as reference countries: Switzerland, South Africa, the US, China, Singapore, Brazil and Australia. The last countries on the list are representative of their continents, as they are the largest economies in terms of gross value added. This selection makes it possible to compare Austria's industrial and innovation policies with those of countries that are global key players by analysing a variety of aspects.

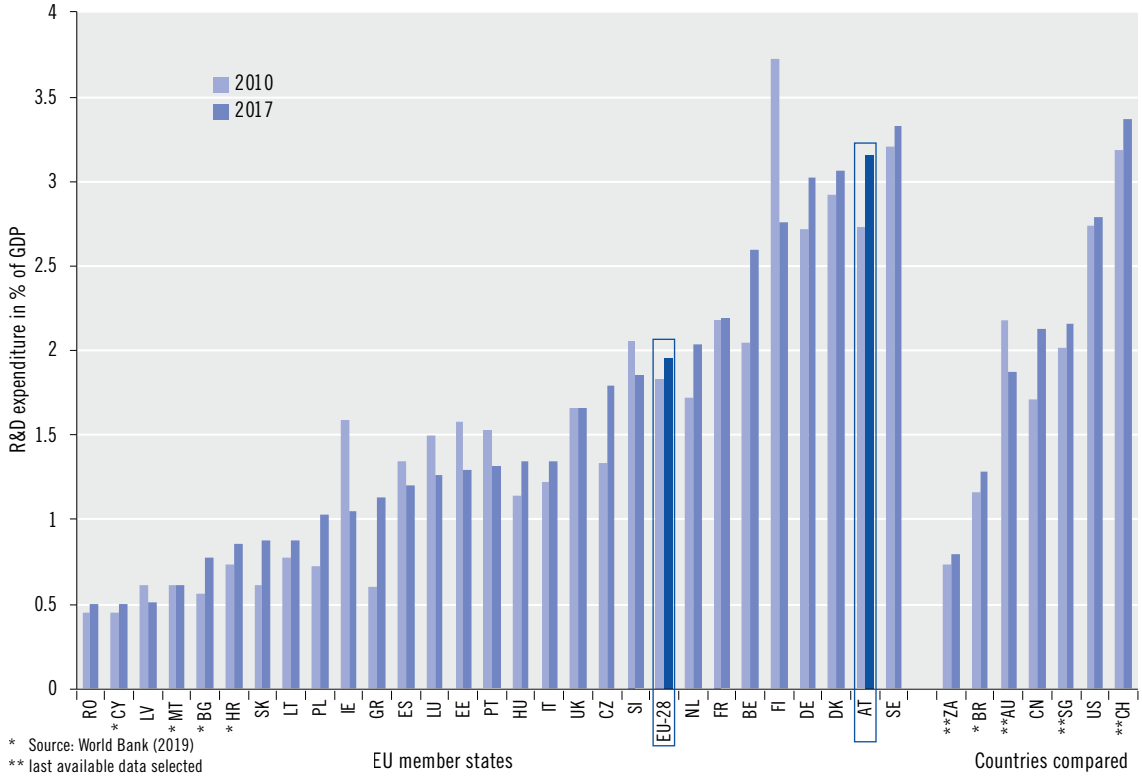
The remainder of the chapter is structured as follows: Section 1.3.1 examines indicators on input and output in research and technology to evaluate Austria's current status. Section 1.3.2 takes a look at explicit indicators on digital industry, as the use of digital technology is of particular importance to competitiveness in the future, both domestically and internationally. Finally, Section 1.3.3 reviews indicators on countries' capacity for innovation, whereby the German Institute for Innovation and Technology's methodology used to create the Capacity for Innovation Indicators [12] has been adapted.

1.2.1 Development of Austria's position in terms of the key performance RTI indicators

This section illustrates Austria's performance in an international comparison using various key indicators in research, technology and innovation. It begins with a selection of classic indicators on input and output of the RTI system in an international comparison. As mentioned above, the analysis of the individual indicators is, as a rule, based on a comparison of the 28 EU nations as well as the following countries: China and Singapore for Asia, Brazil and the USA as

8 See http://stats.oecd.org/, last reviewed on 15.01.2019
9 See https://ec.europa.eu/digital-single-market/en/desi, last reviewed on 15.01.2019
10 Aside from the BDI, the Innovation Indicator was also previously compiled for the German National Academy of Science and Engineering (Acatech) and for the Deutsche Telekom.
11 See http://www.innovationsindikator.de/, last reviewed on 15.01.2019
12 See https://www.iit-berlin.de/de/indikator/laenderanalyse, last reviewed on 25.01.2019

Fig. 1-6: R&D intensity in Austria in an international comparison, 2010 and 2017



Source: OECD (2018b): MSTI, supplemented with data from the World Bank (2019).

well as South Africa and Australia as relevant, dynamically innovative representatives of their continents. Additionally, Switzerland is included as another important player among the global nations of research and innovation.

Fig. 1-6 provides an overview of the development of Austria's R&D intensity in international comparison, i.e. national expenditures for research and development measured as part of GDP in accordance with the OECD – Main Science and Technology Indicators. R&D intensity (Gross Expenditure for Research and Development – GERD as a percentage of gross domestic product (GDP)) is a key indicator for the description of a nation's R&D activities within a defined period (usually a calendar year) and comprises all expenditures for R&D in a national economy. Therefore, R&D intensity also includes funds spent in Austria that were provided by other states. R&D intensity is the most important indicator for an international comparison of R&D activities.[13]

In 2017, Austria's R&D intensity increased significantly in relation to 2010, the year chosen for comparison; it increased from 2.73% to 3.16%[14]. Hence Austria's R&D intensity ranks second within the 28 EU Member States, behind Sweden, whose intensity increased again from 3.21% in 2010 to 3.33% in 2017. While the average, proportional R&D expenditures of the EU-28, measured last at 1.96% (2017), are comparable to those of nations boasting considerable investment power such as China (2.13%) or Singapore

13 See OECD (2015).

14 See OECD Main Science and Technology Indicators, https://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB, last reviewed on 01.03.2019. This OECD figure is slightly different than that calculated by Eurostat (3.13% was calculated for Austria in 2016) and Statistics Austria's global estimate (2016: 3.15%).

(2.16%), Austria already surpassed this level years ago. With its R&D intensity comparable to that of the USA (2.74%) in 2010, in 2017 Austria's R&D intensity is much higher: the USA's R&D intensity nearly stagnated (with slight fluctuations) between 2010 and 2017. The leader among all reference countries in 2016 was Switzerland, with 3.37%.

Compared internationally as well as in terms of chronological development, Austria's R&D intensity is, overall, among those of the leading nations around the globe in view of intense financial engagement in R&D in relation to GDP.

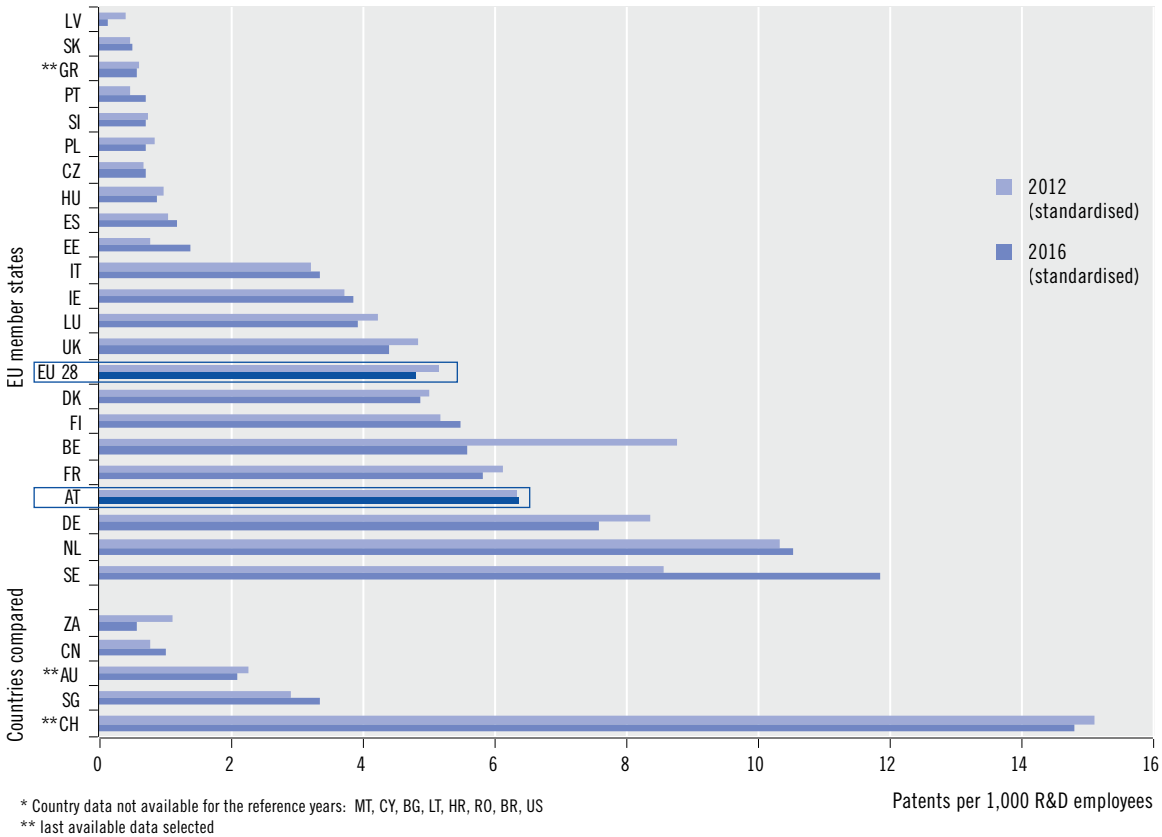
In 2017, the other nations in Europe with similarly high intensities aside from Austria and the EU leader Sweden (3.33%) were Denmark (3.06%), Germany (3.02%), Finland (2.76%) and Belgium (2.60%).

Patent applications

The OECD defines "triadic patents" as a series of patents which have been registered with the European Patent Authority (EPA), the Japanese Patent Organization (JPO) and the United States Patent and Trademark Organization (USPTO). This concept also makes international comparisons possible: Patents created in several countries serve as an indicator of the quality of inventions and, by extension, can be used to evaluate their innovation potential.

Fig. 1-7 depicts triadic patent intensity according to the country of origin for the years 2012 and 2016[15]. It appears as the number of patents per 1,000 employees in research and development. By concentrating on R&D staff, this shows the effectiveness of a

Fig. 1-7: Patent intensity according to the country of origin (triadic patents, 2012 and 2016)*



* Country data not available for the reference years: MT, CY, BG, LT, HR, RO, BR, US
** last available data selected

Source: OECD (2018b): MSTI.

15 For a consistent standard regarding the absolute number of triadic patents per country for the number of R&D staff, the values of the latter were calculated using a two-year interval for both comparison periods (2014 and 2010). This takes account of the usual amount of time needed to submit an application and register the patent.

country's scientific system with regard to its economic potential for application.

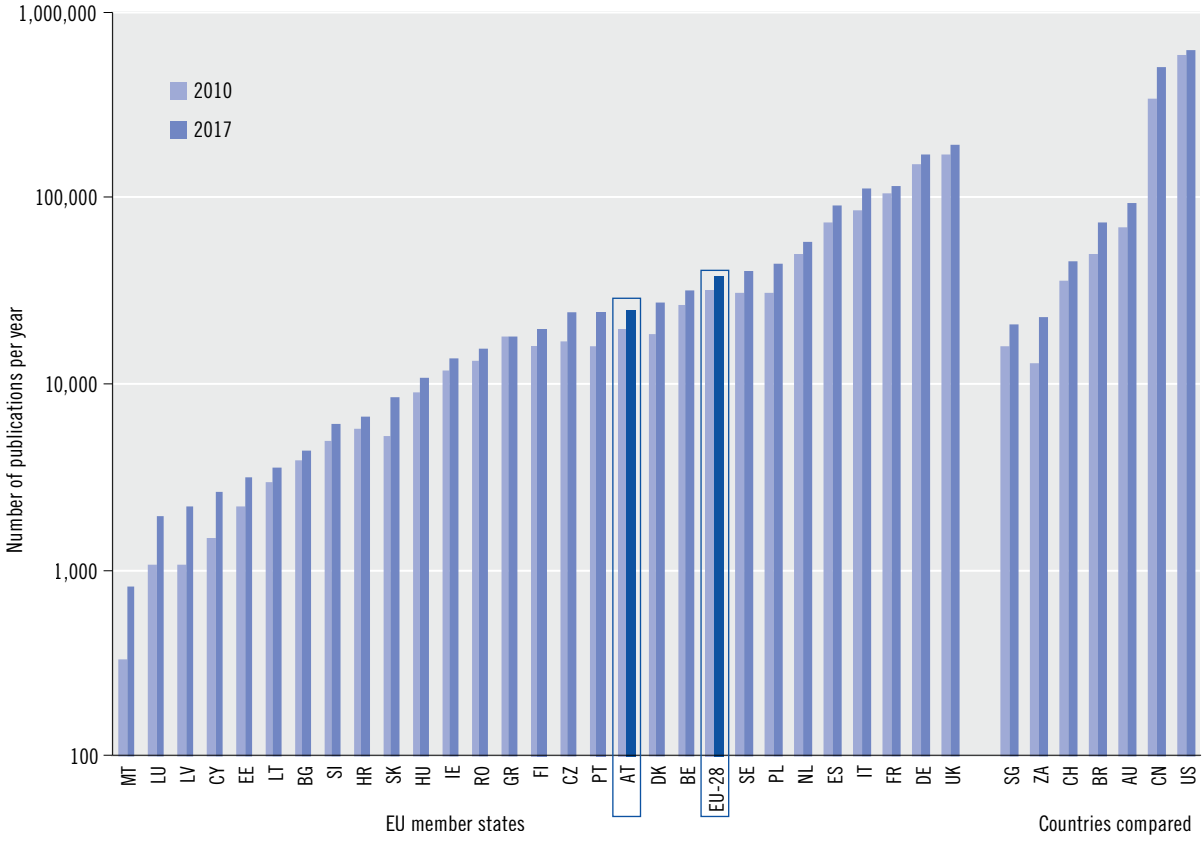
In 2012, Austria registered 6.3 patents per 1,000 employees in research and development. Four years later, the number of patents increased slightly to 6.4. Thus, Austria improved its patent intensity by moving from fifth to fourth place in the international ranking. Among the other leading countries in patent intensity, the picture is mixed: While the number of patents increased slightly in the Netherlands (from 10.3 to 10.5) and significantly in Sweden (from 8.6 to 11.8), the number of patents in Germany decreased from 8.4 to 7.6.

Austria's patent intensity is clearly above the EU-28 average, both in 2012 and in 2016. During this time period, it went down from 5.2 to 4.8. Austria clearly ranks highly, also when compared to the leading economies on other continents, whereas Singapore, for example, a country with a strong dynamic in all areas of innovation, is proportionally much weaker, with 3.6 patents per 1,000 R&D employees in 2016. The leader in this category is Switzerland again, with a most recent patent intensity of 14.8 per 1,000 employees in R&D in 2016.

Austria's international position in terms of scientific publications

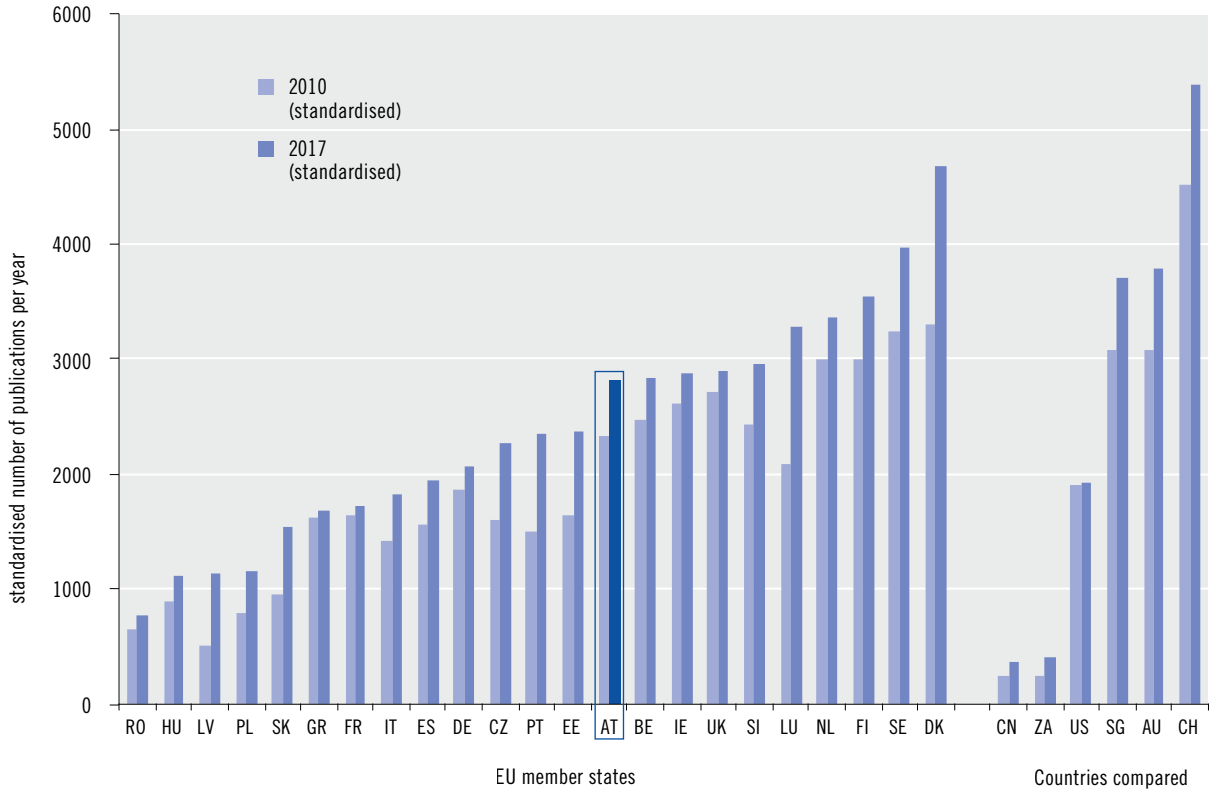
Other relevant indicators for the evaluation of scientific/technological performance are offered through the analysis of scientific publications. As a rule, the quantitative values are initially examined on a national level. It is usually active nations with larger populations, which obviously have the highest rankings.

Fig. 1-8: Number of articles in science and technology, 2010 and 2017



Source: SCImago (2018).

Fig. 1-9: Number of articles in science and technology standardised with country population, 2010 and 2017*



* Country data not available for the reference years: BG, BR, CY, HR, LT, MT, MT
Source: SCImago (2018).

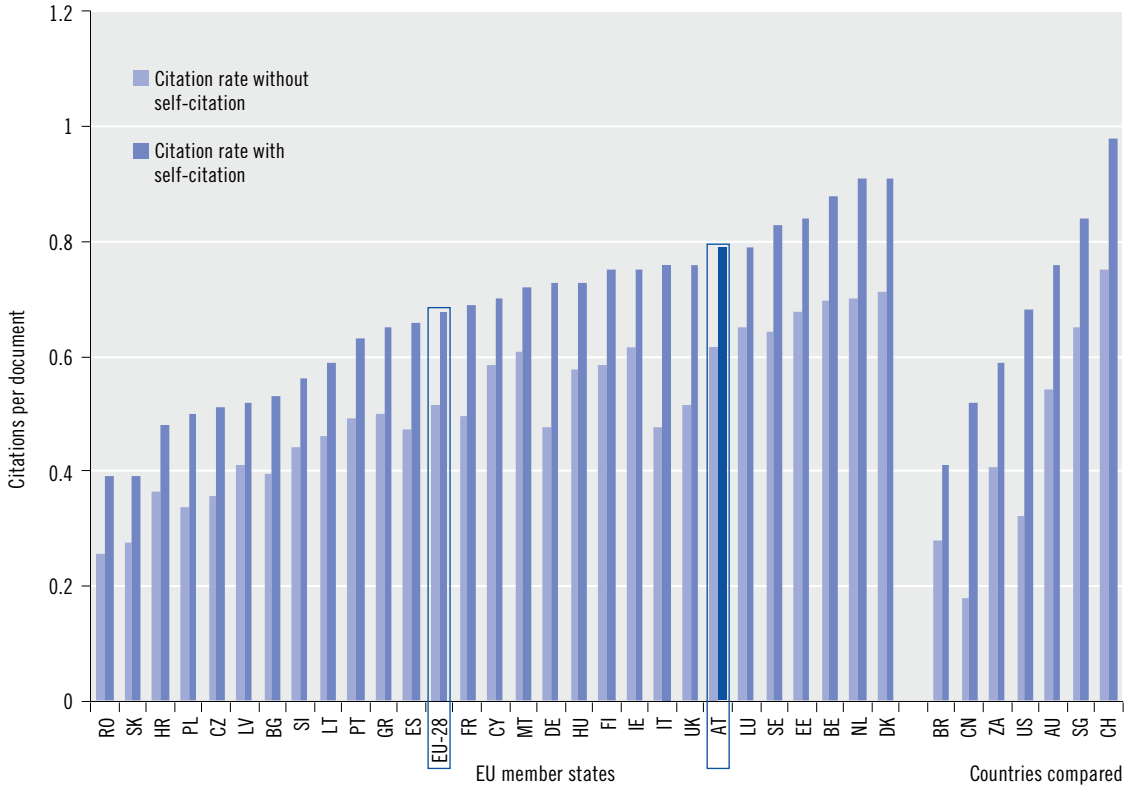
SCImago's[16] publication data offer the following picture: As usual, the USA ranked first in 2017, with the largest number of publications worldwide (and, by extension, it was also first among the reference countries), with 626,403 publications recorded. China placed second, with its number of publications in 2017 going up to a total of 508,654.

In view of the total number of scientific publications in 2017, Austria ranked in the middle as compared to the EU-28, placing 11th. As compared to the year 2010, every country's publication strength increased, which indicates a long-term international trend. Among the countries with a longstanding tradition of publications, such as the USA, UK, Germany or Austria, the increase in their publication numbers is lower compared to that of emerging markets, such as China or Brazil.

In addition, Austria's performance potential will be analysed through an international comparison of the number of scientific publications in relation to each country's national population (compared once again for 2017 and 2010). This standard does not change Austria's position when it is compared to other European nations. However, with regard to the absolute publication figures of the countries considered to be global leaders located outside the EU, in terms of their scientific output measured on a per-capita basis, it is lower overall. In this group of countries it is Switzerland which clearly stands out as a leader. The EU region's comparably high efficiency in this category becomes clear when viewed overall. This is also to be seen as a positive factor for Austria, which is part of the European Research Area (see Fig. 1-9). Nevertheless, it is the Northern European nations leading

16 SCImago Journal & Country Rank collects its data from the publisher Elsevier's Scopus publication database https://www.scimagojr.com/, last reviewed on 25.01.2019

Fig. 1-10: Citation rates with and without self-citations, 2017



Source: SCImago (2018).

this category, such as Denmark, Sweden or Finland, which serve as examples for additional potential for improvement.

Fig. 1-10, which is also based on Scopus data (via SCImago, see above), provides additional information on Austria's scientific performance as compared to that of other countries: By using the citation rate, the perception or further use of publications is regarded in bibliometry as an approach to a qualitatively deeper evaluation within publication analysis. However, since this indicator is not free of influence risks either, a rate of citations minus self citations by authors is compiled here in addition to the rate of all citations on all publications of a country. In particular, with the citation rate minus the number of self-citations, Austria's position is once again relatively strong, with a value of 0.61. It ranks eighth when compared to other European nations (2017). Among the reference countries, only Singapore is ahead of Austria with 0.65 for this performance indicator. Among the EU Member States and compared to the reference countries outside Europe, the leading countries are Denmark with 0.71, the Netherlands with 0.70 and Belgium with 0.69.

As an emerging nation of science and innovation, China has boasted an exceptional performance in terms of absolute publication figures over the past few years. Additionally, it has also made a great deal of progress in its general citation rate. However, its performance is weak with regard to the citation rate minus the number of self-citations (0.17 for 2017). When comparing its general citation rate of 0.68 for the year 2017, the USA, which as a rule is generally strong in terms of publication data, only had a rate of 0.32 when subtracting the number of self-citations.

This final indicator (citation rate minus self-citations) provides an in-depth publication analysis with a qualitative approach. It rounds off the impression

of Austria's international position in research, technology and innovation overall, to the extent that Austria's measurable scientific performance has not only continued to increase, but also that this positive trend perpetuates a sustainably qualitative development (2017 vs. 2010) in view of how it is perceived by the international scientific community (citation rate). However, Austria is only ranked in the upper midfield when examining all publication-related indicators. This shows that endeavours in this field ought to be continued and intensified so that it can be counted among the leading nations.

Austria's international position from the perspective of global innovation rankings

In order to classify Austria's position in an international comparison, the use of composite indicators, which bundle different individual indicators into one key figure, can provide additional insights. They make it possible to aggregate information and thus make it easier to compare global economies. Different composite indicators provide different approaches to the analysis of innovation potential, whereby they also tend to diverge in terms of results overall. Additionally, the selection and weighting of individual indicators and the countries compared may also influence their position within a ranking. For an in-depth overview of Austria's rank with regard to its innovation performance, the use of several composite indicators is the most logical approach. The most commonly used composite indicators within the scope of an international analysis are the Global Innovation Index (GII), the Global Competitiveness Index (GCI) and the Innovation Indicator (Fraunhofer ISI, ZEW).[17] Overall, the picture shows a consistently leading position for Austria in the first third of the countries or National Innovation Systems (NIS) analysed.

The Global Innovation Index (GII) is an innovation ranking index updated annually. It measures countries' innovation performance using various criteria, such as institutional setting, human capital and research, infrastructure, market and entrepreneurial development, knowledge, technological and creative output. 80 individual indicators are used to that end for 126 countries. Austria is placed 21st on the Global Innovation Index for 2018 (value: 51.32 out of 100), which is a slightly lower performance compared to 2017 (20th place). The five leading economies on the Global Innovation Index are Switzerland (68.4), the Netherlands (63.32), Sweden (63.08), Great Britain (60.13) and Singapore (59.83).

The Global Competitiveness Index (GCI) 2018 measures factors that promote long-term growth and prosperity for 140 economies. Competitiveness is defined as the totality of institutions, policies and factors that define a country's level of productivity. The GCI currently includes 98 indicators relevant to productivity and long-term prosperity. They examine criteria such as institutions, infrastructure, the macroeconomic environment, health, education, labour market efficiency, the development of financial markets, technological readiness, market size, business development and innovations. Austria has a front place at the Global Competitiveness Index for 2018 with rank

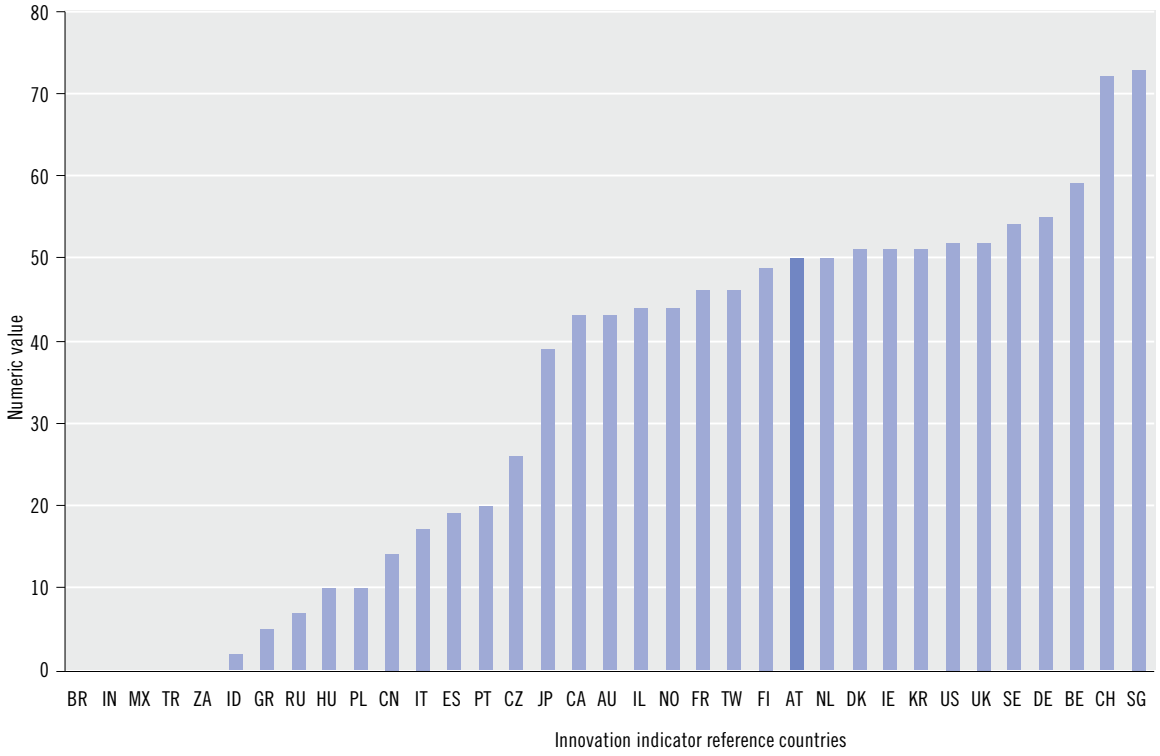
Table 1-1: International position of Austria based on relevant key performance indicators of innovation

Austria's position in international composite indicators	Global Competitiveness Report (GCR) 2018	Global Innovation Index (GII) 2018	Innovation Indicator
Value	76 (of 100)	51.32 (of 100)	50 (of 100)
Ranking	22	21	11
Number of countries	140	126	35
Number of individual indicators	98	80	38

Source: Presentation: iit; note: own presentation based on sources of GCR, GII, innovation indicator (see above).

17 As noted above, no current data on the European Innovation Scoreboard was available when writing the report.

Fig. 1-11: Innovation indicator "Total", 2017



Source: Innovation Indicator 2018.

22 out of 140 (value: 76 out of 100). The top five economies are the USA (value: 85.6), Singapore (83.5), Germany (82.8), Switzerland (82.6) and Japan (82.5).

The Innovation Indicator (Fraunhofer ISI, ZEW, see above) is an approach to innovation systems which combines classic or "hard" indicators of innovation such as R&D expenditures or research staffing with "soft" parameters (usually based on surveys about societal attitudes, for example) to draw a holistic picture of each innovation system. The Innovation Indicator uses a total of 38 input and output indicators classified under the following five sub-areas: industry, science, education, government and society. They are used to compare an international selection of 35 economies that have a strong innovation dynamic.

The most recent Innovation Indicator from 2017 places Austria eleventh, with 50 out of 100 points. The top-ranked country in 2017 was Singapore with 73 points. It is followed by Switzerland, which has led the innovation indicator for many years, with 72 points, and by Belgium (59 points) and Germany (55 points) with a larger margin. Austria ranked tenth in the previous year and ninth in 2015, suggesting a downward trend for the country in this innovation indicator.

The Innovation Indicator's "Science" sub-indicator ranked Austria ninth in 2017 (Singapore placed first, 99 points); it placed twelfth for the "Industry" sub-indicator and eleventh for the "Education" sub-indicator. In 2017 Austria was ranked 13th for the "Government" sub-indicator, with 49. By contrast, Singapore ranked first, achieving the maximum number of 100 points. In the sub-indicator "Society", Austria only reaches 14th place . The leaders in this category of the Innovation Indicator are Australia (82 points), Great Britain (80 points) and Finland (73 points)[18].

The Innovation Indicator's evaluation report comments on Austria's development as follows: *"It seems*

18 See http://www.innovationsindikator.de/mein-indikator/, last updated on 11.12.2018, last reviewed on 25.01.2019

as if the catching-up process of the past few years has stopped in Austria's case. (...) Austria and Germany have a similar structure with regard to the subsystems, as the ratings for all subsystems are respectable but not exceptional."[19] The analysis makes note of the increased efforts and, in particular, the investments Austria has made in R&D over the past few years. However, according to the Innovation Indicator Report 2018, output has so far lagged behind input from Austria (e.g. in patent values and publications or also in the field of innovation).

1.2.2 Development of Austria's position in terms of digitalisation

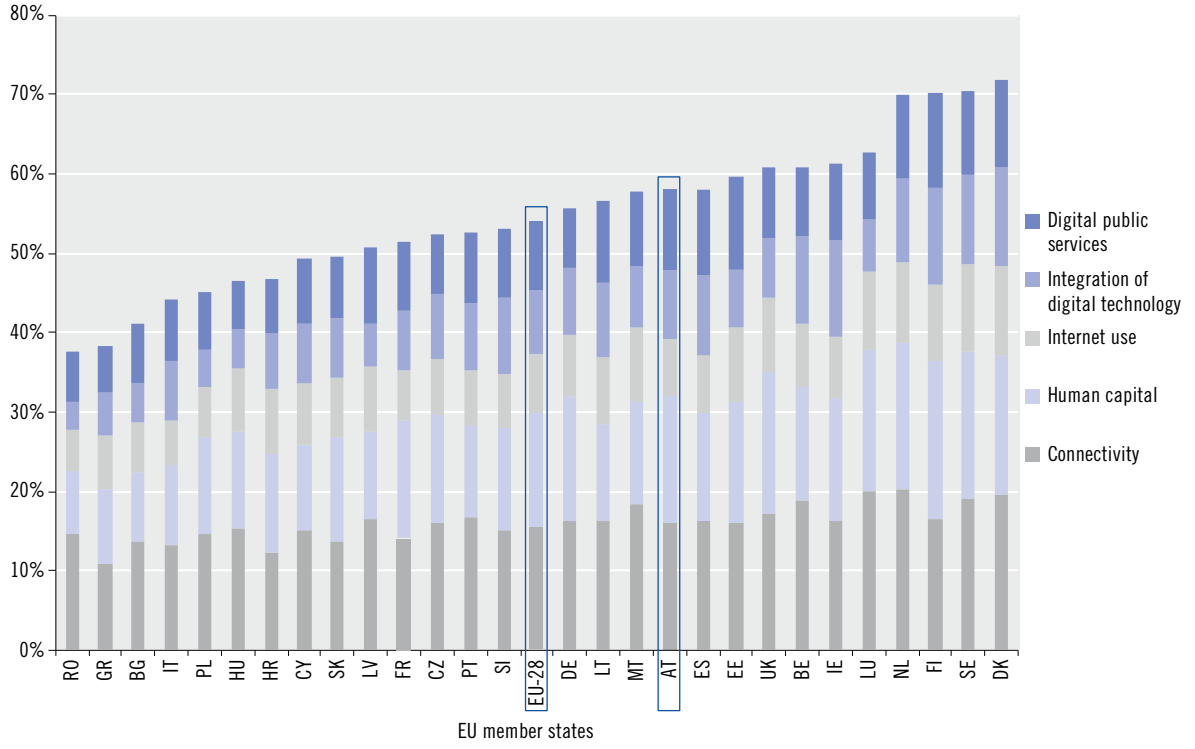
In order to rank Austria on an international scale in terms of digitalisation, the analysis uses information from the Digital Economy and Society Index (DESI) and the Global Innovation Index.

The European Commission's Digital Economy and Society Index (DESI)[20] offers information on how Austria places among the 28 EU Member States. This indicator takes five dimensions into account: Connectivity, Human Capital, Internet Use, Integration of Digital Technology and Digital Public Services. These five dimensions and their structure according to various sub-indicators are depicted in the box below. The maximum possible value on the index is 100% in total.

Digital Economy and Society Index (DESI) Indicators

- **Indicator 1: Connectivity**
  Connectivity is calculated as the weighted average of the following five sub-indicators: landline broadband (20%), mobile broadband (30%), fast broadband (20%), ultrafast broadband (20%) and prices (10%).

Fig. 1-12: Index for the digital economy and society (DESI, 2018)



Source: European Commission (2019b).

19 See Bundesverband der Deutschen Industrie e.V. (Federation of German Industries) (BDI) (2018), p. 6

20 See https://ec.europa.eu/digital-single-market/en/desi, last reviewed on 25.01.2019

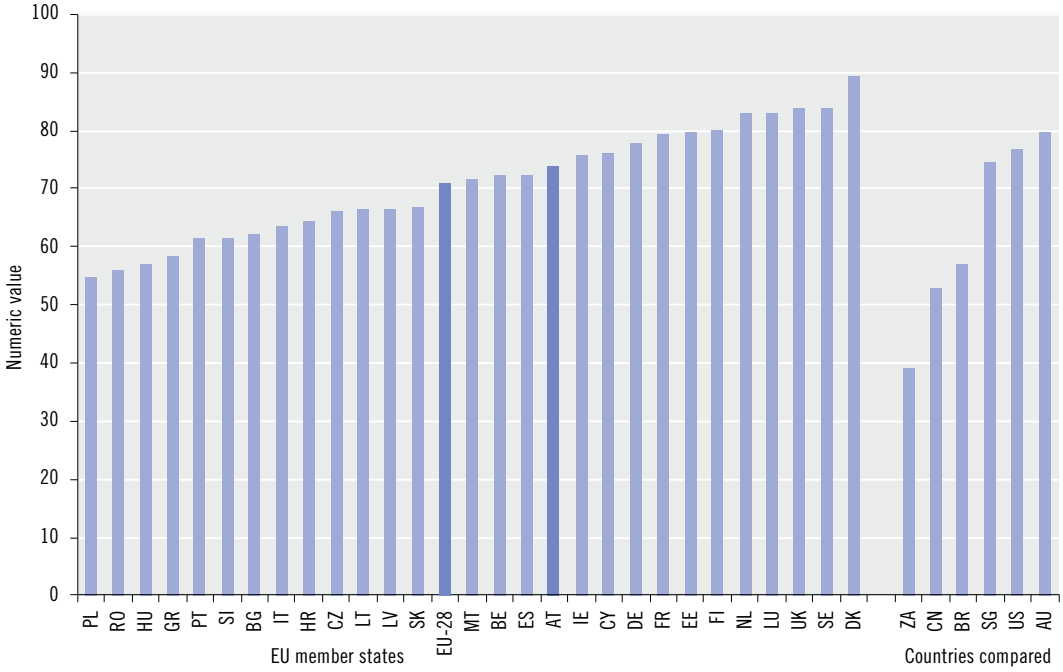
- **Indicator 2: Human capital**
  Human capital is calculated as the weighted average of two sub-indicators: Basic knowledge of internet use (50%) and advanced skills and development (50%).
- **Indicator 3: Internet use**
  Internet use is calculated as the weighted average of the following three sub-indicators: Use of content (33.3%), communication (33.3%) and online transactions by citizens (33.3%).
- **Indicator 4: Integration of digital technology**
  Integration of digital technology is calculated as the weighted average of two sub-indicators: The digitalisation of firms (60%) and e-commerce (40%).
- **Indicator 5: Digital public services**:
  This indicator comprises electronic government services (100%).

These five indicators make it possible to compare the EU 28 (see Fig. 1-12).

The findings show that Austria ranks eleventh when the countries are compared using the cumulative result of all five indicators. The leaders in this ranking are the northern European countries of Denmark, Sweden, Finland and the Netherlands. The difference in the index is minimal among these countries. The difference between Austria and these countries in this index is more than ten percentage points. The difference between Austria and Luxembourg, which placed fifth, is however very small. Nevertheless, it is noticeable that Austria ranks behind Belgium and Spain, among others; their GDP per capita is currently lower than Austria's. Additionally, this index shows that Austria is merely average when compared to the 28 EU countries in term of connectivity and the integration of digital technology. Hence the findings confirm that there is still further potential for development in the expansion of the internet and the integration of digital technology.

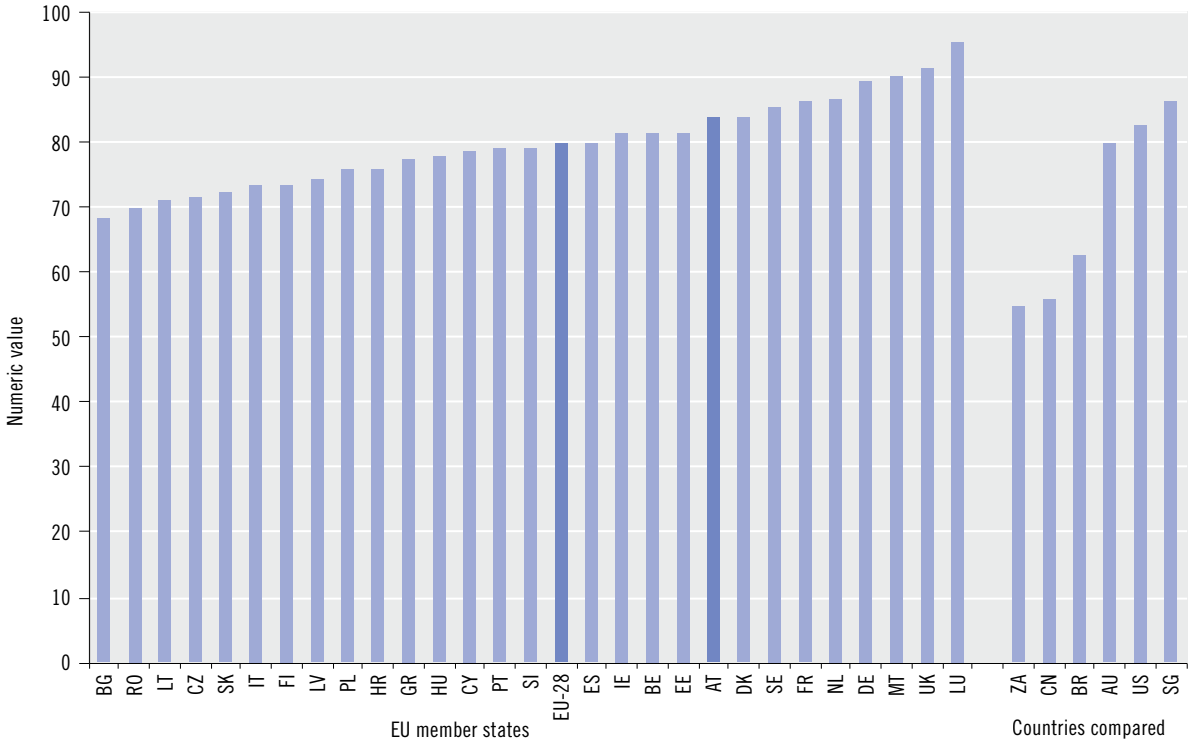
For a more detailed overview of Austria's position regarding information and communication technologies, the following section will look at two individual indicators from the Global Innovation Index: "Use of information and communication technologies" (see Fig. 1-13) and "Availability of information and commu-

Fig. 1-13: Index value "Use of information and communication technologies" in comparison, 2018



Source Cornell College et al. (2018).

Fig. 1-14: Index value "Availability of information and communication technologies" in comparison, 2018



Source: Cornell College et al. (2018).

nication technologies" (see Fig. 1-14). These two indicators are based on data collected by the International Telecommunication Union, which was presented in the "Measuring the Information Society 2017" report. The maximum possible value on the index is 100% in total for both indicators.

The findings show that Austria ranks in the middle among the 28 EU nations for its use and availability of information and communication technologies. It ranks behind the countries Sweden, Denmark, Luxembourg, the Netherlands, Germany and the United Kingdom. With regard to the use of information and communication technologies (ICT), Austria places twelfth when compared to other EU nations and ninth in terms of availability of ICT.

Indicators on the use of ICT in the Global Innovation Index

- **Indicator 1: The use of information and communication technologies**

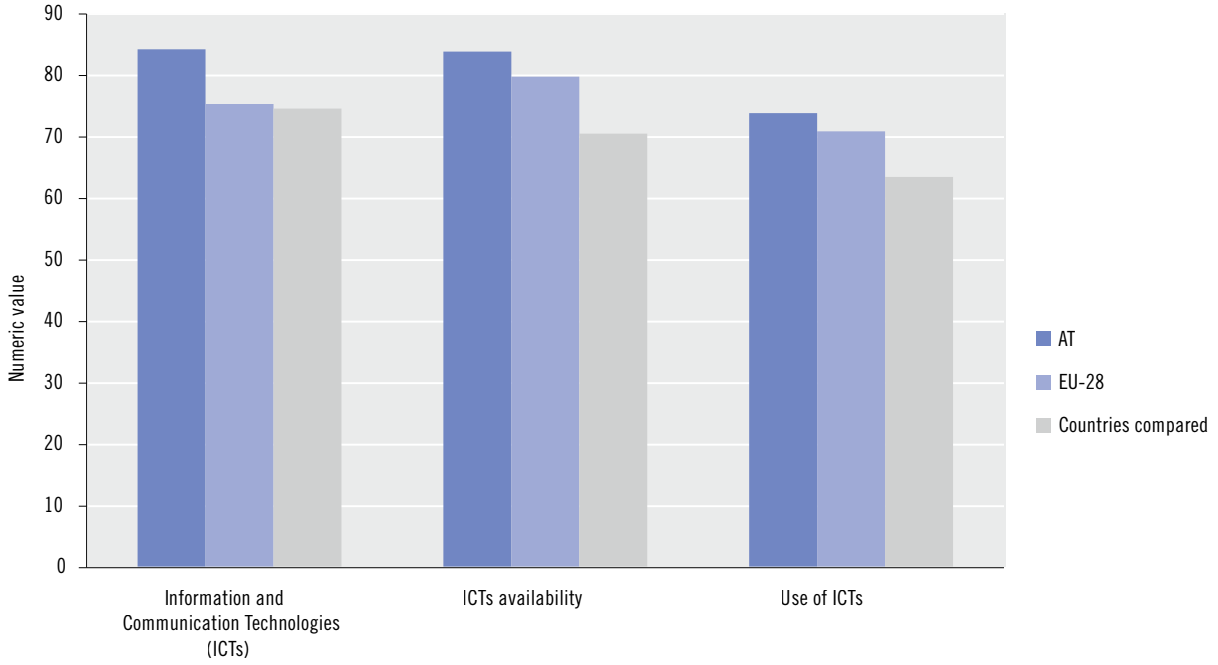
  The *use of information and communication technologies* is calculated using the weighted average of the following three sub-indicators: the number of people who use the internet (33.3%), the number of landline-broadband connections per 100 residents (33.3%) as well the number of actively registered mobile broadband connections per 100 residents (33.3%).

- **Indicator 2: Availability of information and communication technologies**

  Availability *of information and communication technologies* is calculated using the weighted average of the following five sub-indicators: the number of landlines per 100 residents, the number of mobile phone contracts per 100 residents (20%), data transfers to other countries (international bandwidth) in bit/s (20%), the number of households which have at least one computer (20%) as well as the number of households with internet access (20%).

As these indicators are mostly based on sub-indicators which have been standardised according to the

Fig. 1-15: Austria's position in a country comparison – Overview of Global Innovation Index results



Source: Cornell College et al. (2018).

number of residents, the data and indicators between countries of different sizes are also comparable. Thus it can be concluded that, in relation to these indicators, Austria ranks in the middle in Europe, but that there is potential for improvement. Particularly when comparing the use of information and communication technologies, one potential target would be to catch up with the higher-ranking countries. This could be achieved through an increased use of high-speed internet nationwide. However, it can also be concluded that Austria's use and availability of information and communication technologies is comparably greater than the EU-28 average as well the average of non-European countries compared in the ranking.

Ultimately, a "Global Information and Communication Technology Index" will also be considered as part of the Global Innovation Index. This index should take into account both indicators on the use and availability of e-government as well as give additional information on it. Fig. 1-15 depicts Austria's position with regard to this index. The same is also true of the indicators in Fig. 1-13 and Fig. 1-14, whereby Austria is compared with the average value of the 28 EU Member States and the average value of the following countries: Brazil, USA, South Africa, China, Singapore and Australia.

The evaluation shows that Austria's use and availability of information and communication technologies is comparably higher than the EU-28 average as well as the average of non-European countries compared in the ranking. When examining the entire index on ICT, Austria is above the EU-28 average and above the non-European countries' average (see Fig. 1-15). Thus Austria is very likely to keep up with international developments in the field of ICT and its use for its RTI performance. This is particularly true when there is a closely linked strategic relationship between research and technological policies. However, when comparing the 2018 Global Innovation Index with the 2017 Global Innovation Index, we see that Austria's position was slightly worse with regard to the aforementioned criteria, falling from 12th to 16th (when viewed from the perspective of the ICT total index).

The information provided in this section only reflects a small part of the ability to shape digital transformation processes in industry. Additional, highly specific information on measures related to firms and labour market policy is necessary for a detailed picture of digital performance in industry and society.

Despite these restrictions, it can be concluded that Austria ranks in the upper middle internationally with regard to the use of digital connections. However, these results also show that there is potential for development, particularly in terms of increasing the number of broadband connections as well as their comprehensive use.

1.2.3 Austria's capacity for innovation and competitiveness

This chapter takes a closer look at Austria's capacity for innovation and its ability to compete. In particular, factors which represent the starting point of or framework for innovative activities will be examined. In turn, they attest to the ability to be innovative in the future and to ensure competitiveness which is sustainable. Thus, the findings of this section shed light on what basic factors already exist in Austria so as to ensure its role as a technological leader of the future. Additionally, it also provides information on the criteria in need of adjustment so that it can take on said role.

Competitiveness

The section begins by addressing competitiveness as it appears in the "Global Competitiveness Report". This report[21] compares 137 countries in total using 114 indicators. These indicators are assigned to twelve main categories or dimensions. Composite indicators were created and documented for the twelve main categories; they also make country comparisons possible. The twelve categories are as follows:

- *Institutions*,
- *Infrastructure*,
- *Macroeconomic environment*,
- *Health and primary education*,
- *Higher education and training*,
- *Goods market efficiency*,
- *Labour market efficiency*,
- *Financial market development*,
- *Technological readiness*,
- *Market size*,
- *Business sophistication* and
- *Innovation*.

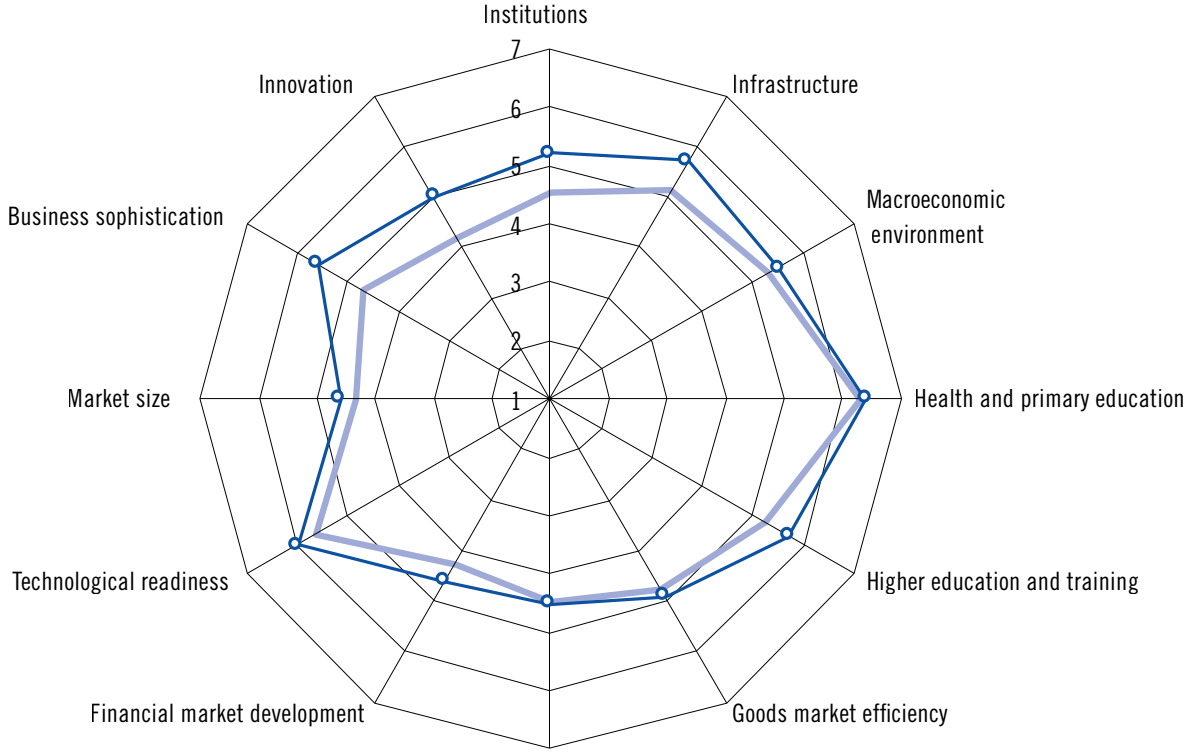
The Global Competitiveness Report's composite indicators are calculated in such a way that each dimension has a value between 1 and 7. The higher the value, the better a country's or an economy's ranking is. A variety of information sources are used as a basis for data, including, among others, data from the International Monetary Fund, the World Bank, the United Nations, UNESCO and the World Health Organization as well as information from the survey conducted among managers by the World Economic Forum. Fig. 1-16 shows how Austria compares to the EU 28 average.

When evaluating the ranking, it must be remembered that the usefulness of the composite indicators' values lies in their comparison to other economies rather than in their absolute total value. Nevertheless, they do allow to draw general conclusions about the economies' strengths and weaknesses. Owing to the composite nature of the composite indicators, however, it is impossible to formulate specific courses of action that are universally valid.

Despite these restrictions, the findings show that Austria is performing better than the EU-28 average in all aspects. Particularly with regard to the maturity of the economic system, innovation activities and the

21 The analysis in this section is based on a previous version of the 2018 Competitiveness Report, https://www.weforum.org/reports/the-global-competitiveness-report2017-2018.pdf, last reviewed 15.01.2019. In the meantime, as seen in Table 1-1, there is a more up-to-date version available which only minimally influences the total result which appears in the analysis of this section.

Fig. 1-16: Dimensions of the Global Competitiveness Report: Austria's position compared to the EU 28 Member State average



Source: World Economic Forum (2017).

institutional frameworks, Austria is achieving significantly better results than the average amongst EU countries. Both Austria and the EU average boast a very high level in terms of technological maturity and education. Furthermore, the findings indicate that labour market efficiency, goods market efficiency and financial market development have the development potential indicated in the report; this is true of both Austria and the rest of the European Union.

Capacity for innovation

The following analysis on Austria's capacity for innovation is based on the Capacity for Innovation Indicator, which was developed by the Institute for Innovation and Technology[22]. The iit Capacity for Innovation Indicator defines the capacity for innovation as the ability to generate new content and to translate it into products, processes and services which can compete on the market. It also takes into account existing knowledge as well as the ability to consolidate various types of knowledge. The iit Capacity for Innovation Indicator comprises the following four areas or "pillars":

- **Human capital**: Employees' continuing education and training as well as life-long learning,
- **Complexity capital**: The diversity of useful knowledge which makes it possible to produce complex products,
- **Structural capital**: The ability to consolidate knowledge within a firm,
- **Relationship capital**: The ability to consolidate knowledge beyond organisational borders.

Using the iit Capacity for Innovation Indicator's theoretical framework and data structure as a basis, it

22 See German Institute for Innovation and Technology (iit) (2018).

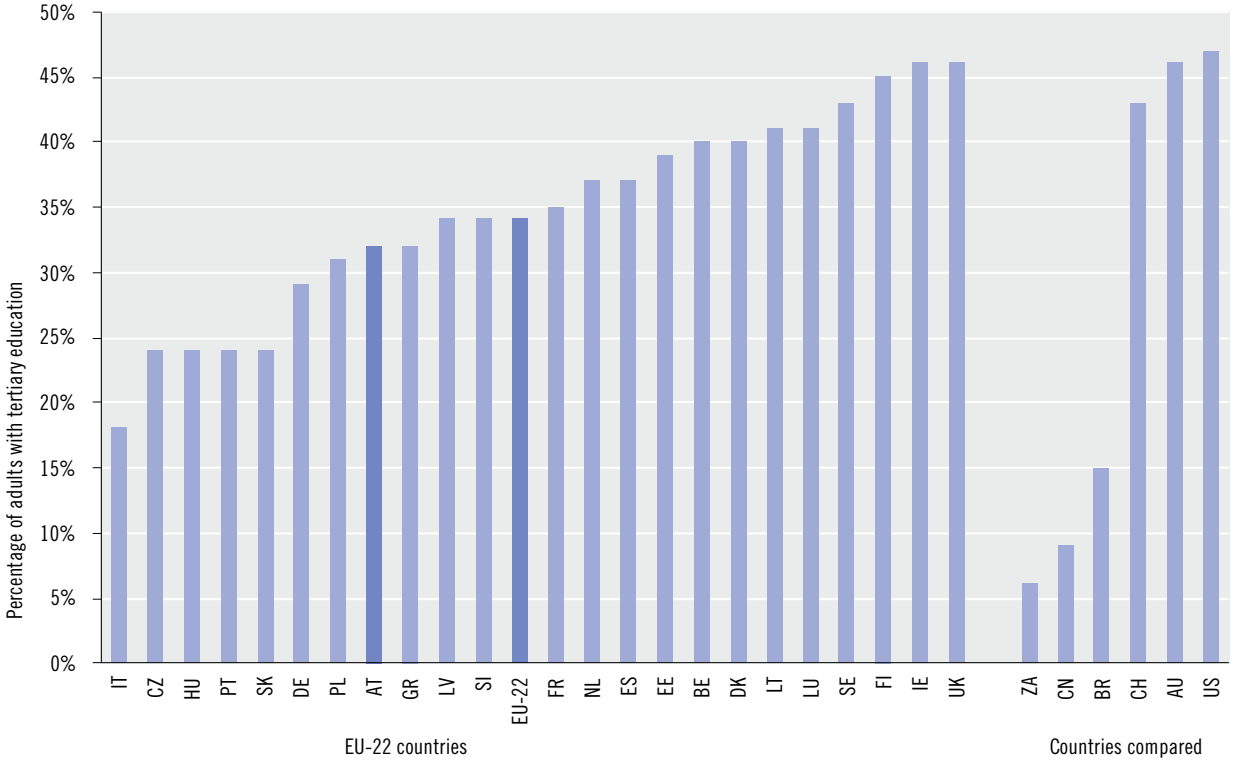
will be used for the first time to analyse countries outside Europe so as to make statements which compare Austria's capacity for innovation to that of other countries on a global level. However, extending this analysis to countries outside Europe is restricted to the extent that data collected in Europe is particularly suited to the adequate evaluation of structural and relationship capital. Therefore, human capital and complexity capital will be compared among all countries, whereas the analysis of structural and relationship capital will be restricted to European countries.

Human capital

Human capital, defined as the amount of skilled labour a country has, is central to the capacity for innovation: Innovation is generated by highly educated employees who can make important contributions to value creation within an economy. Thus human capital represents an additional aspect within the Capacity for Innovation Indicator. Once again, it will be extended to analysis at a global level. This report uses international data from the last OECD report, "Education at a Glance" (2018), to analyse Austria's human capital.

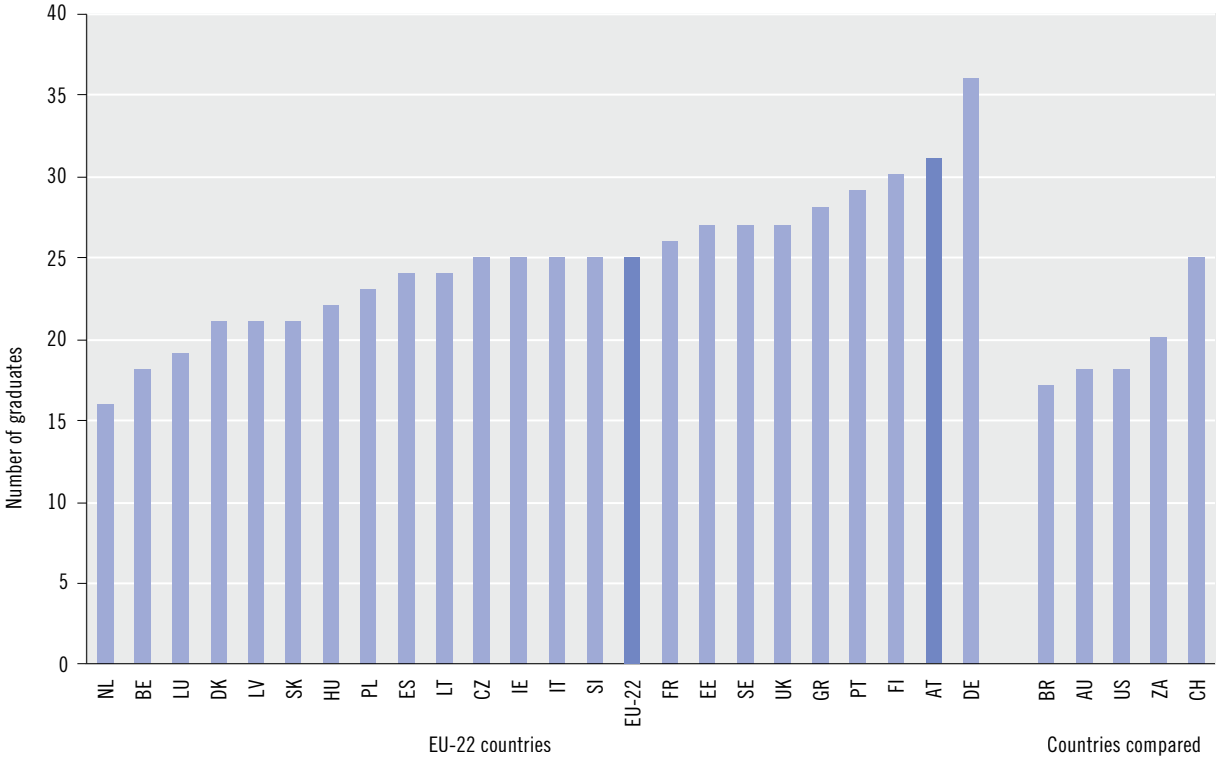
Fig. 1-17 provides an overview of the level of education within each country with a total comparison of the reference countries that is global in its scope. With regard to the general population of all people of working age (25-64 years old), Austria is in the lower midfield at 32%. It is slightly below the average of the 22 EU Member States included in the analysis (34%). Emerging markets such as China and South Africa are far below these figures, at 9% and 6% respectively. Additionally, there is a great deal of room for improvement for Brazil, with an estimated total of 15% of the population having post-secondary education. With regard to formal education, it is currently countries such as the USA, Australia and Switzerland which have high rankings. The 32% in the post-sec-

Fig. 1-17: Percentage of 25-64 year olds with tertiary education, 2017*



* Country data not available for the reference year: SG
Source: OECD (2018b), calculations iit.

Fig. 1-18: Graduates in the tertiary sector in STEM and ICT courses of study, 2016*



* Country data not available for the reference year: CN, SG
Source: OECD (2018b), calculations iit.

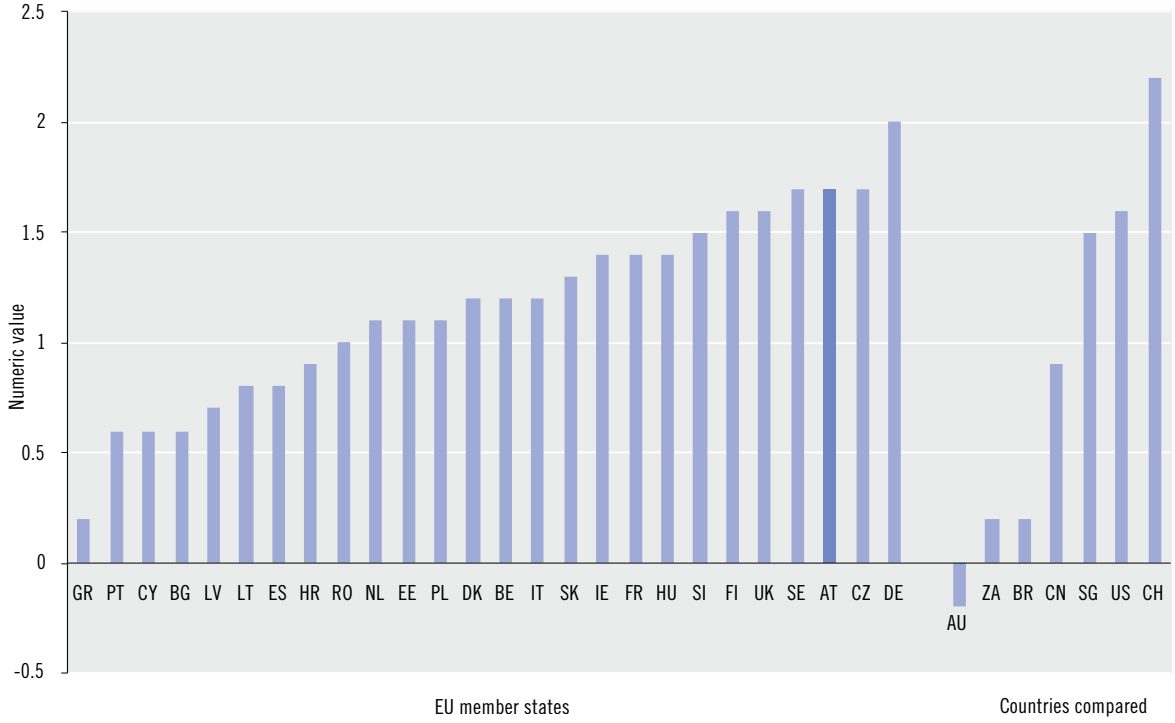
ondary education category already includes qualifications from VET colleges (master craftsmen, foremen, tradesmen).

However, this general overview does not account for the qualitative specificities and differences in each of the education systems. Therefore, when interpreting the data, it is noted that countries with a long tradition of three-tier university degrees (bachelor, master, PhD) usually have a higher percentage of people with an academic degree as compared to countries with a diploma system that takes more time to complete. Furthermore, countries which do not have a developed vocational training system at the secondary education level tend to award formal qualifications at the post-secondary education level (either as advanced vocational training or a bachelor's degree).

In conclusion, although Austria's capacity for innovation can be improved with regard to the current number of people who have a post-secondary degree, this below-average figure can be explained by the specificities of the Austrian education system as they were explained above. In addition, other data from the same OECD source which focuses on the younger population segment of 25-34 year olds shows that, in 2017, there was a visible trend towards an increase in post-secondary education, with 40% of 25-34 year olds in Austria having a degree.

Particularly in terms of future perspectives, a closer examination of data on university graduates from this time (Fig. 1-18) shows a different picture of human capital. Regarding STEM subjects as well as ICT degrees, Austria places second after Germany (Austria: 31% of all university graduates, Germany: 36%) in international rankings. Both countries are characterised by a high percentage of graduates with engineering degrees (Germany: 22%, Austria: 21%). In view of Austria's technology-based innovation potential and its capacity for innovation in the future, these high scores indicate a sustain-

Fig. 1-19: Economic complexity – Austria's position in international comparisons, 2016*



* Country data not available for the reference year: LU, MT
Source: World Economic Forum (2017).

ably positive trend, provided that Austria's innovation system is capable of preventing a brain drain and offer opportunities for personal development. Overall, Europe retains a strong position with regard to human capital that has a technologically oriented form of post-secondary education; on average, 25% of university graduates have degrees in STEM and ICT fields (out of 22 EU countries). In terms of a capacity for innovation, Austria and Europe are currently experiencing a positive trend with regard to human capital. However, for developments in the future, it is important to keep up with the increasing demand for STEM and ICT graduates on the labour market[23] and not to remain satisfied with the status quo.

Complexity capital

Innovation research shows that, in addition to qualifications and human capital, the intensity and the diversity of (useful) knowledge is key to the capacity for innovation. For example, this heterogeneity of knowledge is also decisive for the capacity for innovation in regions and clusters; however, it can also be extended to entire economies. The diversity of useful knowledge which is available is referred to as *complexity capital* according to the concept of the Capacity for Innovation Indicator.

The data on complexity capital are derived from the "Economic Complexity Index", which is based on a concept developed by researchers at MIT and Harvard University.[24] This indicator depicts economic complexity using various economies' diversification of the export of goods. This means that an economy is economically complex when it exports a large variety of different goods to the most diversified number of trade partners possible. The information needed to evaluate each country's economic complexity comes from their data on foreign trade.

23 See Binder et al. (2017).
24 See Harvard University (2018).

Fig. 1-20: Key performance indicator "Labour organisation conducive to learning", 2018

Ranking	Category	Value	Graph
1	Norway	0.88	
2	Finland	0.83	
3	Sweden	0.83	
4	Denmark	0.81	
5	Estonia	0.81	
6	Netherlands	0.78	
7	United Kingdom	0.76	
8	Belgium	0.73	
9	Austria	0.73	
10	Poland	0.73	
11	Romania	0.73	
12	Slovenia	0.73	
13	France	0.72	
14	Ireland	0.72	
15	Lithuania	0.72	
16	Germany	0.7	
17	Spain	0.7	
18	Latvia	0.69	
19	Czechia	0.69	
20	Italy	0.68	
21	Greece	0.66	
22	Portugal	0.66	
23	Hungary	0.65	
24	Slovakia	0.64	
25	Bulgaria	0.63	

Source: German Institute for Innovation and Technology (iit) (2018).

Austria's position in international comparisons appears in Fig. 1-19.

The findings show that Austria's economic complexity is high. When compared internationally, Austria placed third among the 28 EU Member States, and also when compared to other countries outside Europe, it is behind Switzerland, which placed first, and before the USA. Austria's high ranking in terms of economic complexity conforms to the data on competitiveness, among others. Thus, it can be concluded that Austria is in a good position not only to generate innovations in the future, but also to successfully position itself on the international market.

Structural capital:

Structural capital represents all structures and processes which consolidate knowledge within a firm and thus influence its capacity for innovation. Hence structural capital includes both the knowledge of individuals as well the structural learning ability of organisations. This also includes organisations' R&D units or organisational forms "conducive to learning".

The data on labour organisation conducive to learning used in the Capacity for Innovation Indicator comes from the "EWCS – European Working Condition Survey"[25]. For a lack of comparable data from outside Europe, it is used for the analysis to draw conclusions about Austria's structural capital.

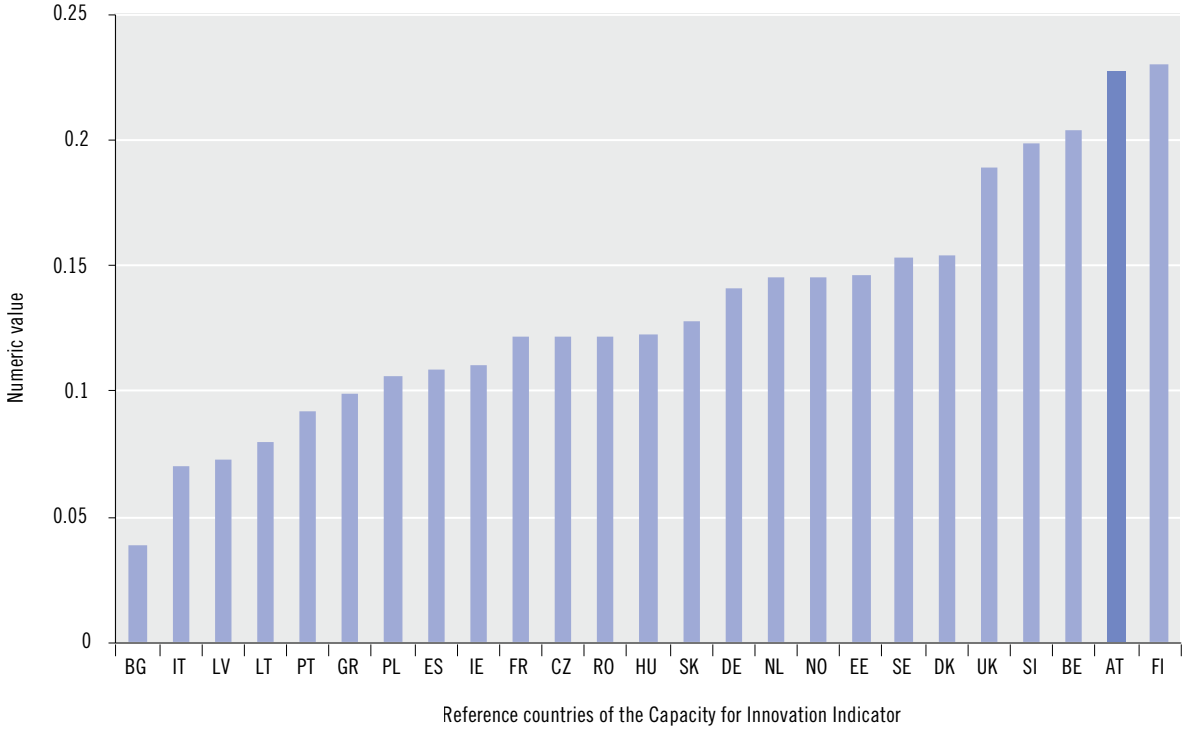
This survey-based indicator comprises various facets of the labour organisation conducive to learning such as autonomous structuring of content and organisation at work or the option of learning new things. Of the 25 countries surveyed, Austria placed ninth (value: 0.73 out of 1). The five leading countries are Norway (0.88), Finland (0.83), Sweden (0.83), Denmark (0.81) and Sweden (0.81). Despite overall positive results in terms of this aspect of capacity for innovation, there is still development potential for Austria's labour organisation conducive to learning. Austria's strengths in this regard include, for example, what firms have to offer for employees' continuing education or the complexity of cognitive tasks. Its weaknesses in this context, on the other hand, include opportunities for continuing education specifically related to computing (EWCS, reference year 2015).

Relationship capital:

Finally, the fourth pillar of the capacity for innovation is relationship capital. Relationships, i.e. networks and collaborations between firms and third parties play a decisive role in the innovation process. The interrelationship between firms and research institutes can be used to develop new products and processes, both through generating knowledge as well as for knowledge and technology transfer. Without this collaboration between research and industry, these products and processes would not be possible. Because of the complexity of (particularly technical)

25 This is the most recent EWCS survey conducted by the EU agency Eurofound in 2015. The survey is conducted once every five years.

Fig. 1-21: Degree of cooperation between firms and higher education institutions



* Country data not available for the reference year: SE

Source: Institute of Innovation and Technology (2018), based on findings of the Community Innovation Survey 2014.

innovations as well as for financial reasons, networks and collaborations are decisive when it comes to increasing the efficiency of research and speeding up the development time for new or improved products (technologies).

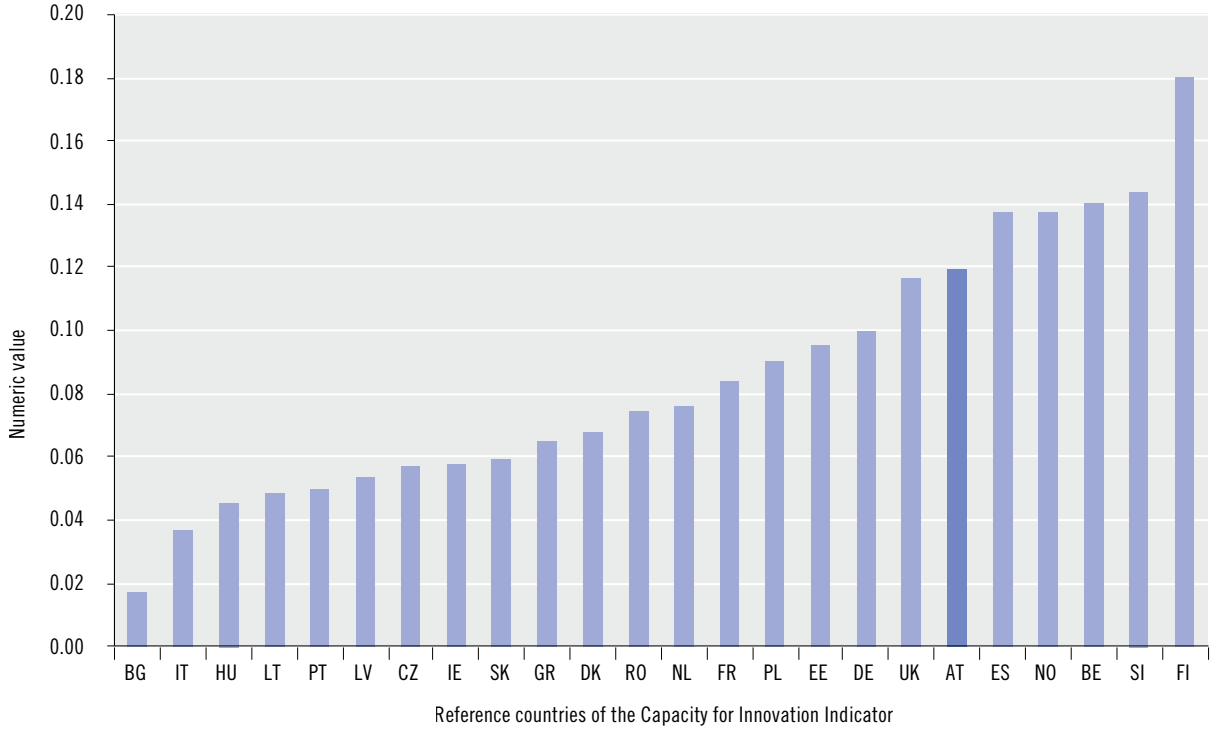
This section examines relationship capital using the degree of collaborations and exchanges between firms and individual research units. It looks at the degree of cooperation between firms and higher education institutions (see Fig. 1-21) and the degree of cooperation between firms and public or private research institutes (see Fig. 1-22). The assessments are based on data from the Community Innovation Survey (CIS). The CIS is a standardized assessment of innovation activities in EU Member States and in a few other European countries. This standardised assessment evaluates information on firms' innovation behaviour as well as various aspects of innovation development.

The degree of cooperation was standardized as a ratio with a value between 0 and 1. This means that with a value of 0.23 (for Austria), 23% of firms with technological innovation activity cooperate with higher education institutions to generate innovation (see Fig. 1-21). Austria's value of 0.12 in Fig. 1-22 means that 12% of Austrian firms with technological innovation activity cooperate with research institutes (on important innovation activities). This figure is part of the upper midfield when compared to other European countries.

The findings show that Austria is a leader within Europe when examining the extent of cooperation between firms and higher education institutions (see Fig. 1-21). In Europe, Austria places second after Finland. When examining the extent of collaboration between firms and public as well as private research institutes (see Fig. 1-22), Austria places sixth in Europe, thus ranking among the top countries.

Overall, these findings show that the cooperation between firms and higher education institutions as

Fig. 1-22: Degree of cooperation between business enterprises and research institutes*



* Country data not available for the reference year: SE
Source: Institute of Innovation and Technology (2018), based on findings of the Community Innovation Survey 2014.

well as research institutes is quite visible in Austria. This means Austria is well placed to ensure a fast and efficient transfer for new procedures, technologies and services on the one hand and, on the other hand, to conduct innovation activities which bring research and industry together. Particularly in view of increasing technical challenges, science characterized by global networks and financial resources, the significance of collaborations between firms and research institutes will probably be even greater in the future. As these assessments show, Austria's relationship capital is highly visible, and future innovation activities can and will benefit from it.

1.2.4 Summary

In the seventh year since the publication of the Federal Government's last Strategy for Research, Technology and Innovation, Austria has clearly improved its position in an international comparison. Austria is one of the leading countries in terms of its expenditure on research and development. Austria has also increased most of the individual indicators for RTI that are commonly used around the world. For example, Austria consistently shows improvements or stable values with regard to the measurable performance of its scientific research system. This refers in particular to quality-oriented parameters such as performance in the citation rate for scientific achievements. Austria's position in the field of digitalisation has not been outstanding, but it has not fallen behind either. Moreover, the relationship between the provisional status quo in the context of ICT and the other (immediate) fields of development in research, technology and innovation is not clear. When considering the use and availability of ICT, Austria is average in an international comparison; the findings indicate possible gaps at systemic interfaces, e.g. in the context of the integration of digital technology.

This chapter also examines Austria's competi-

tiveness and innovative capacity. The analysis of Austria's competitiveness was based on the Global Competitiveness Report. An evaluation of this report shows that Austria performs very well in all dimensions examined – including in terms of technological maturity, political and economic environments and the qualification of people – and is better positioned respectively than the average of the 28 EU countries. Austria also achieves good to very good results in the analysis of innovative capacity. According to the indicators evaluated, the Austrian economy is in a position to generate complex products and processes and to establish them on a global market, the population is well educated, and firms cooperate relatively often with higher education and research institutes in an international comparison.

As has been shown, the common innovation rankings also emphasise different focal points and use varying parameters for their international comparative analyses. For example, some sources[26] note the lack of impact of engagement, especially in the area of innovation. In this respect, composite indicators should only be interpreted with caution. In the overall view, both the composite indicators and the "hard" indicators in Section 1.3.1 show that Austria has good prospects of developing innovations and thus being successful on the global market.

1.3 Austria and EU research, technology and innovation policy

Chapter 1.3 examines the following four aspects in more detail:

1. The outcome of Austria's efforts as holder of the Presidency of the Council of the European Union, with regard to the development of the next European RTI Framework Programme;
2. The achievements of Austrian institutions and researchers within the current European RTI Framework Programme, Horizon 2020, with two years to go until it ends;
3. The implementation of Horizon 2020 in Austria through the designated operational and strategic supervision and support structures;
4. A look ahead to the structure and new features of Horizon Europe, the next European RTI Framework Programme.

In the second half of 2018, Austria once again held the Presidency of the Council of the European Union, for the third time in its history. Under the Austrian presidency of the Council, some key milestones in the field of RTI were accomplished towards the development of the next European Research Framework Programme, in consultation with European member states, the European Parliament and the European Commission. These are summarised in Section 1.3.1. This is followed by an explanation of the Council's conclusions on the further development of the European Research Area (ERA), and a report on the RTI activities of the Austrian Presidency of the Council in support of sectoral policies.

The achievements of Austrian institutions and researchers within the current European RTI Framework Programme, Horizon 2020, are analysed in detail in Section 1.3.2. Areas of the European Research Framework Programme in which Austria is particularly actively involved are described in detail; amongst other things these activities have resulted in Austria exceeding the billion-euro benchmark for funding acquired from the EU budget.

Section 1.3.3. analyses the activities and measures in place for implementation of Horizon 2020 in Austria. The focus is firstly on the advice and support provided by the Austrian Research Promotion Agency (FFG) for Horizon 2020, secondly on the EU performance monitoring also carried out by the FFG and thirdly on the ERA Observatory, which offers an overarching framework for the integration of individual tasks in the area of governance of EU RTI policy in Austria.

26 See OECD (2018b).

Finally in Section 1.3.4., the basic structure of the new European Research Framework Programme, Horizon Europe, is outlined and the anticipated new features are explained.

1.3.1 Activities in the context of the Presidency of the Council of the European Union

On 1 July 2018 Austria assumed the Presidency of the Council of the European Union, taking over from Bulgaria, and continuing the programme of the trio presidency. The three countries holding the presidency consecutively in this "trio" programme were Estonia (presidency for the second half of 2017), Bulgaria (first half of 2018) and Austria (second half of 2018). The Austrian Presidency of the Council of the European Union continued until 31 December 2018; this was followed by Romania, beginning the next trio presidency, which will also include Finland (second half of 2019), and Croatia (first half of 2020).

The official programme of the Austrian Presidency of the Council of the European Union was themed "A Europe that protects". This third period of Austrian presidency of the Council of the European Union was particularly marked by the fact that Europe faced a series of parallel challenges, which were to be considered during the Austrian presidency:

- The proposed multi-year financial framework for the European Union, for the period 2021-2027, was published on 2 May 2018, just before the beginning of the Austrian Presidency.[27] Within this proposal the Commission allocated €97.6 billion for "Horizon Europe" and a further €2.4 billion for the Euratom Research and Training Programme, making a total funding contribution of €100 billion.
- The proposal for "Horizon Europe", the successor to "Horizon 2020", was put forward on 7 June 2018 by the European Commission.[28]
- The second half of 2018 and the first months of 2019 were dominated by the Brexit negotiations.
- The legislative period of the European Parliament ends with the inaugural meeting of the newly elected parliament in July 2019; elections for the European Parliament took place in July 2019; a new Commission will be installed in November 2019.

The priorities of the Austrian period of presidency in the area of science, research and innovation were as follows:

- Negotiations on "Horizon Europe", the 9th EU Framework Programme for Research And Innovation (FP9);
- The Council's conclusions on the European Research Area (ERA), based on the evaluation of the ERA advisory structure by the European Research Area and Innovation Committee (ERAC);
- Support for sectoral policymaking (e.g. defence research, higher education network initiatives etc.).

For these priorities, intensive discussions and negotiations were prepared and held at ministerial level (see Table 8-1 in Appendix I), and amongst senior members of the civil service, conclusions and documents were drafted, and meetings were organised (see Tables 8-2, -3 and 8-4 in Appendix I).

Priority 1: The next European Framework Programme for Research And Innovation

Fundamental to the negotiations on "Horizon Europe", the next and ninth European Framework Programme for Research And Innovation (FP9), is a package of legislative documents. The most important of these documents is the Horizon Europe Regulation, which defines the structure, objectives and principal features of the Framework Programme for 2021-2027. In contrast to the previous versions, the Horizon Europe Regulation includes the rules for participation and for dissemination of findings. In addition, it de-

27 See European Commission (2018e).
28 See European Commission (2018f).

fines all the details of the content and for implementation of the programme in a single specific programme. Additional documents in the area of research are covered by the EURATOM Treaty.

A highlight of the Austrian Presidency with regard to science, research and innovation policy was the agreement on key points of the Horizon Europe Regulation.[29] On 30 November 2018 the Competitiveness Council COMPET arrived at a so-called "partial general approach" (PGA) to this. The PGA (which does not include binding statements on budget allocation, since the multi-annual financial framework proposed by the European Commission has not yet been put forward) was adopted by a very substantial majority (with only one vote against). In addition, the Austrian Presidency of the Council continued the negotiations on the specific programme for "Horizon Europe", resulting in a second compromise text by the Presidency, just before the end of 2018.

The "partial general approach" for the largest research and innovation funding programme in the world, namely "Horizon Europe", was negotiated and agreed in the record time of just five months. According to the European Commission's proposal, a total sum of €100 billion is to be made available in the period 2021-2027 to fund excellent research, and for mobility and training of researchers, and for research infrastructures. Furthermore, key social and economic challenges are to be addressed by integrated cross-topic clusters, working through structures such as the so-called "Missions" for specific issues, with the help of a portfolio of research and innovation measures; these are expected to achieve tangible results and effects within ten years. Similarly, a newly established "European Innovation Council" will support ground-breaking innovations with the potential to create new markets, jobs and prosperity in Europe. Lastly, one element of "Horizon Europe" will concentrate on supporting structural reforms for member states in the European Research Area; here the emphasis is on those countries with low levels of activity in R&D, not least with the aim of reducing the innovation gap within Europe. A further important change is a new approach to governance, characterised by budgetary flexibility and a comprehensive strategic planning process. (For details of the formulation of "Horizon Europe", see Chapter 1.4.4.)

Priority 2: Further development of the European Research Area

The second priority for science, research and innovation during the Austrian Presidency of the Council of the European Union concerns the European Research Area (ERA). The objective of the ERA is to create a unified internal market for science and research within Europe, in which researchers can function without the limitation of borders for themselves or for their research, and in which technologies can be developed for a single common market. Central to the ERA are the reforms which need to be introduced in each member state. This will enable each country to increase the efficiency and effectiveness of its innovation system, and strengthen transnational cooperation at all levels.

On 30 November 2018 the Council also agreed and adopted conclusions on the European Research Area.[30] These Council conclusions were proposed by the Austrian Presidency following the plenary meeting of the European Research Area and Innovation Committee (ERAC) in September 2018 in Salzburg, and successfully negotiated by the Research working group at the beginning of October 2018. The conclusions include three elements: (a) recognition of the important progress made by the various groups involved with the ERA towards implementing the ERA agenda; (b) decision by the research ministers on the "ERA advisory structure" on

29 See Council of the European Union (2018).
30 ibid.

the basis of the relevant evaluation and of the ERAC report; [31] (c) a look ahead to the future of the ERA, with the recommendation that the European Commission publish a new Communication on the ERA by 2020, and the recommendation that future holders of the Council Presidency hold regular conferences of ERA ministers.

Point (b) of these conclusions is based on a request from the Competitiveness Council in 2015 to evaluate the existing ERA advisory structure in Europe.[32] The evaluation process was carried out under the Council Presidency, in cooperation with ERAC, and addressed the definition and implementation of the six priorities of the European Research Area for the reform of national research systems. The priorities are as follows:[33]

- Increasing the efficiency and effectiveness of national research and innovation systems,
- Contributing to the resolution of major social challenges (the so-called "Grand Challenges"), with the support of public or public-private partnerships – for instance in the form of JPIs (Joint Programming Initiatives) – and optimising the use of public investments in research infrastructures,
- Reforming the labour market for researchers, to create an open European research labour market,
- Promoting gender equality in research,
- Optimising the circulation and transfer of knowledge by broadening access to science and innovation ("open science" and "open innovation"), and
- Strengthening international cooperation in science, research and innovation.

As a result of this evaluation by ERAC, the Presidency proposed the Council's conclusions on governance of the European Research Area. Ministers accepted these conclusions unanimously on 30 November 2018.[34] The conclusions acknowledge the progress already made towards the creation of a single market for knowledge, particularly the new ESFRI Roadmap 2018 on research infrastructures[35], and the governance structure of the European Open Science Cloud[36]. The conclusions also pave the way for a revised reform agenda for the European Research Area, which is to be drafted in the year 2020.

Priority 3: Support for sectoral policies

Research and innovation play an increasingly important role in many policy areas. For this reason, the third priority for the Austrian Presidency of the Council in the area of science, research and innovation policy concerned support for sectoral policies through increased collaboration. To meet the demand for new knowledge and innovation in many sectoral areas it is essential to link "Horizon Europe" and other EU programmes ever more closely together, in order to achieve intelligent and efficient synergies. The Austrian Presidency therefore made a point of including some sectoral policy areas in the negotiation process for "Horizon Europe", such as the European Fund for regional development, ERASMUS+, the "Digital Europe" programme and the European Defence Fund. Once the negotiations on 16 different EU programmes are sufficiently advanced, future presidencies will then be able to draw final conclusions on the synergies with "Horizon Europe".

In addition to sectors which are most obviously influenced by science, research and innovation, such as for example climate change or digitalisation, the sustainable development objectives of the United Nations[37] also form an important reference framework for the demand for research and innovation. For

31 See ERAC (2018).
32 See Council of the European Union (2015).
33 See ERAC (2015).
34 See Council of the European Union (2018).
35 See ESFRI (2018).
36 See https://era.gv.at/object/news/4439
37 See United Nations (2015).

this reason the Austrian Presidency treated research and innovation as a generic policy area which needs to be effective for all sectoral policy areas. In particular this includes:

- The contribution of research to addressing health policy issues;
- The contribution of research to developing economic and technological growth paths, particularly in connection with the digitalisation of society, and space research;
- The contribution of research to the transformation of European energy systems for the future;
- The interaction between research and responsible citizens;
- The intersection with education policy and other policy areas, to facilitate a new generation of mobility programmes, within Europe and to other countries.

Summary of meetings held during the Austrian Presidency of the Council

A total of around 40 meetings in the policy area of science, research and innovation were held during the Austrian Presidency in the second half of 2018. These events ranged from meetings of research ministers to conferences of experts, inviting discussion on issues concerning "Horizon Europe", the European Research Area, and the interface between research and innovation and sectoral policy areas.

Ten events organised during the Austrian Presidency of the EU Council resulted in a direct connection with the next European Research Framework Programme, "Horizon Europe". Topics covered by these meetings ranged from the Marie Skłodowska-Curie programme, to industrial technologies, and the contribution of social sciences and humanities to "mission-oriented" research, and included the conference titled "Imagine Digital – Connect Europe" (see Table 8-2 in Appendix I). The outcomes of these events were documented[38] and made available to the negotiating team in Brussels.

With regard to "Horizon Europe" and other matters, there were numerous meetings under the Austrian Presidency of the Council which supplemented the negotiations on the conclusions at EU level on the European Research Area (ERA), or which focused on specific aspects of the European Research Area (see Table 8-3 in Annex I). ERAC, ESFRI, Open Science, Joint Programming and many other forums debated matters concerning the ERA. One specific area that also has an important relationship to the ERA is higher education. With a total of five meetings focused on the intersection of higher education and research, the Austrian Presidency emphasised its willingness to improve cooperation between these policy areas as part of the reform agenda.

In addition, several meetings during the Austrian Presidency in the second half of 2018 supported the relevant specialist discussions in sectoral policy areas (see Table 8-4 in Annex I). These included expert conferences emphasising the connections between education, research, technological development, innovation and each of these policy areas.

1.3.2 Austria's performance in Horizon 2020

The data provided by the European Commission via eCORDA as of 21 January 2019, which will also be further processed in the EU Performance Monitoring of the FFG (03/2019), confirm the good success of Austrian institutions and researchers from industry and science in the current eighth European Research Framework Programme Horizon 2020. The overall amount of project funding allocated to Austria has now reached €1.11 billion, substantially over the billion euro benchmark. Institutions and researchers based in Austria were involved in 8.8% of all 21,472 projects funded under the Horizon 2020 programme.

The proportion of Austrian participation in the total of 104,427 participations in funded Horizon 2020 projects was 2.8%. This is made up of 2,919 participations in a total of 1,894 projects. In 1,344 projects

38 See https://era.gv.at/directory/292

there was only one Austrian partner. In 550 projects there were at least two Austrian partners involved. In terms of the number of participations, Austria, with 2,919 participations, or 2.8%, is ninth in international rankings, behind Sweden (total 3,139 participations) and just ahead of Greece (2,917) and Switzerland (2,788). By their very nature, the largest number of participations are attributed to the larger European countries: Germany (12,582), the UK (11,750), Spain (10,717) and France (10,094).

The share of funding approvals received by Austria from the Horizon 2020 budget stands at 2.8%, parallel with the proportion of participations. The proportion of Austrian project coordinators amongst all coordinators is 2.6%. Compared to other countries, it is evident that amongst all Austrian project coordinations, the business enterprise sector is relatively over-represented (Austria: 32.6%; all: 27.3%), while Austrian project coordinations in the higher education sector are comparatively under-represented (Austria: 41.0%; all: 47.7%).

With a success ratio[39] of 17.9% in terms of participations, Austria ranks significantly above the average success ratio of 15.3% for Horizon 2020, and second only to Belgium (18.7%) amongst the member states of the European Union.

There is a striking variation in the level of involvement of Austrian participants in individual "pillars" and their subdivisions. Table 1-2, "Austria's performance in Horizon 2020 according to pillars, project participations, projects, coordinations and budget", shows that Austria performs particularly strongly in the programme area *"Science with and for society"*. Here the proportion of Austrian coordinations is 9.3%, the proportion of funding acquired is 6.8% and the proportion of project participations is 5.4%. However, this area of the programme has relatively modest budgetary allocation. On the other hand, Austrian participation is strikingly low in the similarly modest funding areas of *"Cross-cutting issues"* (1.6% of all participations and coordinations) *and* EURATOM (1.0% of all participations and 1.9% of all coordinations).

As a whole, however, from the budgetary perspective, the major programme areas ("Pillars*"), "Societal Challenges", "Excellent Science"* and *"Industrial Leadership"* are the most significant. In this respect the largest proportion of the budget was acquired for

Table 1-2: Austria's performance in Horizon 2020 according to pillars, project participations, projects, coordinations and budget

	Approved participation (all countries)	Approved Austrian Participations	Share Austria in all countries (in %)	Approved projects (all countries)	Approved projects with Austrian Participation	Share of Austrian projects in all projects (in %)	Approved coordinations (all countries)	Approved coordinations (Austria)	Percentage of projects with Austrian coordinators out of all coordinators (in %)	EU contribution (all countries) (million €)	EU contribution (Austria) in € millions	Share Austria in EU contribution (in %)
H2020	**104,427**	**2,919**	**2.80%**	**21,472**	**1,894**	**8.82%**	**21,421**	**558**	**2.60%**	**39,382**	**1,107.52**	**2.81%**
EC Treaty	103,302	2,907	2.81%	21,421	1,889	8.82%	21,472	557	2.60%	38,742	1,105.41	2.85%
Excellent Science	34,492	784	2.27%	11,887	583	4.90%	11,887	267	2.25%	14,586	389.33	2.67%
Industrial Leadership	23,613	726	3.07%	4,008	416	10.38%	4,008	121	3.02%	8,214	257.44	3.02%
Societal Challenges	42,327	1,287	3.04%	5,064	803	15.86%	5,064	154	3.04%	14,828	430.51	2.89%
Spreading excellence and widening participation	844	25	2.96%	204	22	10.78%	204	1	0.49%	527	4.93	0.94%
Science with and for Society	1,381	75	5.43%	129	56	43.41%	129	12	9.30%	272	18.57	6.84%
cross-cutting	645	10	1.55%	129	9	6.98%	129	2	1.55%	270	4.64	1.72%
Euratom	1,125	12	1.07%	51	5	9.80%	51	1	1.96%	640	2.10	0.33%

Source: EK/FFT per 03/2019; Calculations Austrian Institute for SME Research.

39 Success ratio = participations on the "mainlist" / "eligible applications".

Austria under Pillar 3, *"Societal Challenges"*, amounting to €430.51 million. The Austrian share under Pillar 3 corresponds to 2.9% of all budgetary support for projects under this pillar. In Pillar 1, *"Excellent Science"* €389.33 million was allocated to researchers based in Austria, corresponding to a share of 2.7% under this Pillar. In Pillar 2, *"Industrial Leadership"* €257.44 million was allocated to Austria: a 3.1% share of the budget. The relative proportion under Pillar 2 is thus significantly over the average for Austria. With a 2.3% share of participations and 2.3% of coordinations, Austrian contributions to the *"Excellent Science"* pillar are significantly below the averages for Austria under Horizon 2020, which stand at 2.8% and 2.6% respectively. The Austrian shares in two other pillars are above average by a similar amount: "Industrial Leadership" (3.07% and 3.02%) and *"Societal Challenges"* (3.04% and 3.04%).

It is under Pillar 3, "*Societal Challenges*", that Austrian institutions have the highest levels of participations, in the thematic clusters *"Intelligent, environmentally friendly and integrated transport"* , with 4.1% in comparison to all participations in this cluster (coordinations 3.9%, and budget 3.6%), *"Integrative, innovative and reflexive societies"* with 4.0% (coordinations 3.6%, and budget 4.4%), *and "Secure, clean and efficient energy"* with 3.6% (coordinations 3.6%; budget 3.6%). These thematic *societal challenge*s can be regarded as Austrian areas of strength in comparison to the rest of Europe. Below-average level participations occur particularly in the clusters *"Food safety and security, sustainable agriculture and forestry, maritime and limnological research and bio-economy"* with 2.1% (coordinations 1.9%; budget 1.8%) and *"Health, demographic trends and well-being"* with 2.0% (coordinations 2.3%; budget 2.0%). It is within the "Industrial Leadership" pillar that Austrian institutions have the highest proportion of participations, particularly in the thematic clusters *"Materials"*[40] with 3.9% (coordinations 2.4%; budget 4.5%), *"ICT"* with 3.4% (coordinations 4.1%; budget 3.4%) and *"Biotechnology"* with 3.3% (coordinations 1.0%; budget 3.8%). These can be recognised as industry-relevant thematic strengths for Austria. In contrast, the proportions for participations in the area of *"Risk financing"* are relatively low, at 2.1%, despite the fact that the proportion of Austrian project coordinations is well above average, at 10.0%, and that the Austrian budgetary allocation is also high, at 4%. In the *"Excellent Science"* pillar, Austrian institutions have an above-average proportion (3.2%) of project applicants within the programme area "*Future and newly emerging technologies (FET)"* (coordinations 4.5%; budget 3.2%), and in applications to the "*European Research Council (ERC*)" with 2.7% (coordinations 2.7%; budget 2.9%). There are comparatively low levels of participation in *"Marie-Skłodowska-Curie Actions (MCSA)"* at 2.1% (coordinations 1.7%; budget 2.4%) and in *"Research infrastructures"*, with 2% (coordinations 3.3%; budget 1.8%).

The largest number of Austrian participations – relative to the total number – under Horizon 2020 come from the business enterprise sector (38.0%), of which almost two-thirds are in small and medium-sized enterprises (SMEs). This is followed by the higher education sector (27.9%) and non-university research (22.6%). These three sectors combined make up 88.5% of Austrian participations in Horizon 2020 projects. The rest is attributable to the public sector (5.3%) and the "other" category (6.3%).

With regard to these sectors there is also considerable variation in the breakdown by individual pillars and programme areas. In terms of funding acquired, the proportion for the Austrian higher education sector under Pillar 1 (*"Excellent Science")* is 68.8%. This can be attributed – unsurprisingly – to a high proportion of participations in ERC projects, at 74.8%. However, in the programme areas *FET* and *MCSA* the higher education sector's share of acquired funding is approximately two-thirds. The corresponding proportion for the non-university area under Pillar 1 is 19.5%, and for the business enterprise

40 This abbreviation stands for the NMP programme (*Nanotechnologies, Advanced Materials and Production*).

sector, 10.6%. Within Pillar 2 *("Industrial Leadership")* and Pillar 3 *("Societal challenges")* in contrast, the pattern of participation – measured in terms of acquired funding – is completely different. Under these two pillars the level of participation by the Austrian enterprise sector is ahead of that by the Austrian non-university sector. The proportion of participation by the Austrian higher education sector, in contrast, is below 20% in both these areas. In terms of funding acquired, the proportion for the Austrian business enterprise sector under Pillar 2 is 54.6%. The corresponding share for the Austrian non-university sector is 23.0%, and for the higher education sector, 17.5%. Under Pillar 3 *("Societal Challenges")*, in terms of funding acquired, the proportion for the Austrian business enterprise sector is 40.4%. The corresponding proportion under Pillar 3 for the non-university sector is also comparatively high, at 29.1%. The non-university sector has a particularly high level of participation in the thematic clusters *"Safe societies"*, at 44.5%, *"Integrative, innovative and reflective societies"* (43.5%) and *"Food safety and security, sustainable agriculture and forestry, maritime and limnological research and the bio-economy"* (32.8%). The corresponding share for the Austrian higher education sector under Pillar 3 is just 19.4%. In the horizontal programme area *"Science with and for society"*, Austrian participation can be broken down by organisation type and amount of funding acquired: Higher education sector: 30.7%; business enterprise sector: 13.0%; and non-university sector: 40.2%. In the programme area *"Spreading excellence and expanding participation"* the proportions are 51.2% (higher education sector) and 38.6% (non-university research). 10.2% can be attributed to the "public sector"; there is no participation in this programme area by the Austrian enterprise sector.

In terms of Austrian federal states, the statistics show that 50.5% of Austrian participation in Horizon 2020 programmes was attributable to Vienna. Styria also has an above-average level of participation, at 20.9%. This is followed by Upper Austria (8.5%) and Lower Austria (7.5%). The lowest level of participation is in Vorarlberg (0.8%) and Burgenland (0.7%). The high level of participation in Vienna is due to the heavy concentration of the higher education sector and non-university research bodies in Vienna. In contrast, the business enterprise sector participation in Horizon 2020 projects is less concentrated. Here too, Vienna ranks the highest, with a 39.9% share, but the corresponding shares for other federal states, particularly Styria (21.6%), Upper Austria (10.9%), Lower Austria (10.6%), and Carinthia (6.8%) are comparatively high.

1.3.3 The implementation of Horizon 2020 in Austria

The Federal Ministry of Education, Science and Research is responsible for coordinating Austria's EU RTI policy in accordance with the Federal Ministries' Act. The implementation of Horizon 2020 in Austria will essentially take place within the framework of activities and measures in the following three areas:[41]

1. Consulting and support of Horizon 2020 and ERA in the field of "European and International Programmes" of the Austrian Research Promotion Agency (FFG–EIP)
2. EU performance monitoring (Austrian Research Promotion Agency, FFG)
3. The ERA Observatory Austria as an overarching framework for the integration of the individual tasks in the area of governance of EU RTI policy in Austria.

Consultancy and support for Horizon 2020 and ERA in the field of "European and International Programmes" of the Austrian Research Promotion Agency (FFG)

The task of the Austrian Research Promotion Agency (FFG) in the area of European and International Programmes (FFG-EIP) is to increase, over the long

41 See Biegelbauer et al. (2018).

run, Austria's involvement in programmes, initiatives and campaigns of European and international research and technology collaborations – particularly in the EU research programme.[42] The framework for this is a commissioning of the Austrian Research Promotion Agency (FFG) by the federal government, represented by several ministries and by the Austrian Economic Chambers (WKO) for the period 2014–2020. In particular, various information, advisory and networking services are commissioned, which benefit all Austrian interested parties and participants in European research initiatives. The "European and International Programmes" section of the Austrian Research Promotion Agency (FFG) regularly informs over 30,000 Austrian interested parties and participants on European programmes and initiatives. On average, 6,500 consultations on the European RTI programmes are held each year.

In addition to Horizon 2020, the EIP of the Austrian Research Promotion Agency (FFG) also supports (partly together with partners[43]) EUREKA, Eurostars, COSME, the Enterprise Europe Network, COST and a large number of European RTI partnership initiatives[44]. The service spectrum for firms, universities, research institutes, etc. ranges from project-specific support to targeted support in strategic positioning in the European research and innovation environment, with increasing emphasis on system-oriented support and empowerment of the actors.

Table 1-3 gives an overview of the information and advisory instruments of the EIPs of the Austrian Research Promotion Agency (FFG).

Furthermore, the EIP of the Austrian Research Promotion Agency (FFG) is the officially nominated National Contact Point (NCP) of the European Commission for Horizon 2020 and all European RTI partnership initiatives related to Horizon 2020 and ERA.

EU Performance Monitoring (Austrian Research Promotion Agency, FFG)

The central task of EU Performance Monitoring (EU-PM) is the collection, processing, processing and communication of data on the participation of Austrian organisations in EU research and innovation programmes.[45] By entrusting the EU-PM to the Austrian Research Promotion Agency (FFG), national and EU participation data are bundled under one roof. Through the synergetic use of content and technical know-how, based on technical expertise of the Austrian Research Promotion Agency (FFG), "strategic intelligence" is to be offered to RTI stakeholders.

In addition to the provision of data, i.e. the collection, processing, evaluation and communication of reliable data on Austria's participation in relevant EU funding programmes and the integration of information from available data sources into a comprehensive database, specific products are also created. These include regular periodic evaluations and ad-hoc assessments upon request, qualitative and quantitative analyses and interpretations of Austria's EU RTI performance, a summary of EU data with relevant national Austrian Research Promotion Agency (FFG) funding data and the operation of an internet portal.

The main objectives of these activities are on-going monitoring of Austria's performance in EU research programmes, comparison with other countries (international positioning), the distribution within Austria, the analysis of strengths and weaknesses in individual areas (e.g. by topic, organisation and industry) and the support for strategic and critical political decisions.

42 See https://www.ffg.at/ffg/eip

43 See for example the Austria Wirtschaftsservice (aws), the Austrian Economic Chambers (WKO), Chambers of Commerce in the federal states, federal state agencies.

44 In addition to Horizon 2020, the European Research Area includes other participation opportunities such as Joint Programming Initiatives (JPI), Future and Emerging Technology (FET) Flagships, Joint Technology Initiatives (JTI), Public-Private Partnerships (PPP initiatives) and the European Technology Platforms (ETP). See also https://www.ffg.at/Europa/partnership_initiativen

45 See https://www.ffg.at/services/eu-pm

Table 1-3: EIP information and consultation instruments of the Austrian Research Promotion Agency (FFG) according to areas of responsibility

Remit	Instruments
Raising awareness and disseminating information	**1. The Austrian Research Promotion Agency (FFG)-EIP Website**: contains general information on the overall structure of the European programme portfolio as well as funding opportunities for all target groups. In addition, specific pages offer targeted support in the implementation of H2020 projects (e.g. legal and financial aspects). **2. eNewsletter**: Review of national and European news **3. "Awareness" and information events**: Information on the H2020 programme portfolio and the respective "programme logic" (events to start call rounds, roadshows, cooperation exchanges etc.)
Program and Project Consulting	**4. Personal consultation & proposal checks** for potential participants from science and industry are offered in all project phases. At universities and organisations with their own "support structures", researchers and multipliers are advised on programme-specific questions within the framework of second-level support. Multipliers/intermediaries are enabled, through the use of different instruments from the toolbox, to successively realise first-level support by themselves. **5. The Austrian Research Promotion Agency (FFG) Academy**: Within the Austrian Research Promotion Agency (FFG) Academy, **training events and webinars** of the EIP are bundled for the purpose of information transfer and knowledge building. A special focus is on project development, application and management of H2020 projects. These are supplemented by the EU Networking format for better networking between Austrian RTI actors and European experts. Discussion rounds within the framework of EU networking deal with current developments in European research agendas and research funding.
Strategic Consulting and ERA Orientation Knowledge	**6. ERA Thematic Dossiers/Analytical Programme Reports:** These analyse the Austrian participation in certain topics (H2020 and European RTI partnership initiatives) and point out important developments and fields of action. Quantitative data is provided by EU performance monitoring. The main target groups are delegates and policymakers, but this information is also made available in customized form to the public. **7. Policy briefs:** "In_brief" are event-related policy briefings on current developments with strategic and/or operational relevance for the Austrian RTI community. **8. Analyses:** Analyses of evaluation results as well as network and participation analyses (ex ante and ex post) are gaining in importance. Network and participation analyses are carried out with the involvement of the clients, the EU performance monitoring and the "stakeholders responsible for the topic" in the departments.

Source: Biegelbauer et al. (2018, 10f.), adapted presentation.

ERA Observatory Austria

The ERA Observatory comprises a number of activities aimed at facilitating the exchange of information and better coordination between those actors who play an essential role in the formulation and communication of Austrian positions with regard to European RTI policy.[46] The overarching objective of the instruments used by the ERA Observatory is to support independent decision-making, especially among policy-oriented RTI stakeholders in the EU context. Specifically, the ERA Observatory pursues these objectives:

1. Providing information and exchange opportunities on relevant EU policies:
   a. Via the ERA Portal Austria[47], the Federal Ministry of Education, Science and Research (BMBWF) provides information on developments in the European Research Area, joint activities (e.g. on the European RTI partnership initiatives) and the Austrian research system.
   b. The event format "Europa Forum on Research" (EFF) addresses the RTI community in Austria several times a year with current EU RTI topics.
2. Provision of needs-based advice and support for the various ministerial departments for H2020:
   a. EIP commissioning (see above)
   b. Steering Committee EIPs of the Austrian Research Promotion Agency (FFG)
   c. Thematic H2020 expert groups: Austrian delegates cooperate with delegates from other

46 See https://era.gv.at/directory/166
47 ibid.

countries in several thematic areas and form alliances (H2020 Programme Committees, supported by national thematic groups).

d. Delegates-*Roundtable*: Delegates meet on average once a quarter for the H2020 Program Committees and exchange information about their work.
e. Provision of strategic policy advice (ERA Council Forum Austria) and processes (ERA-*Roundtable*, working groups on EIT, JPI etc.)
f. The ERA Council Forum Austria is a body consisting of national and international experts that advises the Austrian Minister of Education, Science and Research at the interface between European research agendas and the national science, research and innovation system. It offers strategic orientation and advice in the context of "Europe 2020", "Innovation Union", "ERA Partnership" and "H2020". The five-member forum is chaired by former European Research Council (ERC) President Helga Nowotny and meets several times a year. The ERA Council Forum plays a central role in the discussion of current developments with regard to the objectives of the European Research Area within the framework of the annual "Europatagung" (European Conference).
g. The ERA-*Roundtables* discuss developments in the European Research Area and advise on national measures in the context of the realisation of the European Research Area (ERA) in these six priorities: More effective national research systems (ERA priority 1), transnational cooperation (ERA priority 2), an open labour market for researchers (ERA priority 3), gender equality aspects (EAR priority 4), knowledge transfer/open access (ERA priority 5), and international cooperation (ERA priority 6). The ERA *Roundtable* is attended by the actors responsible for the national implementation of ERA priorities.
h. The working groups on the *European Institute of Technology* (EIT) and JPIs primarily serve to coordinate ministerial positions for these European instruments. Accordingly, the participants consist primarily of ministries, the Austrian Research Promotion Agency (FFG) and Austrian Science Fund (FWF) agencies, the interest representatives Austrian Economic Chambers (WKO) and, in some cases, the Federation of Austrian Industries (IV), as well as uniko (Universities Austria) and the organisations responsible for EIT and JPIs.

3. Provision of an impact-oriented monitoring of Austrian participation in H2020 and ERA via the EU-Performance Monitoring and the ERA *Reporting Board*.

1.3.4 New Framework Programme as proposed by the European Commission

The ninth European Framework Programme for Research and Innovation "Horizon Europe" is expected to start on 1 January 2021 and will run until 31 December 2027. Various inputs, in particular the findings of the interim evaluation of Horizon 2020, stakeholder consultations and external expertise[48] were taken into account in the design of the programme. For research and innovation, the Multiannual Financial Framework provides for a total of approximately 100 billion from the European Commission, of which € 97.6 billion was proposed for the Framework Programme (including € 3.5 billion for the InvestEU Fund) and € 2.4 billion for Euratom. However, these budget amounts are provisional, as all member states (unanimously in the EU Council) and the EU Parliament (by the majority) still have to approve the planned financial frame-

48 In particular, the recommendations of the High Level Group (HLG) reports "*LAB-FAB-APP*" (European Commission, 2017), "*Europe is back: Accelerating breakthrough innovation*" (European Commission, 2018c), as well as the report of Mariana Mazzucato (2018) "*Mission-Oriented Research & Innovation in the European Union*" were taken into account.

Table 1-4: Overview of the Horizon Europe structure as proposed by the European Commission

Pillar I **Open science** (25.8 billion €)	**Pillar II** **Global challenges and industrial competitiveness** (52.7 billion €)	**Pillar III** **Open Innovation** (€ 13.5 billion)
European Research Council – €16.6 billion	Cluster: • Health • Culture, Creativity and Inclusive Society • Civil Security for Society • Digitalisation, Industry and Space • Climate, Energy and Mobility • Food, Bioeconomy, Natural Resources, Agriculture and Environment	European Innovation Council – €10 billion
Marie Skłodowska Curie Actions – €6.8 billion	Joint Research Centre – € 2.2 billion	European Innovation Ecosystems – €0.5 billion
Infrastructures – € 2.4 billion		European Institute of Innovation and Technology – €3 billion
Strengthening of the European Research Area (€ 2.1 billion)		
Sharing excellence – € 1.7 billion		
Reforming and strengthening the European R&I system – € 0.4 billion		

Source: Council of the European Union (2019).

work. Table 1-4 gives an overview of the structure of Horizon Europe proposed by the European Commission and the respective budgetary allocations of the programme components.

The first pillar "Open Science" comprises the programme parts "European Research Council", "Marie Skłodowska-Curie Actions" and "Infrastructures" already implemented in Horizon 2020, and is intended to expand and strengthen the scientific basis of the Union. The term "open science" also refers to the stronger orientation of the European Framework Programme towards an "open science policy". In general, research under Horizon Europe should be made more accessible to society, and the dissemination and exploitation of R&D findings should be strengthened. In addition to publications from research projects, more and more research data should be made publicly accessible or published.[49]

The second pillar "Global Challenges and European Industrial Competitiveness" comprises five thematic clusters to address the major global challenges, which in turn are divided into areas of intervention[50]. Pillar II is intended to support the diffusion of high-quality new knowledge, new technologies and sustainable solutions. It also aims to strengthen the competitiveness of the European industry and the impact of research and innovation on development. Pillar II will also support innovative solutions in industry (in particular SMEs and start-ups) and society to address global challenges. The instruments used are Calls, EU-wide R&I missions and EU RTI partnerships. EU-wide R&I missions represent a new instrument in the Framework Programme. They comprise a bundle of measures, are intended to be highly visible and address goals of high social relevance. In the context of these missions, research and innovation should make greater reference to society and the needs of European citizens. The following areas for missions have been defined: (1) Adaptation to climate

49 *"Open access to research data shall be ensured in line with the principle 'as open as possible, as closed as necessary"*, see Section 10(1) of the*"Proposal for a Regulation of the European Parliament and of the Council establishing Horizon Europe – the Framework Programme for Research and Innovation, laying down its rules for participation and dissemination"* (European Commission, 2018e).

50 Examples of this include: "*Artificial Intelligence and Robotics*", "*Clean Transport and Mobility*", "*Cultural Heritage*" etc.

change, including social transformation, (2) cancer, (3) healthy oceans, seas, coastal and inland waters, (4) climate-neutral and "smart" cities, (5) soil health and food[51].

These missions are carried out with the participation of citizens, various stakeholders, the European Parliament and the Member States. The impact of these missions on science, technology and society should go beyond the impact potential of individual measures.[52] In future, European RTI partnerships should only be established if the planned impacts cannot be achieved by other measures of the European Framework Programme or by national activities alone. Fundamentally, they should be limited in time. Finally, the Joint Research Centre (JRC) is also assigned to the second pillar. The Joint Research Centre is the scientific service of the European Commission and supports European policies with independent scientific knowledge, expertise and technical support throughout the policy cycle.[53]

The European Innovation Council, the European innovation ecosystems and the European Institute for Innovation and Technology are integrated into the third pillar "Open Innovation", which is aimed at innovation stakeholders from all economic sectors. The European Innovation Council will support market-oriented, potentially disruptive and high-risk innovations through two thematically open, complementary programmes: The Pathfinder programme supports high-risk projects for the development of radically innovative technologies and focuses on the early stages of the innovation cycle (from ideation to prototype development). The focus of the second programme, "Accelerator", is on the market launch phase of innovations and the scale-up phase of start-ups, thus supporting the economic exploitation of innovation services. Interventions are aimed in particular at start-ups and SMEs. The European Innovation Council is thus setting up two Europe-wide bottom-up innovation support programmes within the framework of Horizon Europe. The European innovation ecosystems, on the other hand, serve to network innovation actors at the regional and national level, while the European Institute for Innovation and Technology (EIT) supports the cooperation of different actors from research, education and industry - with the aim of strengthening innovation and entrepreneurship in the EU.

Outside the pillar structure of Horizon Europe, further financial resources (approx. €2.1 billion) shall be provided to strengthen the European Research Area; they will be divided into the areas of "Sharing excellence" and "Reforming and Enhancing the European R&I system". As regards to "Sharing excellence", member states and regions which are structurally weaker in the field of RTI should be specifically supported in the direction of building excellence (*Teaming*, *Twinning*, continuation of COST). Within the framework of the "Reforming and Enhancing the European R&I system", *Foresight* activities, the monitoring as well as the evaluation of Horizon Europe are planned.

In addition, Horizon Europe seeks synergies with a number of other EU programmes.[54] Successfully evaluated projects may be awarded a "Seal of Excellence Certificate", which is intended to support them under other programmes (including, for instance, the European Regional Development Fund ERDF). Links to other EU programmes[55] are also to be promoted, funding guidelines between programmes harmonised, flexible co-financing rules

51 See Council of the European Union (2019).

52 Mariana Mazzucato (2018) sometimes mentions the following fictitious examples of such missions: "*100 carbon neutral cities by 2030*", "*A plastic-free ocean*", und "*Decreasing the burden of dementia*".

53 See https://ec.europa.eu/info/departments/joint-research-centre_de

54 The synergies targeted are described in Annex IV of "*Proposal for a Regulation of the European Parliament and of the Council establishing Horizon Europe – the Framework Programme for Research and Innovation, laying down its rules for participation and dissemination*" (European Commission, 2018e).

55 Such as: *COSME, European Space Programme, Digital Europe Programme* and *European Defence Fund*.

drawn up and resources pooled at EU level. The openness of the programme to international partnerships with third country organisations (EFTA Member States, candidate countries, European Neighbourhood Policy (ENP) countries) will be maintained. In addition, the possibilities of cooperation with other non-member countries should be made possible, provided that these fulfil certain criteria[56].

Negotiations on the European Commission's proposal were provisionally concluded between the European Council and the European Parliament in April 2019, and a provisional agreement on the content of the programme was reached. A detailed analysis and presentation of the final framework programme can only be made in the light of the outstanding budget negotiations on the EU's Multiannual Financial Framework. In addition, complementary parts of the Framework Programme must be negotiated under the Finnish EU Presidency (e.g. synergies with other EU programmes, third country participation).

1.3.5 Summary

During the time that Austria held the Presidency of the Council of the European Union, the country was able to record several successes in the field of RTI policy despite the difficult framework conditions and considerable time pressure. Overshadowed by the ongoing Brexit negotiations and – related to this – without an agreed-upon Multiannual Financial Framework of the European Union for the period 2021–2027, an agreement on the main contents of the Horizon Europe Regulation was reached in a record time of only five months on the basis of intensive coordination and negotiations. This was put forward by the Competitiveness Council COMPET on 30 November 2018 through the adoption of a so-called "Partial General Approach". According to the European Commission's proposal, an amount of approximately €100 billion should be available for Horizon Europe from 2021–2027. Horizon Europe will again focus on supporting excellent research, mobility and training of researchers as well as research infrastructures. In future, the major social and economic challenges are to be tackled in cross-cutting clusters and implemented, among other things, through so-called "Missions" on specific problems. Another innovation will be the "European Innovation Council", which will promote groundbreaking innovations (such as "Blended Finance", combining grant and equity elements for fast-growing enterprises with breakthrough innovations).

The second priority in the field of science, research and innovation during the Austrian Presidency of the Council of the European Union dealt with the European Research Area (ERA). In this respect, the Council unanimously adopted Conclusions on the European Research Area on 30 November 2018. These were successfully negotiated in the Working Party Research at the beginning of October 2018. The Conclusions recognise important progress in implementing the ERA agenda, include consequences of the review of the ERA Advisory Structure and provide an outlook on the future of ERA. The main purpose of the Conclusions is to pave the way for a revised reform agenda for the European Research Area in 2020.

For Austria, the EU Framework Programme for Research and Innovation was and is an important source of competitive research grant at the highest level. Actual data provided by the European Commission confirm the positive achievements of Austrian institutions and researchers from science and industry under the current eighth European Framework Programme for Research and Innovation, Horizon 2020.

56 As to these criteria, see Article 12 of "*Proposal for a Regulation of the European Parliament and of the Council establishing Horizon Europe – the Framework Programme for Research and Innovation, laying down its rules for participation and dissemination*" (European Commission, 2018e).

So far, more than one billion euros have been successfully raised from Horizon 2020. Institutions and researchers based in Austria were involved in an average of 8.82% of all 21,472 projects funded under the Horizon 2020 programme. Measured in terms of the number of investments, Austria ranks ninth in an international comparison. With a success ratio of 17.87% in terms of participations, Austria ranks significantly above the average success ratio of 15.32% for Horizon 2020 and is second only to Belgium amongst the member states of the European Union.

From a budgetary point of view, the major programme areas ("pillars") *"Societal Challenges", "Excellent Science"* and *"Industrial Leadership"* are the most important. In contrast to other EU member states, Austria was able to raise most of its budget from Pillar 3 *"Societal Challenges"*. Areas of strength for Austria under this pillar, compared to other European countries, include the thematic clusters "*Smart, green and integrated transport"*, *"Inclusive, innovative and reflective societies"* and *"Secure, clean and efficient energy"*. Within the pillar *"Industrial Leadership"* the thematic clusters *"Materials", "ICT"* as well as *"Biotechnology"* are identified as Austria's strong fields.

Overall, the business enterprise sector is responsible for the largest proportion of the Austrian participation in Horizon 2020 (37.99%). Almost two thirds of the firms involved are SMEs. This is followed by the higher education sector (27.85%) and non-university research (22.61%).

The professional consulting and support structures contribute to the successful performance in Horizon 2020 through their work. The "European and International Programmes" of the Austrian Research Promotion Agency (FFG-EIP) should be mentioned in particular. The framework for this is a commissioning of the Austrian Research Promotion Agency by the federal government, represented by several ministries and by the Austrian Economic Chambers (WKO) for the period 2014–2020. On average, 6,500 consultations on the European RTI programmes are held each year.

1.4 Strategic measures, initiatives and further developments

Numerous strategic interventions and initiatives have been designed and developed both at the federal government and ministerial department levels to help achieve the targets of the RTI strategy that were set in 2011. The RTI Task Force set up to define and coordinate the implementation of the strategy continued its activities in 2018. It is made up of representatives from the relevant ministerial departments: Federal Ministry of Finance (BMF), Federal Ministry of Education, Science and Research (BMBWF), Federal Ministry for Transport, Innovation and Technology (BMVIT), Federal Ministry for Digital and Economic Affairs (BMDW), and is chaired by the Federal Chancellery (BKA). The following section provides an overview of the latest trends in strategic processes, RTI-related activities and the implementation of new projects and programmes.

The action plan for the future of research, technology and innovation

Based on the government programme, the Federal Government put forward the following measures in the area of research, technology and innovation in the Council of Ministers presentation 25/63 "Action Plan for the Future of Research, Technology and Innovation" in August 2018:

- Updating the research strategy (RTI strategy)
- Initiative to strengthen and further develop competitive basic research in Austria to promote cutting-edge research (Excellence)
- Research Funding Act – Pact for Research
- Merger of the Council for Research and Technology Development (RFTE), the Austrian Science Board and the ERA Council Forum as a consultancy body to the Federal Government, supplemented by economic expertise
- Implementation of a research funding database

First results will be presented at the RTI Summit 2019.

Implementation of selected sub-strategies

The implementation of the Open Innovation Strategy for Austria

In July 2016 Austria put forward a comprehensive national Open Innovation Strategy (OI Strategy), the first EU member state to do so.[57] Numerous activities and interventions have been implemented since then by the ministries entrusted with implementation, the Federal Ministry for Transport, Innovation and Technology (BMVIT) and the Federal Ministry of Education, Science and Research (BMBWF), as well as by stakeholders at the federal, state and local authority level. The following are examples of current implementation examples in the 2018 reporting year.

The Federal Ministry for Transport, Innovation and Technology (BMVIT) relies on innovation laboratories with different thematic orientations and above all on test environments that provide a broad basis for generating knowledge with the involvement of stakeholders. For example, test environments are being promoted to test the function and use of drones and of automated driving. In order to coordinate and protect the important areas of the infrastructure in the best possible way, the use of OI methods has also been promoted in the area of *Cyber Security* since 2018. Together with the Digitalisation Agency, the Federal Ministry for Transport, Innovation and Technology (BMVIT) is also planning a "Federal States Road Show" with explanatory methods for 3D printing, broadband expansion and drones. In addition, the Federal Ministry for Transport, Innovation and Technology (BMVIT) continues to run its extremely successful "Massive Open Online Courses" programme, in which an average of 20,000 users participate every month.

With the public research infrastructure database, the Federal Ministry of Education, Science and Research (BMBWF) makes a significant contribution to the development and operation of an innovation map (see detailed sections 3.3.1, 3.3.5 and 4.4.6).

Furthermore, the Federal Ministry of Education, Science and Research (BMBWF) and the *Future Learning Lab* of the University College of Teacher Education Vienna, together with experienced pedagogues, developed learning sequences in the summer semester 2018 that are intended to promote the STEM interest and the creative will of young people in all forms of Secondary Level schools and to create understanding for Industry 4.0 processes. Subsequently, teachers from approx. 20 schools were familiarised with the learning sequences created and trained in the use of the 3D printers. In addition, the teaching sequences provided are made available as *Open Content* under a CC BY licence in an appropriately designed Wiki.

Other ministerial departments are also playing a crucial part in the successful implementation of the OI Strategy measures. The Federal Ministry for Digital and Economic Affairs (BMDW) and the Federal Ministry for Transport, Innovation and Technology (BMVIT) play, in well-proven form, an essential part in using OI methods in public administration via the "Public Procurement Promoting Innovation" initiative (PPPI) using a *Matchmaking Platform*, *Crowdsourcing Challenges* and *Community Management*.[58]

The Federal Ministry for Europe, Integration and Foreign Affairs (BMEIA) also supports monitoring of the OI Strategy with international status reports on the development of OI in other countries. For the 2018 reporting year, they also point to a trend towards increased interest in OI in various countries (e.g. Estonia, Norway, Sweden, Slovakia, South Africa, United States); however, no other country besides Austria has developed an explicit Open Innovation Strategy so far.

Particularly pleasing is also the increased involvement of the regional governments, of which the holding of an OI Workshop in Salzburg for the first time is

57 See http://openinnovation.gv.at/wp-content/uploads/2016/08/Open-Innovation-barrierefrei.pdf
58 See www.ioeb-innovationsplattform.at/

an example: In June 2018 a regional Open Innovation Stakeholder Workshop with the title "Open Innovation Praxistag Salzburg" was held for the first time jointly by the ITG Salzburg, the two ministries Federal Ministry for Transport, Innovation and Technology (BMVIT) and Federal Ministry of Education, Science and Research (BMBWF) as well as the federal province of Salzburg. The workshop primarily addressed regional *Good Practice* examples from the Open Innovation sector.

The federal funding agencies are important intermediaries for the implementation of Open Innovation through their programmes and funding activities. Consequently, the Austrian Research Promotion Agency (FFG) anchored OI in existing programme lines and promotes the implementation of the OI strategy through targeted measures, such as the "Impact Innovation Programme", which is funded by the National Foundation. As part of the international "cOAlition S" consortium, the Austrian Science Fund (FWF) has undertaken to publish research results from public funding in compliant Open Access journals or on compliant Open Access platforms after 1 January 2020. The Austria Wirtschaftsservice (aws) also specifically helps implement the OI strategy by supporting the development of fair sharing and remuneration models for *Crowdworking*; the Austria Wirtschaftsservice (aws) also coordinates a working group on "Fair(er) remuneration in Open Innovation" as part of the NCP-IP. The Ludwig Boltzmann Gesellschaft (LBG) has set itself the goal of systematically anchoring Open Innovation in Science (OIS) in practice by implementing concrete projects.

There are numerous *Good Practice* examples demonstrating an open flow of knowledge between research and application. For example, within the framework of the EU research project "RiConfigure" (*Reconfiguring Research and Innovation Constellations*)[59], the reproduction of actor constellations in innovation processes is investigated. In so-called *Social Labs*, innovation is further developed with the participation of actors from industry, research, public institutions and civil society. In Austria there is the *Social Lab* for *Quadruple Helix Innovation,* on which the Institute for Advanced Studies works together with the *ÖBB Open Innovation Lab* in coordination with the leading OI ministerial departments, the Federal Ministry for Transport, Innovation and Technology (BMVIT) and the Federal Ministry of Education, Science and Research (BMBWF).

Furthermore the Austrian Patent Office (ÖPA) has prepared data on property rights such as patents, registered designs and trademarks in the sense of a *Open Data Initiative* and made them extensively accessible to the public. Universities and universities of applied sciences are also implementing corresponding projects with OI relevance within their field of action; thematic hackathons are an example of this.

The examples listed here merely provide a rough overview of ongoing OI initiatives[60], but they also illustrate an increased readiness to implement actions across all stakeholder areas, covering the entire content-related breadth of the measures defined in the OI Strategy for Austria.

Implementation of the Strategy for the future for Life Sciences and Pharmaceuticals in Austria

The objective of the "Strategy for the future for Life Sciences and Pharmaceuticals in Austria"[61] presented in November 2016 is to maintain and extend the industrial and scientific competitiveness of the sector, which is important for Austria as a research location. Also in the second year of implementation in the nine fields of action (namely basic research, research infrastructures, *Big Data*, personalized medicine, clinical research, science-economics cooperations, enterprises, production & market, dialogue science society) defined measures could be initiated, followed up

59 See www.riconfigure.eu

60 A tabular overview of the current OI initiatives can be found in Annex I.

61 See https://bmbwf.gv.at/fileadmin/user_upload/forschung/Life_Science_Strategie_barrierefrei.pdf

and implemented. The following measures and activities in the area of responsibility of the Federal Ministry of Education, Science and Research (BMBWF) were implemented:

In the field of action "Research infrastructures", decisive steps were taken in 2018 towards Austria's accession to the ESFRI research infrastructure "Euro-BioImaging"[62] in the field of imaging techniques, which resulted in Austria's official letter of accession at the beginning of 2019. After the very positive evaluation of the national biobank network "BBMRI.at"[63] (partner of the European research infrastructure BBMRI-ERIC[64]) by an international jury of experts, the second funding phase of the network was successfully launched. In addition, BBMRI.at was also anchored in the performance agreements of the relevant universities in order to ensure the further development of the operation of the biobanks and reinvestment in infrastructure at the sites. With regard to "Core Facilities", preparatory steps were also taken for the creation of the "Vienna Biocenter Vision 2030", which is intended to guarantee the operation of Vienna Biocenter Core Facilities GmbH (VBCF GmbH[65]) for a further ten years.

In overlapping with the field of action "Big Data", equally important activities for the establishment of e-Infrastructures were considered in the performance agreements of the relevant universities and thus necessary prerequisites for the preparation of participation in European research infrastructures (e.g. ELIXIR) were created. For the sustainable coordination of research activities in the field of "Personalised Medicine", participation in the Austrian Platform for Personalised Medicine (ÖPPM)[66], which was founded in October 2017, has now also been included in the performance agreements of the relevant universities.

In the area of clinical research, the interministerial and interinstitutional working group coordinated by the Federal Office for Safety in Health Care (BASG/AGES) is still active in preparing for the implementation of the EU Clinical Trials Regulation, which is expected to come into force at the end of 2020. The Federal Ministry of Education, Science and Research (BMBWF) has provided €1.3 million within the framework of the performance agreements for the development of the IT interfaces of the ethics commissions of the medical universities into a central EU portal for the administration of all applications for clinical studies.

The following measures and activities were implemented in the area of responsibility of the Federal Ministry for Digital and Economic Affairs (BMDW):

For the *Translational Research Center* (TRC), which is intended to close a financing and competence gap between basic research and application-oriented research, negotiations between the Federal Ministry for Digital and Economic Affairs (BMDW) and the Austria Wirtschaftsservice (aws) with an international fund construction are underway.

Within the framework of the funded Christian Doppler Laboratories and Josef Ressel Centres, about one third of all laboratories (97) active in 2018 already come from the thematic clusters "Life Sciences and Environment" and "Biotechnology". "Medicine". During the reporting period, five Christian Doppler Laboratories and one Josef Ressel Center were opened in these topic clusters. One of the three COMET centres newly approved in 2018 also comes from the life sciences sector. The discussion process on the establishment of a knowledge transfer centre (WTZ) in the field of medical devices was continued.

In 2018, the "LISA" (Life Science Austria) initiative provided eight life science start-up projects with a total of € 1.5 million in PreSeed funds and nine firms with € 6.1 million in seed financing. The financing tools of the Federal Ministry for Digital and Economic

62 See http://www.eurobioimaging.eu/
63 See http://bbmri.at/
64 See http://www.bbmri-eric.eu/
65 See https://www.viennabiocenter.org/facilities/
66 See https://www.personalized-medicine.at/

Affairs (BMDW) for life science enterprises were presented at the LISAvienna Business Meeting 2018. In addition, LISA is also responsible for location marketing in the life sciences sector; Austrian biotech start-ups and firms were represented at six trade fairs abroad; the largest seasonal European life sciences fair (*BIO-Europe Spring 2019*) in Vienna offered a wide range of networking and presentation opportunities for the Austrian life sciences location.

Furthermore, the Life Sciences Prize "*Best of Biotech 2019*" (BoB, prize for best business plan) was redesigned, and the "*Life Science Research Awards Austria 2018*" of the Austrian Society for Molecular Biosciences and Biotechnology (ÖGMBT) were awarded for the two categories basic research and application-oriented research; for the first time a special prize for outstanding research with social relevance was announced. Several conferences were supported, among them the "*BioNanoMed 2018"* in Graz on the topic "*Nanotechnology Enables Personalized Medicine*" and the "*Life Science Success 2018*" with the topic "*Alles digital*" in Vienna.

The "Life Science Report Austria 2018" together with a business directory for the Austrian research and business location in the field of life sciences was compiled and published. The report shows consistent growth in the life sciences sector in terms of the number of firms (11% increase compared to the Life Science Report 2015), the number of employees in the sector (+ 7.4%) and the level of turnover (+ 17.2%), as well as a continuous positive development of the science location in the life sciences by the universities and non-university research institutes active in it.

Implementation of the IP strategy

Two years after the IP strategy[67] came into force by decision of the Federal Government in February 2017, almost 90 % of the proposed measures could be implemented. The rapid implementation and the good reception of the proposed measures suggest that existing needs of the community could be appropriately addressed. For example, numerous new offers were already taken up very heavily in the first few months:

The online platform *IP Hub*, whose establishment at the Austrian Patent Office represents an essential step in the IP strategy, has established itself as a central contact point for all those wishing to obtain information, advice and support services related to intellectual property protection. New offers and partners are constantly being added to the service platform; the platform currently comprises a total of 76 offers from 20 partners.

During the implementation of an improved range of services in the patent and trademark area, the Austrian Patent Office developed internal evaluation designs for each individual service, with the support of which the impact is checked and the services further developed if necessary. The new services of the Austrian Patent Office in the field of trademarks, the *Trade Mark Similarity Examination* and the *Pre Check,* additionally equipped with a legal assessment of protectability are well accepted by customers. The possibility of rapid trademark registration *Fast Track* is also heavily used – in 2018 already 45 % of all online applications were administered via *Fast Track*, which enables national trademark registration in only ten days.

The *Patent Scheck*, a funding instrument designed together with the Austrian Research Promotion Agency (FFG) specifically to strengthen IP competence and IP use by SMEs and start-ups, recorded a further increase in demand in 2018 compared with the previous year. A total of over 800 applications have been received by the Austrian Research Promotion Agency (FFG).

The new IP support measures rolled out by the Austria Wirtschaftsservice (aws) from 2017 have also been very well received. The IPR promotion

67 See Federal Ministry of Science, Research and Economy (BMWFW) and Federal Ministry for Transport, Innovation and Technology (BMVIT) (2016).

and consulting services of the Austria Wirtschaftsservice (aws) for firms are well established and the measures are aimed overall at "leveraging" IP by realising innovations. With the new *IP.Coaching* programme the Austria Wirtschaftsservice (aws) supports SMEs with development and implementation of a tailor-made strategy for use of intellectual property (IP strategy). This sustainable IP strategy is coordinated with the firm's relevant business model and their innovations in the course of the coaching by the Austria Wirtschaftsservice (aws). So far 65 firms have registered for *IP.coaching*.

The new *IP.Market* support services help SMEs and research institutes that develop technology in exploiting their intellectual property outside of the firm (licensing) or outside of the research institute (third-party exploitation). The programme includes consultancy and marketing services as well as grants.

For the *"National Contact Point for Knowledge Transfer and Intellectual Property (NCP-IP)"* a new website[68] was successfully launched in autumn 2018. Thus both the visibility of the *NCP-IP* was increased in order to disseminate the IP information essential for knowledge and technology transfer even better and the sample contract bank IPAG[69], which has had 25,000 hits to current and free sample contracts on technology transfer since 2014, was integrated. In addition, the *NCP-IP* continuously takes up new (international) topics in connection with knowledge transfer and discusses them with representatives from science and industry at IP-relevant events. In the course of implementing the Open Innovation Strategy, for example, the working group "Motivation and fair exchange in open innovation processes" was set up. The aim of this working group is to expand the sample contract bank IPAG by a new *Open Innovation Toolkit* by the end of 2019.

In the field of education, measures have been taken to specifically prepare teachers and students to use IP, in particular with regard to pre-scientific and diploma theses in vocational education and training. For example, seminars such as "Knowledge of property rights for teachers", focusing on copyrights, patents, trademarks, designs, exploitation of IP, etc. are offered at the university colleges of teacher education.

The further development and sharpening of the intellectual property rights and exploitation strategies of Austrian universities was also promoted in the current performance agreements of the Federal Ministry of Education, Science and Research (BMBWF) with the universities (2019–2021) as well as with the Austrian Academy of Sciences and the IST Austria (2018–2020). The regional knowledge transfer centres are continuing their work on the basis of performance agreements with the universities and with support from the Austrian Fund and are thus also to further expand IP-relevant knowledge.

Implementation of the strategic further development of the framework conditions for humanities, social sciences and cultural studies

In the strategy document on the strategic further development of the framework conditions of the humanities, social sciences and cultural studies (GSK)[70], which was published at the end of 2017, a total of 41 measures were bundled in five thematic fields, namely in: 1) Freedom for research, 2) Quality and performance measurement, 3) Internationalisation, 4) Alternative networking spaces, and 5) Promotion of early stage researchers. In 2018, they were implemented to a large extent: Of the 41 measures, 17 have been implemented and more than half have partial results. The aim is to implement all measures by the end of 2021 and to have them accompanied by a monitoring group. The central result of numerous discussions with research funding

68 See www.ncp-ip.at
69 See www.ipag.at
70 See Federal Ministry of Science, Research and Economy (BMWFW) (2017b).

institutions is that the humanities, social sciences and cultural studies (GSK) are seen as part of a broad concept of innovation. This perspective is also increasingly being incorporated into the implementation of research funding programmes.

In the humanities, *awareness* was created in the area of museums and archives for the specific requirements of research, especially when it comes to the digitalisation of historical books and archival documents.

Sixty new humanities, social sciences and cultural studies (GSK) research infrastructures were included in the Federal Ministry of Education, Science and Research (BMBWF)'s research infrastructure database in 2018. By registering in the database, archives, museums and collections, among others, as well as social science data collections are offered the opportunity to present themselves and thus initiate national and international cooperation. At the national level, there are a number of smaller research infrastructures in the humanities, such as regional and local collections and archives, which are of high value for research, but which, due to their comparatively low visibility, are not yet as intensively used by research as would be possible. The potential for using data from research infrastructures is great. 70 % of researchers in the humanities stated in an Austria-wide survey that they used external data, i.e. data that they had not collected themselves, for research purposes.[71]

The *Austrian Social Science Data Archive* (AUSSDA) was institutionally anchored for the long term within the framework of the performance agreement negotiations with the universities of Vienna, Graz and Linz; the University of Innsbruck will consider joining the consortium in the course of the next performance agreement period.

Implementation of the Creative Industries Strategy

In order to support the Federal Ministry for Digital and Economic Affairs (BMDW) in steering and monitoring the implementation of the concrete measures of the Creative Industries Strategy[72], a Creative Industries Advisory Board of national and international experts was set up in 2018. The latter should carry out an annual monitoring of the measures and make appropriate recommendations.

On 4 October 2018 the eighth *European Creative Industries Summit* took place for the first time in Vienna in the course of the Austrian EU Council Presidency. Around 150 participants discussed the orientation and priorities of European innovation policy with the key players in the European creative industries and those responsible at the European level. Groundbreaking innovations, for example in the fields of health, mobility, green energy or climate change, are emerging particularly at the interface between the creative industries and digitalisation. The aim of the *European Creative Industries Summit 2018* was to show how the creative industries drive the overall economy and the development of regions and society as a whole through cross-innovation.

As part of the monetary promotion of creative economy-based, non-technological innovations, a special focus was placed on digitalisation projects in 2018 in order to take account of the key role of the creative industries as a digitalisation driver. With two half-yearly calls each from the two subsidy programmes "aws impulse XL" and "aws impulse XS", a total of more than 50 innovative project ideas could be supported and implemented with more than €4 million.

In order to strengthen the entrepreneurial skills of creative professionals with regard to interna-

71 See Bauer et al. (2015, 112).

72 See https://www.kreativwirtschaft.at/wp-content/uploads/2016/06/Kreativwirtschaftsstrategie_f%C3%BCr_%C3%96sterreich.pdf

tionalisation, the Austrian Economic Chambers (WKO) launched the pilot "Creative Industries Webinars" in cooperation with Advantage Austria. Innovative business models are scouted worldwide and presented to the Austrian creative industries within the framework of digital webinars. The aim is to transfer know-how from international markets to Austria as a stimulus for new business models and innovative ideas.

In order to further strengthen economic competence, creativity and cooperation among creative professionals, the "C to the power of 3" ("C hoch 3") creative industry coachings were implemented throughout Austria for the first time, and Austria-wide network meetings for all participants were initiated. Under the motto "Giving room to innovations", one-day innovation camps for creative firms called "Creative Industries Workshops" were offered in order to jointly develop questions, enter into cooperations and initiate innovations. Within the framework of the "impulse lectures" series current questions from the field *soft & creative innovation* were taken up, among others the topics *social design & social impact* or *biomimicry* - design principles from nature and learning tools for nature-inspired design.

Bioeconomy – a strategy for Austria

In March 2019 the first Bioeconomy Strategy[73] for Austria was put forward in the Council of Ministers. It addresses the question of how society can deal with natural resources in a sustainable and responsible way and at the same time operate successfully. Bioeconomy stands for an economic concept that aims to replace fossil resources (raw materials and energy sources) with renewable raw materials. It encompasses all industrial and economic sectors that produce, process or use biological resources. Bioeconomy should thus offer a great opportunity to meet global challenges such as advancing climate change, food and water scarcity or increasing environmental pollution, while at the same time strengthening economic development.

The working paper "Bioeconomy RTI Strategy"[74] on "Climate Change and Resource Scarcity" of the RTI Task Force, which was created to better coordinate the numerous activities and policy fields in the field of bioeconomy, identifies essential research tasks and important conflicting objectives that need to be addressed. Numerous experts from science and research were involved at an early stage in the preparation of the Bioeconomy RTI Strategy.

Since the economic transformation towards a bioeconomy is a complex process, adequate RTI instruments covering all phases of innovation are essential. In addition to technological development, the systemic combination of technical with economic, political, social and ethical aspects is essential for the successful implementation of a knowledge-based bioeconomy. Bioeconomy research must therefore - based on basic research - be inter- and transdisciplinary, orient itself to principles such as "Open Innovation"[75] and "Responsible Science"[76] and promote cooperation. The Bioeconomy Strategy therefore identifies the following fields of action in the area of science and research[77]:

- Basic research on resource availability, ecological functions (soil, biodiversity, etc.), location conditions and social framework conditions of a bio-based economy;
- (Physical, chemical, biological) analysis of material properties;
- Assessment of the institutional and legal framework as well as regional and local effects of the bioeconomy;

73 See Federal Ministry for Sustainability and Tourism (BMNT) et al. (2019).
74 See https://nachhaltigwirtschaften.at/resources/nw_pdf/biooekonomie-fti-strategie-ag2-2018.pdf
75 See http://openinnovation.gv.at/
76 See https://www.responsiblescience.at/
77 See Federal Ministry for Sustainability and Tourism (BMNT) et al. (2019).

- Topic-specific, interdisciplinary analyses and evaluations (combining basic and applied research), taking into account research in the humanities, social sciences and cultural studies;
- Applied research: Increase efforts in the area of product and process development for the material and energy recycling of biogenic materials;
- Survey of the utilisation potential of biobased materials taking into account ecological, economic and social effects;
- Systemic assessment of the interactions between climate change and increased biomass production and biodiversity;
- Development of new products from biogenic raw materials or waste and by-products;
- Topic-specific initiatives of universities and higher education institutions on education and life-long learning (according to the Austrian National Development Plan for Public Universities);
- Creation of legal and organisational framework conditions for the bioeconomy and private investors.

In recent years, Austria has already been able to position itself as a key player in the field of bioeconomy. For example, one third of Austrian universities are active in the field of bioeconomy. The University of Natural Resources and Life Sciences Vienna, is particularly noteworthy in this respect, as it was early to shape the international development trend towards bioeconomy and plans to establish a Centre for Bioeconomy in 2019, which will serve as a contact point for stakeholders from industry and politics. In addition to institutional bodies, cooperation platforms are dedicated in particular to the process chains "agriculture - food - biotechnology" and "forestry - timber industry", as well as to the linkages between resource flows. For example, 16 Christian Doppler laboratories and four Josef Ressel Centres are working on bioeconomy-relevant research questions with the participation of universities, universities of applied sciences and business enterprises.

On the basis of the Bioeconomy Strategy, an action plan for bioeconomy was started at the beginning of 2019, which is addressed to all relevant actors in this field. The target areas identified in the strategy form the framework for the selection of the measures in the action plan:

1. Achieve the climate goals
2. Reduction of dependence on non-renewable raw materials
3. Funding innovation
4. Promotion of economic development
5. Safeguarding and creating jobs
6. Promotion of sustainable social transformation

Artificial Intelligence Mission Austria 2030 – AIM AT 2030

The government is currently working across departments on the "*Artificial Intelligence Mission 2030*", the Federal Strategy for Artificial Intelligence, for short: AIM AT 2030[78]. Until summer 2019 working groups, which already started their work in January of this year, will work out proposals for this on the basis of the "*White Paper*" of the Austrian Council on Robotics and Artificial Intelligence. In the autumn, the strategy document will be available, which shows the potential for action as well as the framework for Austria as a key player in the international context. A primary goal is to reduce dependence on international market leaders. To this end, investments are to be made primarily in basic research in order to position Austria as an international research location for AI in the future.[79]

78 See https://www.bmvit.gv.at/innovation/publikationen/ikt/downloads/aimat_ua.pdf

79 See the Federal Ministry for Transport, Innovation and Technology (BMVIT) and the Federal Ministry for Digital and Economic Affairs (BMDW) (2019).

Current developments in the higher education sector

Implementation of Sustainable Development Goals (SDGs) at the universities

The resolution "*Transforming our world: the 2030 Agenda for Sustainable Development*" was adopted at the General Assembly of the United Nations. It consists of a catalogue of 17 goals and 169 targets for sustainable development in the period 2016 to 2030. The aim is to meet global challenges such as poverty, hunger, inequalities, crises and conflicts as well as climate change with the participation of all governments in the world. The coherent implementation of the SDGs in Austria was agreed with a decision of the Council of Ministers of 12 January 2016 and was also the topic of the decision of the Bologna Ministerial Conference on 25 May 2018.[80]

The implementation of the SDGs in the higher education sector takes place in a variety of ways, such as by anchoring them in the performance agreements of the universities, in the Austrian National Development Plan for Public Universities, and in a system-oriented research approach to the societal challenges in the RTI strategy of the federal government. Through their educational and research mission, Austrian universities are predestined to play an important role for society in the implementation of the SDGs through interdisciplinary cooperation, visionary thinking and innovative solutions. The network "UniNEtZ – Universitäten und Nachhaltige EntwicklungsZiele" (Universities and Sustainable Development Goals) also operates in this context. It endeavours to anchor the SDGs at universities in research, teaching and university management. Corresponding binding sponsorships or memberships of universities for the implementation of individual SDGs were laid down in the performance negotiations 2019–2021 between the universities and the Federal Ministry of Education, Science and Research (BMBWF). Members of UniNEtZ are currently 15 universities as well as the Zentralanstalt für Meteorologie und Geodynamik (ZAMG) (Institute for Meteorology and Geodynamics), the Geological Survey of Austria (GBA) and the Climate Change Center Austria (CCCA). The goals include the preparation of a cross-university and cross-disciplinary option papers to support the Federal Government in implementing the sustainability goals, inter- and transdisciplinary cross-university networking, interaction with stakeholders from politics, administration, business and civil society, as well as the development of knowledge competence on SDG-related topics.

Expansion of structured doctoral training and promtion of a cooperative model

The promotion of early stage researchers is a central element in sustainably strengthening Austria as a scientific location in international competition.

With regard to the increasing number of successful doctoral students, Austria has not set itself an absolute figure as a target. The strategy is rather to improve the ratio of students to graduates, to avoid drop-outs wherever possible and to increase the number of university degrees. To achieve these objectives, a qualitative approach is being pursued. The Austrian model of the "structured doctorate" is based on qualitative cornerstones (see Section 3.2.5) and special attention is also paid to its qualitative further development in the performance agreements 2019–2021.

The promotion of a doctoral programme for the purpose of cooperation between universities and universities of applied sciences, as recommended by the Austrian Higher Education Conference in 2015, is in preparation; depending on budgetary coverage.

"Cooperative doctorate" means that a university and a university of applied sciences jointly offer doctoral programmes. It is of relevance that the right to award doctorates continues to be conferred exclu-

80 See EHEA Paris 2018 Ministerial Conference (2018).

sively by a university, while the support and supervision of doctoral students is carried out jointly. These efforts are complemented by further measures to support the career development of researchers, such as the promotion of international mobility, intersectoral and interdisciplinary knowledge transfer via e.g. Marie Skłodowska-Curie Actions of the European Union and a fundamental qualitative improvement of doctoral education.

In the winter semester 2018/19 the first cooperative doctorate programme at the Vienna University of Technology started together with the University of Applied Sciences Technikum Wien in the topic area "Resilient Embedded Systems".

Implementation status of higher education planning

As of 2019, the following strategic documents will be continued or newly introduced:

- Austrian Development Plan for Higher Education (Österreichischer Hochschulentwicklungsplan, HoP)
- Revision of the Austrian National Development Plan for Public Universities (GUEP)
- Continuation of the Future of Higher Education (Zukunft Hochschule, ZH)

Introduction: "Austrian Development Plan for Higher Education" for the higher education sector

The Austrian Development Plan for Higher Education (HoP) will be the strategic document that focuses on the entire Austrian higher education sector. This means that the Development Plan for Higher Education (HoP) will be established as a "strategic umbrella" for the existing strategy papers in the Austrian National Development Plan for Public Universities (GUEP), the development and financing plan for universities of applied sciences and the strategic framework of the university colleges of teacher education (PH-EP). The Development Plan for Higher Education (HoP) is currently in preparation and is expected to be completed by 2020.

The Development Plan for Higher Education will focus on development variables, e.g. what percentage of a single age cohort should be educated in the tertiary sector? Which higher education sector should develop quantitatively and qualitatively, and how?

With the preparation of the Development Plan for Higher Education, the Federal Ministry of Education, Science and Research (BMBWF) is responding to recurring requests from the Austrian Court of Audit and the Parliament to develop a planning instrument covering the entire Austrian higher education area.

Rolling out the Austrian National Development Plan for Public Universities (GUEP): revision of the Austrian National Development Plan for Public Universities (GUEP) in 2019 according to Section 12b of the Universities Act (UG)

The Austrian National Development Plan for Public Universities (GUEP) is the strategic planning document of the Federal Ministry of Education, Science and Research (BMBWF) in which the goals that shape the further development of the universities are prioritised. The first version of the Austrian National Development Plan for Public Universities (GUEP) referred to the planning horizon 2016–2021 and was prepared in 2015 after a consultation process with 42 higher education institutions. The Austrian National Development Plan for Public Universities (GUEP) was revised already in 2017 on a rolling basis for the 2019–2024 planning period in preparation for the negotiations for the performance agreement in 2018 and formation of the 2019–2021 performance agreements. By the end of 2019, it will be further developed in terms of content in order to serve as a leading strategy paper for the universities in drawing up their respective university development plans. These, in turn, are an essential basis for the drafting process of the forthcoming 2022–2024 performance agreements.

Continuation of the Future of Higher Education

The "Future of Higher Education" project launched by the Federal Ministry of Education, Science and Research (BMBWF) in spring 2016 and successfully completed in 2017 is to be continued in a revised form. The project aimed at the strategic further development of the Austrian higher education system - in particular better coordination between public universities and universities of applied sciences. Findings from the 2016/17 Future of Higher Education project have been incorporated into the plan for universities of applied science and the performance agreements 2019–2021.

The continuation of the successful project serves to further deepen the coordination between the higher education sectors and to prepare the content of the priority topics for developments from 2022 onwards. What will be new in particular is the involvement of the university colleges of teacher education and the private universities in the joint coordination process.

The topics under discussion range from new learning environments and their virtual and real infrastructures (such as short-cycle programmes) to questions about innovative study formats. The focus will continue to be on emphasising the differences between various higher education sectors as well as on future content developments in the portfolios of the higher education sectors in general, coordination in the field of studies (transferability/recognition) and cooperation between the higher education sectors.

2. Major Federal Funding Agencies in Austria

There are several institutions which provide funding for research, technology and innovation in Austria, both at the federal and regional level. Most funding at the federal level is awarded and/or administered on behalf of the federal government by the three large agencies: the Austrian Science Fund (FWF), the Austrian Research Promotion Agency (FFG) and the Austria Wirtschaftsservice (aws). While the Austrian Science Fund (FWF) and the FFF, the largest predecessor of the Austrian Research Promotion Agency (FFG), were founded in 1968, the Austrian Research Promotion Agency (FFG) and the Austria Wirtschaftsservice (aws) were created through the merging of various agencies in 2002 and 2004, respectively.[1]

This chapter describes the three largest federal funding agencies, their statutory basis, current figures and priorities, as well as new strategic initiatives and funding programmes.

The **Austrian Science Fund** (FWF) is Austria's central institution for the promotion of basic research. Its responsibilities include enhancing and developing the country's scientific research system and increasing Austria's attractiveness as a location for research: supporting researchers with their stand-alone projects has traditionally been the most important funding programme. Funding for projects is mainly awarded bottom-up based on applications which are subject to an international peer-reviewing process. With a budget of €230.8 million in 2018 (€217.3 million in 2017), 684 projects (2017: 642) received new support from the Austrian Science Fund (FWF). Owing to a significant increase in the application volume to approx. €950 million (2017: €879.4 million), the total approval rate (by sum) sank slightly, from 22.4% to 22.1%, while the approval rate of stand-alone projects remained stable, at approx. 28%.

The **Austrian Research Promotion Agency (FFG)** is the national funding institute in Austria for applied research and development . It offers a wide range of instruments to firms in particular as well as research institutes and higher education institutions: the portfolio includes everything from low-threshold programmes, which facilitate the entrance to on-going research and innovation activity, to the promotion and funding of thematic groups and competence centres. In addition to financial support, the Austrian Research Promotion Agency (FFG) also offers services and consultation – for example, it acts as the national contact point for research programmes of the European Union and as interface to the European Space Agency. The number of contractually guaranteed grants, liabilities and loans in 2018 amounted to €617.6 million. This corresponds to a present value of €500.8 million.

Austria Wirtschaftsservice GmbH (aws) is the federal promotion bank. By providing loans, grants and guarantees with low interest rates, firms receive support for the implementation of their innovative projects, particularly when other forms of financing are unable to provide the necessary funds. In addition, specific information and consultation services offer support to firms which are in the making, already exist or are in the process of expanding. In 2018, total funding in the amount of €2,189.5 million was 91.2% more than the comparative value of the previous year, whereby grant programmes which were offered temporarily and had a broad impact (in particular, the employment bonus) were responsible for the high increase in grant volume (from €223.6 million in 2017 to €1,241.2 in 2018). The approval rate was 54%.

2.1 Austrian Science Fund (FWF)

Legal framework and funding aims

The Austrian Science Fund (FWF) is Austria's central institution for the promotion of basic research as well as artistic-scientific research. It was founded in 1968 and is a legal entity under public law, estab-

1 See Pichler et al. (2007) for an overview of the agencies' history.

lished by the federal Research and Technology Promotion Act (FTFG)[2]. In accordance with Section 2 of the FTFG, the Austrian Science Fund (FWF) was established to promote research that serves to increase knowledge and to both broaden and deepen scientific understanding, rather than focusing on profit. The Federal Ministry of Education, Science and Research (BMBWF) serves as a supervisory body to the Austrian Science Fund (FWF).

Instruments, key performance indicators and priorities

Austrian Science Fund (FWF) programmes are divided into three main programme categories:

Funding of top-quality research – exploring new frontiers, the largest group in terms of volume which, among others, comprises the most important FWF programme: Stand-alone projects

1. **Development of human resources – cultivating talents** includes programmes for the funding of early stage researchers and mobility, as well as
2. **Scientific – Societal Interplay – Realising ideas** has several smaller programmes and initiatives at the interface between science, industry and society.

A budget in the amount of €184 million annually plus additional funding amounting to €110 million has been approved for the Austrian Science Fund (FWF) for the years 2018-2021. Based on a step-by-step increase of the budget in the multi-year plan, an increase of up to €224 million until 2021 has been planned. Further budget increases were made through the higher endowment of the National Foundation for Research, Technology and Development (NFTE) as well as through additional funding from regional governments and foundations.

Due to the budget increase, in 2018 new approvals increased by around 6%. The total approval rate (calculated as the quotient of application volume and new approval volume) sank slightly, from 22.4% to 22.1%, due to the increase in application volume, while the approval rate of stand-alone projects remained high, at approx. 28% (see Table 2-3).

In 2018, board of trustees at the Austrian Science Fund (FWF) made decisions on more than 2,500 project applications with a total volume of approx. €950 million. This significant increase in application volume as compared to the previous year (€879.4 million in 2017) shows that the Austrian research community's need for funding continues to increase. This need for funding will remain constant in the future as the country's presence as a place for research continues to grow. This increase – similar to the decrease in the previous year – may also be attributable in part to the lifting of restrictions on applications, which took place in August 2018. By lifting these restrictions, it was possible to apply for funding for three projects instead of two without any limitation concerning the maximal amount of funding that could be applied for.

In turn, the number of project applications (which decreased slightly in 2017) went from 2,493 to 2,501, a minimal increase of 0.3% (see Table 2-1). The increase in new approvals amounted to 6.5%.

In much the same way the number of applications increased, there were also changes to volume: 7.9% for application amounts, 6.2% for new approvals (see Table 2-3). This demonstrates a steady increase in the size of projects as well as longer project times.

The FWF promotes individual researchers in particular. In total, the number of individuals who received funding increased to 4,155. This amounts to a full-time equivalent of 2,843 people. They are mostly PhD students working on FWF projects. The number of female researchers receiving FWF funding increased in 2018 once again in all personnel categories following a decrease in 2017. This increase surpassed the increase recorded in 2016 (see Table 2-2). Women also feature more frequently as project leads: the figure was still at 28% in 2017, and in 2018 it increased to more than 34.5%. This can be attributed to two factors: the increased likelihood that a project would be

2 See https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=10009523

Table 2-1: Number of grants in 2017–2018

Programme	Project proposals		Projects led by women (as %)	Project employees[1]	New approvals		Approval rate in %	
	2017	2018	2018	2018	2017	2018	2017	2018
Stand-alone projects	1,025	1,052	*28.2*	733	295	298	*28.8*	*28.3*
International programmes	466	456	*26.5*	242	106	121	*22.7*	*26.5*
Special Research Programmes (SFBs) – new applications[2,3]	33	62	*22.6*	55	7	29	*5.3*	*10.3*
Special Research Programmes (SFBs) – extensions[3]	24	-	-	-	20	-	*83.3*	-
Young Independent Researcher Groups	-	61	*47.5*	46	-	7	-	*11.5*
START Programme	88	84	*20.2*	25	6	6	*6.8*	*7.1*
Wittgenstein Award	20	21	*19.0*	N/A	1	2	*5.0*	*9.5*
Doctoral Programmes – new applications[2]	5	-	-	-	4	-	*25.0*	-
Doctoral Programme – extensions	8	8	*0.0*	126[4]	7	6	*87.5*	*75.0*
doc.funds	45	-	-	-	7	-	*15.6*	-
Erwin Schrödinger Fellowships	146	132	*32.6*	53	53	53	*36.3*	*40.2*
Lise Meitner Programme	209	238	*35.3*	70	50	70	*23.9*	*29.4*
Hertha Firnberg Programme	83	91	*100*	22	21	22	*25.3*	*24.2*
Elise Richter Programme	74	83	*100*	44	17	29	*23.0*	*34.9*
Programme Clinical Research	81	79	*41.8*	43	13	17	*16.0*	*21.5*
Programme for Arts-based Research	67	68	*47.1*	44	9	11	*13.4*	*16.2*
Top Citizen Science Funding Initiative	18	10	*10.0*	9	7	5	*38.9*	*50.0*
"Tyrol-South Tyrol-Trentino" interregional project network	38	56	*16.1*	11	2	8	*5.3*	*14.3*
Open Research Data	40	-	-	-	12	-	*30.0*	-
Science Communication Programme	23	-	-	-	5	-	*21.7*	-
Total	**2,493**	**2,501**	***34.3***	**1,523**	**642**	**684**	***25.5***	***26.7***

1 Figures are based on proposed project staffing on approved projects. These figures may not correspond exactly with the number of persons ultimately financed in the projects.
2 The approval rate is calculated from the ratio of approved projects to concept applications. Concept applications are not included in this table. The total percentage of approvals also takes this correlation into account.
3 SFB sub-projects were evaluated.
4 This figure includes proposed project staffing and proposed PhD places "*fully funded by the Austrian Science Fund (FWF)*". Additional PhD places with partial funding are not included.

Source: Austrian Science Fund (FWF).

Table 2-2: Research staffing funded by the Austrian Science Fund (FWF) 2017–2018

Research staffing	FTE (full time equivalents) 2017 per 31 December	including women in %	FTE (full time equivalents) 2018 per 31 December	including women in %	Change in number of women as %
Researchers	2819.3	*42.15*	2843.1	*44.39*	*+2.24*
Post-docs	1114.9	*37.46*	1134.7	*41.11*	*+3.65*
Pre-docs	1373.6	*42.49*	1381.0	*44.02*	*+1.53*
Other staff	330.9	*56.51*	327.4	*57.29*	*+0.78*

Source: Austrian Science Fund (FWF).

approved and the success of the FWF in promoting women's participation in FWF projects at all levels.

Strategic developments

Many important events occurred in 2018, and they will also be of strategic importance for the Austrian Science Fund (FWF) in the future:

- The Austrian Science Fund (FWF) celebrated its 50-year anniversary in 2018 with the **BE OPEN – Science & Society Festival**, which took place while the Austrian presidency of the EU . The FWF used the festival as a way to promote trust in research and to highlight the significance of basic research. The stakeholder initiative **PEARL** is the

Table 2-3: Total funding in € millions, 2017–2018

Programme	Value of funding applications		New approvals		Approval rate in %		Total funding amount including supplemental grants[1]	
	2017	2018	2017	2018	2017	2018	2017	2018
Stand-alone projects	337.4	360.2	97.8	102.7	*29.0*	*28.5*	98.7	104.7
International programmes	131.6	126.9	27.5	30.0	*20.9*	*23.6*	27.6	30.6
Special Research Programmes (SFBs) – new applications[2]	13.3	26.4	3.3	13.3	*4.3*	*11.0*	3.3	13.6
Special Research Programmes (SFBs) – extensions	11.0	-	8.4	-	*76.8*	-	9.1	-
Young Independent Researcher Groups	-	118.9	-	13.0	-	*10.9*	-	13.0
START Programme	101.1	98.4	6.8	7.1	*6.7*	*7.2*	6.8	7.2
Wittgenstein Award	30.0	31.5	1.5	2.8	*5.0*	*8.9*	1.5	2.8
Doctoral Programmes – new applications[2]	11.6	-	7.7	-	*19.0*	-	7.7	-
Doctoral Programme extensions	23.5	26.0	17.9	19.0	*76.0*	*73.2*	19.5	22.2
doc.funds	65.3	-	11.3	-	*17.3*	-	11.3	-
Erwin Schrödinger Fellowships	18.7	17.5	7.2	7.1	*38.4*	*40.5*	8.0	8.0
Lise Meitner Programme	32.6	38.8	7.9	11.4	*24.2*	*29.4*	8.2	11.9
Hertha Firnberg Programme	19.1	21.3	4.8	5.2	*25.3*	*24.2*	5.0	5.5
Elise Richter Programme	21.4	24.0	4.8	8.3	*22.2*	*34.5*	5.1	8.6
Programme Clinical Research	22.7	24.2	4.0	5.4	*17.5*	*22.2*	4.0	5.4
Programme for Arts-based Research	25.1	25.2	3.4	4.1	*13.5*	*16.5*	3.4	4.2
Top Citizen Science Funding Initiative	0.8	0.5	0.3	0.2	*41.5*	*47.1*	0.3	0.2
"Tyrol-South Tyrol-Trentino" interregional project network	4.9	8.8	0.3	1.3	*5.8*	*14.3*	0.3	1.3
Open Research Data	8.2	-	2.2	-	*27.0*	-	2.2	-
Science Communication Programme	1.1	-	0.2	-	*23.2*	-	0.2	-
Total[3]	**879.4**	**948.7**	**217.3**	**230.8**	***22.4***	***22.1***	**222.6**	**239.5**

1 Total costs include supplementary amounts approved for ongoing projects in addition to new approvals. These supplementary amounts cover items such as inflation allowances and accounting allowances.
2 The approval rate is calculated from the ratio of approved projects to concept applications. Concept applications are not included in this table. The total percentage of approvals also takes this correlation into account.
3 In the case of overall approvals, this includes additional approvals in programmes in which there were no new approvals in 2017 or 2018.
Source: Austrian Science Fund (FWF).

result of many conversations that took place on this topic. Its aim is to continue to enhance the network between the FWF and organisations from industry and society. The first pilot projects began in 2018. Following a final evaluation in 2019, they will serve as a basis for the continuation of these initiatives.

- The following continues to be of strategic importance: the research action plan for the future, based on the government programme drawn up by the relevant federal ministries (see the Austrian Council of Ministers' presentation "Action plan for research, technology and innovation" from August 2018), and the commissioning of the development of an **excellence initiative** for Austria.
- In cooperation with partner organisations in Central Europe, the FWF has also begun to intensify its international collaborations in this region. This **Central European Science Partnership** (CEUS) will be developed further in 2019.
- As a continuation of its policy **for Open Access and Open Science**, the Austrian Science Fund (FWF) was one of the biggest promoters of "cOAlition S", a coalition of European funding organisations that wish to decisively promote free access to scientific publications with "Plan S". Their aim is

to formulate common principles and an implementation plan by 2020.[3] With the introduction of a modified Open Research Data Policy and a Data Management Plan, the FWF has taken an additional step in the area of Open Science.[4]

- Another priority includes the expansion of measures related to **scientific ethics and research integrity**[5]: in addition to the annual publication of suspected cases in which scientific misconduct occurred, as well as active participation in the SOPs4RI network (Standard Operating Procedures for Research Integrity), a working group that is part of the Austrian Higher Education Conference is in the process of creating a Code of Conduct.
- **Transition to PROFI:** The comprehensive consultation process with researchers, research institutions and Austrian Science Fund (FWF) committees on PROFI, the implementation of project funding through institutions, was completed in 2018. In an initial phase that began in 2018, the three funding programmes doc.funds, Young Independent Researcher Groups and Research Groups in line with PROFI were administered. Subsequently, existing programmes will be converted to the new funding format in the years 2019/20.
- **Strategy 2019–2021**: The Austrian Science Fund (FWF) presented its Strategy 2019–2021 (multi-year programme 2019–2021) at the end of 2018. The focus lies on the following three aspects: quality assurance, consolidation of the funding portfolio and the dialogue with society.[6]

Changes in the portfolio of instruments

For some time now, the Austrian Science Fund (FWF) has been working intensively and in close coordination with the universities, the Austrian Academy of Sciences (ÖAW) and the Austrian Research Promotion Agency (FFG) to develop new formats that meet the needs of the scientific community, close gaps in

Table 2-4: New initiatives and funding programmes in 2018

Funding programme/initiative	Target group	Objective
Young Independent Researcher Groups (in cooperation with the Austrian Academy of Sciences, ÖAW): Post-doc programme for innovative, interdisciplinary teams	Early stage researchers (post-docs from Austria and abroad who have received their PhD 1 to max. 5 years ago) from all scientific disciplines.	Promotion of young post-docs; collaboration in the medium term (up to 4 years) on an interdisciplinary, complex and current topic in mixed teams of between 3 and 5 researchers; transdisciplinary collaboration on innovative topics.
Research groups: Linkage between inter- or multidisciplinary research teams of three to five researchers regardless of location	Teams of three to five internationally renowned researchers from all scientific disciplines.	Funding for cooperation projects between three and max. five researchers in smaller areas or in specific scientific disciplines that are working together in smaller setups. The aim is to enhance or to reconsolidate work on a topic within inter- or multidisciplinary research projects
Quantum Research and Technology (QFTE) (in cooperation with the Austrian Research Promotion Agency, FFG)	Researchers from quantum research following their PhD whose scientific qualifications are substantiated by renowned international publications	Knowledge transfer from basic research in quantum physics to the development and application of quantum technologies and vice versa. This provides researchers with career opportunities in the business enterprise sector as an alternative to a purely academic career

Source: Austrian Science Fund (FWF).

3 See the support for Plan S by cOAlition S: https://www.coalition-s.org/
4 See https://www.fwf.ac.at/en/research-funding/open-access-policy/open-access-to-research-data/
5 See https://www.fwf.ac.at/en/research-funding/research-integrity-research-ethics/
6 See https://www.fwf.ac.at/fileadmin/files/Dokumente/Ueber_den_FWF/Publikationen/FWF-relevante_Publikationen/fwf-mehrjahresprogramm-2019-2021.pdf

the existing portfolio and facilitate new partnerships. Table 2-4 describes new programmes or instruments which were initiated in 2018.

2.2 Austrian Research Promotion Agency (FFG)

Legal framework and funding aims

The Austrian Research Promotion Agency (FFG) is the national funding agency for applied research and innovation in Austria. It was founded on 1 September 2004 by the "Act on the Establishment of the Austrian Research Promotion Agency" (FFG-Gesetz), Federal Law Gazette I no. 73/2004. It is entirely owned by the Republic of Austria. The federal ministries in charge are the Federal Ministry for Transport, Innovation and Technology (BMVIT) and the Federal Ministry for Digital and Economic Affairs (BMDW). As a provider of funding services the Austrian Research Promotion Agency (FFG) is also often commissioned by other regional, national and international institutions. It supports the execution of programmes of the Austrian Climate and Energy Fund, provides funding in connection with regional cooperation programmes and reviews applications for the research tax premium.

The Austrian Research Promotion Agency (FFG) supports RTI policy in 1) broadening the basis for innovation, 2) structural change (e.g. funding for start-ups and for particularly risky but strategically important R&D proposals) and 3) strengthening the basis for Austrian research and innovation in strategic areas (e.g. energy, manufacturing, mobility, ICT). Improving the interaction between science and industry, promoting early stage researchers, supporting career development in applied research for science and industry, and promoting equal opportunities are further goals of the Austrian Research Promotion Agency (FFG), which are being implemented through a wide-ranging portfolio of funding instruments.

Instruments, key performance indicators and priorities

The instruments used by the Austrian Research Promotion Agency (FFG) span a wide range: from low-threshold entry formats to the funding of top quality research. Specific funding objectives are associated with various types of projects. The funding instruments of the Austrian Research Promotion Agency (FFG) have the following approaches:

- **Entry:** Projects which involve exploring possible research and development themes and options for innovation, and devising initial preparatory steps for projects
- **Research, Development and Innovation Project (RDI Project):** Specific R&D projects, from targeted basic research through to market-oriented development projects
- **Market launch:** Results of the R&D phase are launched on the market.
- **Structure:** The development and improvement of structures and infrastructure for research and innovation
- **People:** Person-specific projects to promote early stage researchers, develop the qualifications of R&D personnel and improve equal opportunities
- **Expenses:** R&D services required to implement commissioned R&D for research investigations on specific issues.

Facts and figures on the RTI funding of the Austrian Research Promotion Agency (FFG) will be presented below. It should be noted that the presented key data on the FFG's funding activities focuses on RTI agendas, while funding administered within the scope of the Federal Ministry for Transport, Innovation and Technology's (BMVIT) broadband initiative has not been taken into account. Table 2-5 and Table 2-6 list the number of projects, participations associated with those projects and the number of various actors involved (firms, research institutes etc.) as well as the contractually guaranteed funding for the year 2018. The latter (including liabilities and loans) amounted to €617.6 million. This corresponds to a present value of €500.8 million. Compared to 2017,

Table 2-5: Funding provided by the Austrian Research Promotion Agency (FFG), without broadband initiative, 2018

Programmes	Projects		Participations		Actors	
	2017	2018	2017	2018	2017	2018
Total	**3,602**	**3,854**	**5,870**	**6,622**	**3,407**	**3,897**
General Programmes	1,664	1,794	2,192	2,355	1,608	1,709
Thematic Programmes	1,475	1,502	2,318	2,526	1,485	1,646
Aeronautics and Space Agency (ALR)	421	490	1,271	1,617	991	1,027
European and International Programmes	33	32	77	87	57	61

Source: Austrian Research Promotion Agency (FFG).

Table 2-6: Austrian Research Promotion Agency (FFG) funding amounts by sector, without broadband initiative 2017 and 2018 (in € millions)

Programmes	Total costs		Total funding		Present value	
	2017	2018	2017	2018	2017	2018
Total	**1,102.5**	**1,244.6**	**562.5**	**617.6**	**434.3**	**500.8**
General Programmes	606.8	491.1	307.7	294.4	179.5	177.7
Structural Programmes	217.4	317.7	90.6	118.8	90.6	118.8
Thematic Programmes	267.7	348.1	155.5	196.6	155.5	196.6
Aeronautics and Space Agency (ALR)	9.1	9.2	7.3	7.0	7.3	7.0
European and International Programmes	1.5	0.9	1.4	0.8	1.4	0.8

Source: Austrian Research Promotion Agency (FFG).

this results in an increase in the present value of funding in the volume of 15.3% (2017: €434.3 million present value). This funding initiated research projects with a total volume of more than €1.2 billion (an increase of 12.9% as compared to 2017). The number of funded projects amounted to a total of 3,854; this includes 6,622 participations and 3,897 different actors. This corresponds to a 14.4% increase in funded actors as compared to the previous year (3,407 actors), while the number of projects increased by 7.0%. These increases clearly show that the Austrian Research Promotion Agency (FFG) successfully contributes to the promotion of Austria as a place for research and to the ongoing broadening of the research base in Austria.

The most important programmes within this portfolio are the General Programmes. They have the largest share of funding volume, the largest present value, and they also include the largest number of projects and the largest amount of incurred total costs. Approximately 1,800 projects with a present value of €177.7 million are included here. Their share of all the FFG's funding amounts to 46.5% (projects) and 35.5% (present value).

Thematic Programmes receive €196.6 million of approved funds, measured in present value. These programmes ensure that priorities are set in selected fields of technology. Their aim is to induce critical masses in research activity and hence to ensure Austria's connection to the international *technological frontier*. The spectrum of selected fields of technology is very large. In terms of their quantitative importance, the following fields rank high: energy, ICT, mobility and transport, production technologies, security research and air transport. The Aeronautics and Space Agency (ALR) can also be included among these thematic specialisations. However, it is considered a separate department and listed as such.

The third largest category of programmes at the Austrian Research Promotion Agency (FFG) are Structural Programmes. There are €118.8 million worth of funds (present value) intended for these programmes. They include, among others, the COMET programme

(nearly €85 million in present value of funding in 2018), the Austrian "flagship programme" for the promotion of cooperation between science and industry through the development of common research competencies. In particular, the programme focuses on excellence, the inclusion of international research know-how as well as developing and ensuring firms' technological leadership to strengthen Austria as a location.

The funding opportunities of the Austrian Research Promotion Agency (FFG) are, as a matter of principle, available to all stakeholders and types of organisations. The focus lies on the promotion of applied research in business, which receives 61% (or €376.8 million in absolute figures) of the total funding of the Austrian Research Promotion Agency (FFG) (see Table 2-7). The second largest category of funding recipients are (non-university) research institutes, which have received a total of €135.9 million in funding. Their share of the total FFG funding is thus 22%. In 2018 Austrian universities received €88.2 million or 14.3% of the funding provided by the Austrian Research Promotion Agency (FFG).

The Research Promotion Agency classifies funded projects according to fields of technology, whereby this classification is based on the "CORDIS Subject Index Classification Codes" (SIC). This makes it possible to also depict the thematic (and technological) structure of FFG research funding. Fig. 2-1 shows the result of this classification.

It ought to be noted that the SIC fields of technology can vary in terms of their "bandwidth". "Generic" fields of technology with a wide range of funded projects, such as "Industrial manufacturing" or "ICT applications", stand in contrast to very narrow and specifically defined fields of technology (e.g. agricultural biotechnology, aeronautics and aviation technology, quantum technologies). Nevertheless, this classification presents an interesting depiction of the thematic orientation of projects which receive funding.

With a confirmed present value of €64.9 million, the field of "Industrial manufacturing" receives most of the FFG's funds, followed by "Surface transport and technologies" [7](€56.5 million), "Electronics/microelectronics" (€48.7 million) and "Advanced materials" (€48.0 million). If "ICT applications" and "Information processing, information systems", two fields that are clearly ICT-related, are taken together (they are defined separately in the CORDIS SIC system), then ICT would rank first, since it has a total present value of nearly €73.8 million. Considering that ICT topics are also addressed in many other fields as a generic form of technology, and as many fields of technology are inextricably linked to ICT (e.g. electronics/microelectronics, automation, robotics), it is obvious that this field of technology is one of the most important topic for applied research funding in Austria. Indeed, a special analysis[8] conducted by the Austrian Research Promotion Agency (FFG) shows

Table 2-7: Austrian Research Promotion Agency (FFG) funding by organisation type (costs, funding and present value in € millions), without broadband initiative, 2018

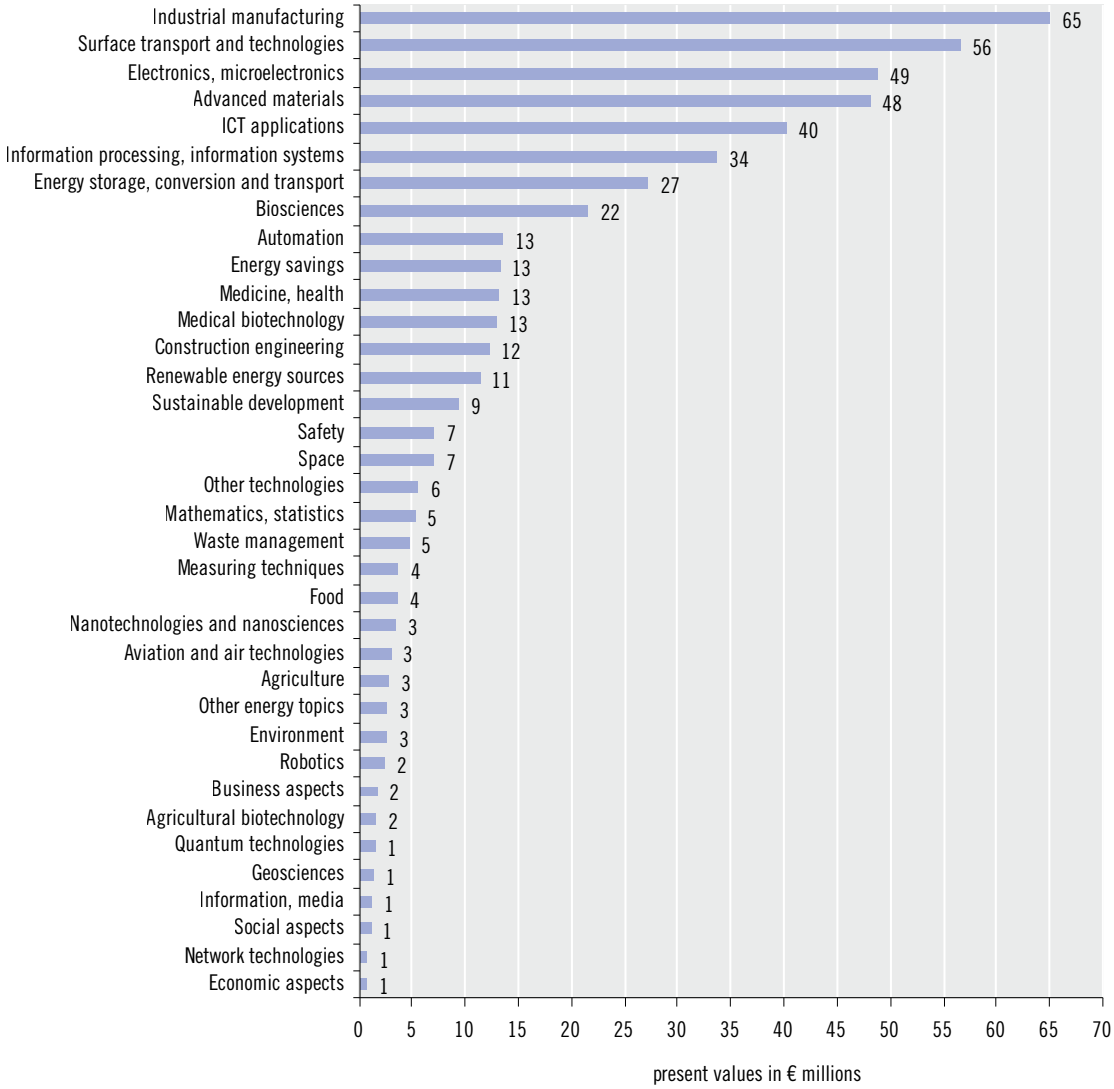
Organisation type	Actors	Participations	Total costs	Total funding	Present value
Business enterprises	2,542	3,770	769.6	376.8	260.4
Research institutes	203	976	324.7	135.9	135.8
Higher Education Institutions	582	1,199	122,9	88.2	88.2
Intermediaries	34	46	5.8	3.4	3.4
Other	536	631	21.7	13.2	13.0
Total	**3,897**	**6,622**	**1,236.1**	**617.6**	**500.8**

Source: Austrian Research Promotion Agency (FFG).

7 Surface transport (i.e. streets and tracks) is also included in the *CORDIS Subject Index Classification*.

8 See Egerth und Pseiner (2019).

Fig. 2-1: Austrian Research Promotion Agency (FFG) funding according to fields of technology, 2018 (present values in € millions)



Note: Fields of technology with present values less than €1 million do not appear here.
Source: Austrian Research Promotion Agency (FFG).

that the percentage of funds allocated towards projects with a strong focus on digitalisation has increased significantly over the past few years: from 40% in 2015 to 61% in 2018. As regards digitalisation, the topics of "Artificial intelligence" and "Robotics" play an important role. Taking the average amount of funding for 2017 and 2018, nearly €100 million worth of FFG funds went towards these key technologies. When looking at each of the programmes for which these funds are needed, we see that General Programmes are most popular, with a share of 51%. In other words, research on AI and robotics is done mostly bottom-up. The programme "Production for the future" (Produktion der Zukunft) comes in second, with 10% of all funds for AI and robotics being distributed through this particular programme. The programmes COMET and "ICT of the future" follow, with 9% and 8%, respectively. These figures show that research on these new key technologies is being pushed forward with a balanced combination of bottom-up and top-down instruments.

Strategic developments

In 2018, an important strategic milestone took place: the creation of the **Digitalisation Agency** (DIA). The DIA is financed by the Federal Ministry for Digital and Economic Affairs (BMDW) and the Federal Ministry for Transport, Innovation and Technology (BMVIT). It is a separate department within the Austrian Research Promotion Agency (FFG). With this, the federal government is promoting the digital transformation of Austria. Its goal is to turn Austria into a global player for digital excellence and innovation. The DIA offers digitalisation-related support to the public, governing bodies and, in particular, Austria's industry. This support includes sharing know-how and expertise as well as offering projects geared specifically towards firms. The DIA defines itself as a networker for the digitalisation community. In its function as a consultant for the federal government, the DIA also supports the "Digital Austria" initiative. For the first time it brings projects, skills and stakeholders from society, industry and government bodies together.

The following projects demonstrate the practical implementation of the DIA's tasks:

- **Community Map**: Access to digital initiatives and knowledge about potential cooperation partners for digitalisation is currently of a decentralised and unstructured nature in Austria. The DIA is tackling this problem: it brings various stakeholders together and offers support in scaling specific projects. Key stakeholders in digitalisation appear on a steadily growing Community Map, available at https://www.digitalaustria.gv.at/. This Community Map presents players, projects and initiatives for digitalisation in Austria. The visual database creates a basis for the development of relationships between the most important stakeholders, initiatives and organisations. It allows firms interested in digitalisation easy access to information such as: Where is digitalisation taking place in my vicinity? With whom can my SME cooperate?
- **DIAlogues** – Learn from the best. Successful SMEs in every industry demonstrate how they are already using the opportunities of digitalisation in a perfect way. DIAlogues, a new series of talks, provides the Digitalisation Agency with a forum in which digital pioneers share their expertise with others. These talks bring the most successful innovators and firms together; SMEs learn from the best and are able to expand their knowledge. The DIAlogue talks for firms started across Austria in March 2019. Events are being planned in every Austrian federal state for the first year and will take place within the scope of a roadshow.
- **Team SME**: Digitalisation requires, in particular, leading firms which have the resources to push their digital transformation forward. Supplier firms need digital skills in order to remain competitive. This is precisely where Team SME comes in: With the support of the DIA, leading firms and their partners develop digitalisation processes together. In doing so, they create ecosystems which work together more efficiently.
- **Digital Austria Day:** Successful digitalisation projects need talented people to conquer this professional field. Using the well-established Girls Day format as a model, Digital Austria Day is an integrative day of action where firms present their digitalisation focuses. It offers an experience-orientated and hence emotional approach to digitalisation projects. As an initiative taking place across Austria, it shifts the focus towards the digitalisation power of SMEs in Austria. Firms in Austria will have these open Digital Austria Days for pupils all across the country for the first time in autumn 2019 under the auspices of *Insight Digitalisation*. An additional *Insight Digitalisation* competition for schools will also allow pupils to explore this topic in depth.
- An example of further developments on a strategic level is the new approach during the selection process, with the Flagship Region Energy Programme, an initiative of the Climate and Energy Fund (KLIEN). A wide-scale validation and demonstration of innovative energy technologies

Table 2-8: New trends in the portfolio of instruments

Funding instruments	Target group	Objective
Digital Pro Boot camps: https://www.ffg.at/ausschreibung/digital-pro-bootcamps-1-ausschreibung	**SME**	• Qualification for the use of digital technologies • Development of customised curricula for training to become digital professionals
Digital Innovation Hubs https://www.ffg.at/dih/1. Ausschreibung2018	**SME**	• Improved infrastructure conducive to innovation • Access to expertise, infrastructure and coaching for innovation projects, with a focus on the use of new technologies

Source: Austrian Research Promotion Agency (FFG).

implemented in real-life application settings is central to this programme. It requires long-term planning so that it can also ensure the necessary participation and active involvement of firms and users.

- A new two-step selection process was introduced for the execution of the Flagship Region Energy Programme in 2017/2018. Its aim was twofold: to ensure the necessary amount of available funds were allocated accordingly and to make sure the programme could operate in the long term (2018-2025). An additional benefit relevant to the programme was to reduce the application effort. During the first step of this selection process, strategic concepts focusing on the long term competed against one another. In the second step, an international jury selected three Flagship Regions[9]. These Regions were evaluated as holistic concepts and could then apply for funding through the relevant stand-alone projects.

Changes in the portfolio of instruments

The Austrian Research Promotion Agency (FFG) expanded its portfolio in many directions in 2018 for the development of new funding formats. On the one hand, the two pilot programmes "Impact Innovation" and "Ideas Lab" passed the test for real-life application and are about to be incorporated into the portfolio of the Austrian Research Promotion Agency (FFG). On the other hand, new priorities were set within the field of digitalisation: qualification and diffusion (see Table 2-8). The changes will be explained in detail in the following paragraphs:

- **Impact Innovation**: Following two calls for proposals in the pilot phase – funded by the FFG (1st call) and the National Foundation for Research, Technology and Development (2nd call) – the format was developed further with regard to addressing target groups and the evaluation criteria. As of March 2019, the evaluation of the pilot phase is ongoing; the interim results have been consistently positive. For this reason, a transition to regular operations is being planned for 2019.
- **Ideas Lab**: The reaction to the first proposal, which was funded by the National Foundation for Research, Technology and Development, was very positive. From a total of 112 applications, 14 female and 16 male researchers were invited to the Ideas Lab. Their topic was: "Human 4.0? – The Future of Collaboration between Humans and Machines". The ideas that participants contributed were then turned into five project outlines; three of them were invited to submit a complete application. In the meantime, all three projects have received funding.
- **Digital Pro Boot camps:** These are an attempt to fulfil the need for qualifications in the use of digital technologies. Employees at Austrian firms (with a focus on SMEs) participate in a 9-week

9 See https://www.vorzeigeregion-energie.at/

boot camp that offers a tailored curriculum qualifying them as *Digital Professionals*. The first round calling for applications began in mid-November 2018 and ends at the end of May 2019. This format is sponsored by the Federal Ministry for Digital and Economic Affairs (BMDW).

- **Digital Innovation Hubs (DIH):** The Digital Innovation Hubs are a structural measure in which the infrastructure conducive to innovation for small and medium-sized enterprises is improved on a local level. The focus of these improvements lies on the use of digital technologies. The DIH will provide SMEs with specialists boasting state-of-the-art expertise, infrastructure and coaching for specific innovation-related projects. The deadline for the first call for proposals was at the end of February 2019, and the proposals were presented at the end of April.

2.3 Austria Wirtschaftsservice (aws)

Legal framework and funding aims

Austria Wirtschaftsservice GmbH (aws) is the Republic of Austria's wholly owned promotion bank for the Austrian economy. It was founded by the Act to establish the Austria Wirtschaftsservice (Federal Law Gazette 130/2002), effective from 31 December 2001, and opened on 1 October 2002 under special legislative provision. The owners' interests are represented by the Federal Ministry for Transport, Innovation and Technology (BMVIT) and the Federal Ministry for Digital and Economic Affairs (BMDW), which appoint the management team and supervisory board of the Austria Wirtschaftsservice (aws). The owners are also clients along with other federal ministries, states and public bodies.[10]

In accordance with its legal remit, the Austria Wirtschaftsservice (aws) is the central point of contact for promoting growth and innovation (Section 2 of the Austria Wirtschaftsservice Act). The most important functions of the Austria Wirtschaftsservice (aws) as defined in the Act include: protecting and creating jobs, strengthening competitiveness, and supporting research locations by awarding and implementing firm-related federal funding for industry and providing finance and advisory services to support industry.[11]

Instruments, key performance indicators and priorities

The funding instruments of the Austria Wirtschaftsservice (aws) are geared towards achieving an improvement in the resource basis for innovation and growth projects in the business enterprise sector with the two priority areas, "new enterprise" and "growth and industry". The main instruments are:

- **Austria Wirtschaftsservice (aws) guarantees** to access private funding for new ventures, innovation projects and growth spurts in order to compensate for missing or insufficient bank loans.[12]
- **erp loans** to finance planned investments using good conditions with regard to the loans' terms and interest rates.[13]
- **Austria Wirtschaftsservice (aws) subsidies** to strengthen firms' equity basis when financing investment projects.[14]

In addition to the guarantees, loans and subsidies, the Austria Wirtschaftsservice (aws) also uses other instruments to enhance firms' equity. On the one hand, public funds are used as leverage to bring in private capital. On the other hand, corresponding matching services reduce the costs of firms and investors finding one another. The promo-

10 See https://www.aws.at/en/legal-basis-owners-clients/
11 See Federal Ministry for Digital and Economic Affairs (BMDW) and Federal Ministry for Transport, Innovation and Technology (BMVIT) (2018).
12 See https://www.aws.at/foerderungen/aws-garantien-fuer-investitionen-in-oesterreich/
13 See https://www.aws.at/professionals/zinssaetze-konditionen/kreditkonditionen/
14 See https://www.aws.at/professionals/zinssaetze-konditionen/konditionen-zuschuesse-praemien/

Table 2-9: Number of grants and grant totals in € millions, 2018

Programme/ Instrument	Number of applications		Number of new approvals		Approval rate (in %)	New approvals in € millions		Present value of new approvals in € millions	Total project costs in € millions
	2018	2017	2018	2017	2018	2018	2017	2018	2018
Guarantee	1,755	1,666	1,165	1,114	*67*	335.4	306.4	22.3	485.9
Loan	1,761	1,782	1,296	1,367	*77*	600.0	600.0	14.5	734.6
Grant	3,681	18,917	13,800	2,932	*33*)*	1,241.2	223.6	1,240.6	5,559.8
Participation	669	623	44	69	*9*	12.9	15.4	0.0	36.3
Total	**7,866**	**22,988**	**16,305**	**5,482**	***54***	**2,189.6**	**1,145.4**	**1,277.4**	**6,816.6**

*) Approval rate of grants without the employment bonus programme.
Source: Austria Wirtschaftsservice (aws).

tion services that the Austria Wirtschaftsservice (aws) provides are not strictly of a monetary nature; they are highly effective services to increase awareness, as well as offers of consultation, information and coaching

The support offered by the Austria Wirtschaftsservice (aws) expanded substantially in 2018. This exceptional growth is reflected in output indicators such as the number of new approvals and the volume of funding provided for monetary instruments.

Improvements to existing service offerings and the Austrian business enterprise sector's readiness to invest enabled the full utilisation of the credit products with a volume of €600 million. In the area of guarantees in particular, it is clear that Austrian firms frequently need help in accessing credit and capital markets to fund new venture, innovation and growth projects. By contrast, in terms of the grant instruments, the Austria Wirtschaftsservice (aws) portfolio has been expanded to include predominantly temporary programmes (including, in particular, an employment bonus, premiums for increased investment, incidental wage cost funding and a venture capital premium) which have resulted in an extraordinary increase in approvals, financing services and funding values.

With a total funding of €2,189.5 million, it is approximately 91.2% higher than in the previous year. The volume of loans remained unchanged, participations dropped by 16.2% and guarantees increased by 9.5%. At the same time, grant programmes which were offered temporarily and broadly used (in particular, the employment bonus) enabled an almost six-fold increase in grant volume (from €223.7 million in 2017 to €1,241.2 in 2018). Thus, the present value of funding increased by 395.3% to a total of €1,277.4 million (see Table 2-9).

With regard to the distribution of funding by sector, the majority of newly approved funding is for manufacturing; adjusted for cases not directly attributable to a specific industry, this amounts to 45% of total funds in 2018. This reflects positive economic developments with an exceptionally high willingness to invest within the manufacturing industry. There were also slight increases in trade, with a percentage of 16%. By contrast, newly approved funds for the services sector fell to a total of 20% per cent.

Among the recipients of funds, small enterprises appear most frequently, receiving 80% of funding. Despite smaller projects, sole proprietorships (10%), microenterprises (16%) and other small businesses (23%) receive nearly half of all funding, whereas medium-sized enterprises and large enterprises receive 20% and 32% respectively.

The federal states of Upper Austria and Lower Austria confirmed their traditionally strong positions as compared with all other federal states, receiving nearly half of the total Austria Wirtschaftsservice (aws) funding in 2018 with 27% and 19% respectively. An additional 15% was allocated to Vienna and 12% to Styria, two federal states that showed particularly strong dynamics in 2018. The federal states of Carinthia, Salzburg and Tyrol received approximately 7% each. Similar to last year, Vorarlberg received 3% of

funding. Overall, the distribution of funding among the federal states in 2018 had a more balanced structure as compared to previous years. This can be attributed to the grant programmes which were offered temporarily and implemented on a broad scale.

Strategic developments

The strategic orientation of the portfolio of instruments at the Austria Wirtschaftsservice (aws) in recent years has been characterised by on-going measures aimed at increasing the impact of funding at firms' level, as well as improving access to funding and reducing administrative costs and efforts. Aside from the special effects of temporary measures that increased the volume in 2018, the growth of the portfolio is only partially due to the introduction of new programmes. The main reason lies rather in the numerous adjustments to the terms and conditions for funding, which make the Austria Wirtschaftsservice (aws) funding more attractive overall for financing innovation and growth projects. At the same time, a targeted use of instruments ensures that firms' heterogeneous financing needs are met. This is particularly true for innovative start-ups as a target group. In many cases, project-related public funding for R&D activities alone does not provide sufficient financial support for the firms' ambitious activities. It is also necessary – particularly during the founding phase – to offer appropriate support that includes sharing information and knowledge.

For this reason, the Austria Wirtschaftsservice (aws) uses a mixture of instruments that, in the meantime, have been adapted and tuned to address the needs of new ventures. They not only entail easier access to foreign capital through guarantees and erp loans, they also address the following typical shortcomings in view of firms' development and equity availability or their access to private equity:

The cornerstone of public funding for highly innovative new ventures in their initial stages of development (which are characterised by high risk and barriers accessing private equity) is "aws Seed financing", which is a conditionally repayable grant. The increase in seed funding earmarked in the budget for 2017-2019 made it possible to expand "aws PreSeed" and "aws Seed financing" to a total of 54 approvals in 2018. This funding amounted to €18.7 million; options for funding in the early stages of new ventures with similar amounts of funds are also being scheduled for 2019.

The seed family is a key starting point for public funding: following successful qualification in a competitive selection process, innovative new enterprises receive support in the form of grants and consultation services to improve their financial situation as well as to expand their knowledge. These consultation services address, among other things, these start-ups' innovation process through an individual strategy for intellectual copyrights.[15] In addition to the high-technology segment, "impulse XS" and "impulse XL"[16] are additional grant instruments available to innovative projects in the creative industries. These instruments also use a selective jury system. In 2018 there were 53 such projects which received a total of €4.1 million in funding. €1.5 million is still available in 2018/19 for innovative, cutting-edge concepts developed by incubators and their start-ups.

At the Austria Wirtschaftsservice (aws), an important goal of the funding strategy for the innovative new ventures segment is also to successively increase its capital basis by using private equity. This strategy entails both the use of monetary instruments which share risks between the public sector and private investors and the creation of incentives for increased use of equity in the field of new ventures as well as instruments which aim to reduce the

15 Today, for example, patent usage patterns are used in addition to the original prohibition of exploitation with the goal of attracting investors and generating income from out-licensing – whether for strategic reasons (blocking patents, i.e. those patents not used by one's own firm but which reduce the competitors' ability to act) or for marketing reasons – in order to use them to create norms/standards or to facilitate (R&D) collaboration.

16 See https://www.aws.at/foerderungen/aws-impulse-xl/

costs of finding investors. The Austria Wirtschaftsservice (aws) has various funding schemes to solve problems specific to financing or strengthening the knowledge base. Participation in various schemes may either be successive or combined.

- The **aws Founder Fund**[17], which has €68.5 million at its disposal, offers its target group equity at market conditions, with investments ranging from €0.1 million to €3 million. By co-investing, the Founder Fund allows for risk sharing either with or through the use of private capital leveraging. Until now, it was possible to fund 30 portfolio firms with a total of €153.7 million in capital, of which €124.7 million were private co-investments.
- The Austria Wirtschaftsservice (aws) also offers a service called **i2 Business Angels** that seeks to reduce the costs associated with bringing young ventures and private investors together. With this platform's on-going development to a current total of approximately 350 Business Angels and almost 800 venture projects, nearly 20 successful connections are made possible each year. This not only improves access to private capital for innovative new ventures, it also allows them to access networks and the expertise of Angels.
- The Austria Wirtschaftsservice (aws) and the European Investment Fund (EIF) have teamed up to create the **aws Business Angel Fund**[18], an important addition to the Business Angel activities of the Austria Wirtschaftsservice (aws). This Fund, which has been endowed with €32.5 million, uses the co-investment principle to foster Business Angels' willingness to provide equity to Austrian start-ups and, in doing so, continues to revitalise the local Business Angel scene.
- The **Venture Capital Initiative (VCI)**[19], first introduced in 2011, is a *fund-of-fund* programme designed to mobilise private capital and, with participation from the Austria Wirtschaftsservice (aws) in the amount of approximately €37 million, has stimulated over €100 million in capital for venture projects and the initial growth phases of innovative start-ups. In October 2018, an additional call received €10 million in funding.

Changes in the portfolio of instruments

The course of action taken back in 2017 to introduce the employment bonus made it possible for the Austria Wirtschaftsservice (aws) to nearly double its funding power in 2018 to approximately €2.2 billion. In 2019 the Austria Wirtschaftsservice (aws), as the Austrian funding bank, plans to provide support for the domestic economy totalling over €1 billion – in credits, guarantees, grants and participation as well as services and consulting. While funding for grants are showing an overall decrease (due to time limits and budgetary restrictions for grant programmes implemented on a broad scale such as the employment bonus, the venture capital premium and the SME premium for increased investment), guarantees and loans continue to offer a great degree of potential for funding.

In particular, adjustments to the terms and conditions of funding for guarantees and loans, which began at the beginning of 2017 and continued in 2018, made a significant contribution in this regard. Examples of these adjustments include increases in maximum volumes available, increased willingness to take risks as well as a reduction in processing and guarantee fees. They also entail the streamlining of erp loan guidelines in a new growth and innovation programme whilst maintaining an interest rate at an all-time historical low. The focus lies equally on the innovative investment projects of existing firms as well as those of new enterprises and young firms; the latter continue to profit from the special conditions offered by the founding microcredit, which has a fixed interest rate of 0.5% for the duration of its term.

17 See https://www.aws.at/ueber-die-aws/
18 See https://www.aws.at/foerderungen/aws-business-angel-fonds/
19 See https://www.aws.at/foerderungen/aws-venture-capital-initiative/

With regard to network and matchmaking programmes, the **„Global Incubator Network" (GIN)**, an international networking programme offered in cooperation with the Austrian Research Promotion Agency (FFG), continued to expand in 2018. The National Foundation for Research, Technology and Development agreed on a budget increase in September with the goal of strengthening contact between existing partners as well as entering a new target market in China (Shanghai region). Another networking programme at the Austria Wirtschaftsservice (aws) is the "Industry-Startup.Net" programme, which began in 2016, offers start-ups opportunities to network with established firms (corporates). Its aim is to bring together cooperation partners and enable, for example, better market access for start-ups, and faster use of innovative developments for corporates. With over 250 members, "Industry-Startup.Net" is already the largest cooperation networking platform of its kind in Austria. Over 20 cooperation partners have linked up in this programme, which demonstrates a great deal of potential and will continue to expand in 2019 as new services are introduced.

The introduction of new products onto the market was barely significant with regard to the support measures of the Austria Wirtschaftsservice (aws) in 2018 and in 2019. The **Digital Innovation Call** is worthy of mention, receiving €3 million in funding from the National Foundation for Research, Technology and Development. It targets start-ups with digital products and services within the scope of the UN's 17 *Sustainable Development Goals*. The focus lies primarily on instruments which are tried and tested, taking into account the experience gathered in a project's pilot phase or when initially testing newly introduced instruments. The latter applies for instance to **IP.Market** (with assistance on external commercial utilisation and market transition of innovation and technology) and **License.IP** (which provides support to SMEs and new enterprises in the search and licensing of technological solutions), two forms of service and consultancy for the IPR programme family. The portfolio also includes **IP.Coaching,** a programme aimed at developing and implementing IP strategies for SMEs focused on technology. This programme was continued in a modified form in 2018.

In 2018, the Austria Wirtschaftsservice (aws) created the **DigiCoach**, an online consultation platform, designed to help applicants better understand its large instrument portfolio, (which contains a great deal more than has been presented here), and to easily and unbureaucratically find information on the appropriate funding options.[20] After answering a few questions (e.g. on the firm's industry and its field of activity) DigiCoach provides start-ups, SMEs and investors with customised information on the Austria Wirtschaftsservice (aws) funding options that are available. In addition, following successful registration it is possible to select the relevant funding products and to apply for them online using the funding manager[21]. The funding manager supports firms during each step of the application process and provides an overview of the necessary documentation and deadlines to be met. With its **Pitch-your-idea consultation events**[22], the Austria Wirtschaftsservice (aws) recently introduced an additional format in which start-ups can pitch their ideas to receive funding that meets their needs. Following a five-minute presentation on their business idea and a subsequent Q&A session on their plans and financing strategies, firms receive immediate feedback on which funding programme is best suited to their business idea. Funding programmes and consultation services are changing all the time – the digital transformation is undoubtedly an important driving force in this process.

20 See https://www.aws.at/foerderbaum/aws-digicoach/
21 See https://www.aws.at/service/web-services/aws-foerdermanager/
22 See https://www.aws.at/foerderbaum/pitch-your-idea/

3. RTI strategy review 2020

On 8 March 2011, the Austrian Federal Government adopted its Strategy for Research, Technology and Innovation (RTI Strategy)[1], which was developed by the Federal Chancellery and the Federal Ministry of Finance, the Federal Ministry of Education, Arts and Culture, the Federal Ministry of Transport, Innovation and Technology, the Federal Ministry of Science and Research and the Federal Ministry of Economics, Family and Youth, including all consultations in advance. In the course of this, an Austria-wide research dialogue[2] took place in 2007-2008, with the aim of gathering various experiences, ideas and visions of the entire research community to develop Austria as a leading research location by 2020. Furthermore, international expertise was obtained in the form of a CREST review in 2008,[3] followed by a system evaluation with a results report in 2009,[4] and the Austrian Council for Research and Technology Development itself drew up a Strategy 2020,[5] also in 2009. Ten years later, in 2017/18, the OECD performed a *Review of Innovation Policy*[6] in Austria, the results of which were only recently presented at the 2018 European Conference.

There was on-going reporting on the implementation of the RTI strategy. Thus there have been presentations on the targets and measures of the RTI strategy in the annual Austrian Research and Technology Reports, as well as on the work of the *RTI Task Force* and the working groups – prepared for the parliament and for the citizens. In addition, the implementation of special departmental projects has been regularly discussed. Implementation reports were also published annually on substrategies – such as the Open Innovation Strategy, for which the federal government was accountable to parliament. Finally, a *mid-term review*[7] of the RTI strategy was also conducted as part of the Austrian Research and Technology Report 2016.

This report is the first *comprehensive review* of the RTI strategy – prepared for all the years of the RTI strategy and from the perspective of external experts. Based on quantitative and qualitative analytical methods, the report examines the implementation and attainment of each objective of the RTI strategy. The basis for this also includes a list of measures drawn up by all ministerial departments involved in the RTI strategy, showing which measures had already been implemented by the ministerial departments and which not, or which were no longer considered as relevant (e.g. in view of changes in circumstances). In addition, discussions were held with the members of the *RTI Task Force*[8] in order to explicitly consider their views on the development of the Austrian innovation system in this report, as well as to critically reflect the role of the RTI strategy in general.

Thus, the following sections aim to present and analyse the objectives and measures of the RTI strategy with regard to their implementation. Finally, a brief summary of the most important findings of the *OECD Review of Innovation Policy (2018)* will be given and a summary drawn of the major lines of development of the Austrian innovation system. In some cases, the findings intend to serve as input for the RTI strategy 2030.

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1 See Federal Chancellery (BKA) et al. (2011).
2 See Federal Ministry of Science and Research (BMWF) (2008).
3 See Lambert et al. (2008).
4 See Aiginger et al. (2009).
5 See Austrian Council for Research and Technology Development (RFTE) (2009).
6 See OECD (2018a).
7 See Federal Ministry of Science, Research and Economy (BMWFW) and Federal Ministry for Transport, Innovation and Technology (BMVIT) (2016).
8 See https://www.bundeskanzleramt.gv.at/task-force-fti

3.1 The RTI strategy in the context of national and international developments

The development of the RTI strategy for 2011 and the associated formulation of ambitious targets began when it was still assumed that growing dynamic development paths existed after the end of the financial and economic crisis.[9] In the years that followed, however, the budgetary resources fell short of original expectations. In addition to this change, which was already noted in the *mid-term report* on the implementation of the RTI strategy in 2016, the crisis in the European Union has worsened, particularly since 2015, and the development and longer-term effects cannot yet be assessed. Nevertheless, or precisely because of this, efforts at European level to further develop the European Research Area were ambitious. These include the communication of the European Commission in 2012, which defines five priority areas and a concept for completing the ERA in 2014[10], the launch of Horizon 2020 in 2014 and the associated orientation of research agendas towards societal challenges, as well as the adoption of the European ERA Roadmap 2015. About a year later, in April 2016, the Austrian Council of Ministers adopted the Austrian ERA Roadmap with a binding action plan. None of these developments could be foreseen and were therefore not part of the RTI strategy of 2011, but were taken up over time and addressed by Austrian RTI policy through the respective sub-strategies.

The role of national sub-strategies

From 2011 to today, a total of 17 sub-strategies were actually adopted against the background of the RTI strategy 2020 – as illustrated in Fig. 3-1. A national strategy on *Artificial Intelligence* is currently being developed as part of a broader strategy of digitalisation.

Over the years, the RTI strategy 2020 was considered as an orientation framework within which targets and measures were formulated and supplemented with additional new and current topics via sub-strategies. These included *Open Innovation*, *Life Sciences*, Intellectual Property (IP), or the humanities, social sciences and cultural sciences. The sub-strategies thus filled strategically important gaps in Austrian RTI policy and supplemented the RTI strategy from an overall systemic perspective. At the national level, the sub-strategies were characterised by an orientation towards societal challenges, a comparatively high readiness for open participation procedures, but also by the broad political recognition of the relevance of this policy area, which manifested itself for the first time in the RTI strategy 2020.

The ambitious and cross-sectoral vision to become an *Innovation Leader* served over the years as a coherent framework that has guided the associated objectives and measures. All in all, there was a conviction that the area of research, technology and innovation must strive to match the best countries (in an international context) and must therefore continue its development. This vision, which was also the main objective of the RTI strategy 2020, has thus achieved its goal – namely to send a clear, consistent signal of intent, over and above all other individual objectives of Austrian RTI policy – even if according to the *European Innovation Scoreboard* the goal of advancing into the group of *Innovation Leaders* was not reached.

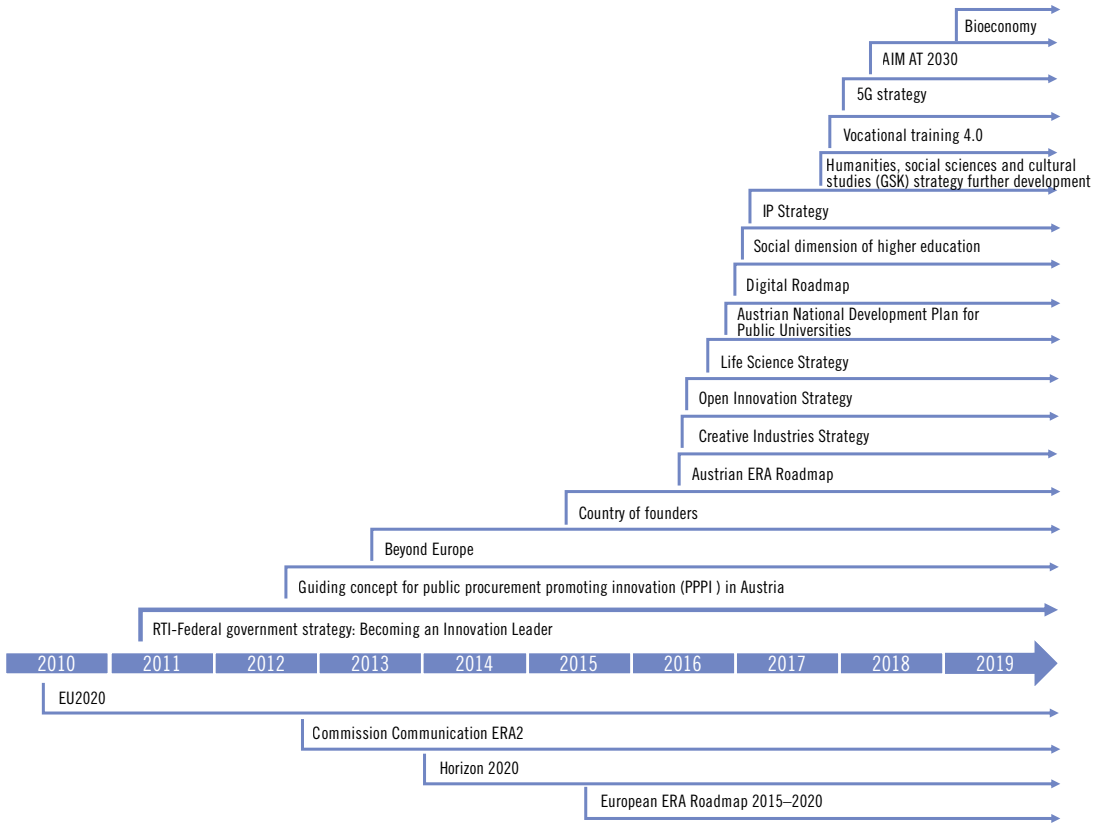
The role of the RTI Task Force and its monitoring

In order to better coordinate the numerous policy areas affecting the RTI strategy 2020, an inter-ministerial *RTI Task Force* was set up at senior civil servant level and chaired by the Federal Chancellery (BKA). The purpose of the *RTI Task Force* is the strategic and system-oriented monitoring of the implementation of the RTI strategy and in part also its specification, as well as the coordination of the activities of the individual ministerial departments involved in the

9 ibid.

10 See European Commission (2012).

Fig. 3-1: RTI Strategy 2020 and additional national sub-strategies in the context of European developments



Source: Presentation of Technopolis.

implementation of the RTI strategy.[11] The *RTI Task Force* thus also had positive effects on inter-ministerial cooperation and helped building trust at the various governance levels. In addition, working groups were set up in special thematic areas to provide further support for the inter-ministerial coordination at the operational level. Some of the strategies shown in Fig. 3-1 even emerged at this level, i.e. from the working groups.

The following working groups (WG) support the implementation of the RTI strategy at the governance level:

- WG 1: Human potential
- WG 2: RTI focus areas: Climate change / Scarce resources
- WG 3: RTI focus area: Quality of life and demographic change
- WG 4: Research infrastructure
- WG 5: Knowledge transfer and new ventures
- WG 6: Corporate research
- WG 7: Europe and International Affairs
  - 7a: Internationalisation and RTI foreign policy
  - 7b: Action Plan for Austria and the European Knowledge Space 2020
- WG 8: International rankings

In addition to these nine working groups established at the outset, further working groups were formed over time, such as a supporting working group for the OECD review. Some of these working groups, which were set up at short notice on specific request, have since been dissolved or are no longer active.

The implementation of the measures to achieve the objectives postulated in the RTI strategy for 2011 is the responsibility of the relevant ministerial de-

11 See https://www.bundeskanzleramt.gv.at/task-force-fti

partments. The numerous stakeholders of the Austrian RTI system, in particular the federal funding agencies and the research and higher education institutions, are, of course, also involved in the implementation. In this sense, the strategy is implemented by the responsible ministries; however, this strategy (based on an impulse set at the governance level) has a lasting impact if it is taken up by the stakeholders operating in the national innovation system and if the objectives are implemented by them. For example, the universities or the Austrian Academy of Sciences (ÖAW) have anchored the objectives of the RTI strategy in their respective performance agreements. As the reports on the sub-areas of the strategy show, it is precisely this sustainable, system-modifying effect that has been achieved in key points.

The RTI strategy was also subject to monitoring. The Austrian Council for Research and Technology Development was entrusted with the task of preparing an annual report on Austria's scientific and technological performance capability. This focused on an evaluation of Austria's *performance* with regard to the objectives and measures of the RTI strategy *per se* as well as the performances of the Austrian science and innovation system in an international comparison, primarily measured against the performances of the *Innovation Leader* countries.[12]

3.2 Innovations in the education system

The vision of the RTI strategy 2020:
"Unleash talent, awaken passion – Sustainably transform the education system"

A good education system at all levels (including continuing education) is the basis of an emerging innovation system, especially when it comes to a small, high-wage economy like Austria being successful in international competition. Well-trained people determine the potential, not only for generating new knowledge and new technologies but also for implementing these. The RTI strategy has thus set itself a series of objectives and measures – as shown in detail below – to sustainably improve the Austrian education system.

3.2.1 Structural reforms of the education system and improved educational transitions

When the RTI strategy was adopted in 2011, the problems of making an early selection of the training and education strands and the effects this has on study and career choices were expounded on. In contrast to the OECD average of 61%, only 39% of an age cohort in Austria acquired a higher education entrance qualification at that time. Reference was also made to the visible gender imbalance in technical and natural science training on the one hand, and in language teaching on the other, which led to the "masculinisation" or "feminisation" of entire occupational fields.

In order to remedy the shortcomings described above, reforms were proposed and aimed at *"defusing social selectivity, improving permeability between educational pathways, improving quality in teaching and university instruction, improving the integration of immigrants and equalising gender imbalances in research". "The quota of early school leavers is to be reduced to 9.5% by 2020. The ratio of pupils with a Higher School Certificate is to be raised to 55% of an age cohort by 2020."* [13]

The following measures[14] were therefore been proposed in the RTI strategy 2020:

- Improve early support through a compulsory kindergarten year (half-day) for five-year-olds, free of charge.
- Increase the number of all-day schools and expand demand-based all-day supervision

12 See https://www.rat-fte.at/leistungsberichte.html
13 See Federal Chancellery (BKA) et al. (2011, 16).
14 See Federal Chancellery (BKA) et al. (2011, 17).

- Expand the vocational baccalaureate for apprentices and the professional maturity examination for adults as a means for accessing study programmes
- Introduce Austria-wide educational standards and partially standardised final examinations
- Further development of the school system with a view to better individual support and increased permeability, especially in secondary education level 1
- Strengthen the human potential in mathematics, information technology, natural science and technology through targeted support in (pre-)school education and at university institutions
- Expand career guidance and study counselling (e.g. Study Checker, Trying out Studying) during schooling

Improved early support

In 2009, the experts from the federal states, the "Charlotte Bühler Institute for Practice-Oriented Infant Research" and the Federal Ministry for Education, Arts and Culture jointly developed a national educational framework plan for children aged between zero and six years.[15] All regional governments have approved the use of the educational plan. It provides guidance to all institutions in all federal states on how kindergarten teachers can support children in the best way possible. Within the scope of 15a agreements between the federal government and the states, parameters were defined and a controlling system set up.

Concrete measures refer to:

- Language assessment at kindergarten
- Half-day free and compulsory support in the final year of kindergarten totalling 20 hours, spread over at least four days a week
- Shaping the transition from kindergarten to school
- Expanding the offering of institutional child support and supervision for children under three years
- Flexibilising and extending opening hours in order to improve the reconciliation of work and family life
- Introducing new skills-based curricula at the Federal Institute for Elementary Education (Bundesbildungsanstalt für Elementarpädagogik), developing of a post-secondary VET course with additional qualification for after-school education
- Compulsory teaching of basic values and principles in kindergartens, such as equality, tolerance and participation

According to Statistics Austria's information on day-care centres for children, the number of crèches and day-care facilities for toddlers has increased massively from 1,200 in 2010/11 to approx. 2,100 in 2017/18. The expansion of crèches and day-care facilities for toddlers was accompanied by a significant increase in the number of children cared for. While the proportion of 0 to 2 year-old children in institutional childcare facilities in Austria was 17.1% in 2010, the figure reached 26.1% in 2017 – an increase of 9 percentage points. The number of kindergartens remained almost unchanged in the same period (2010/11: 4,690, 2017/18: 4,570). Nevertheless, the support and supervision rate of 3 to 5 year-old children rose from 90.7% in 2010 to 93.4% in 2017. However, there were on average 15.9 closed days in crèches and day-care facilities for toddlers throughout Austria and 26.5 closed days in kindergartens in 2017, which may well pose a challenge for reconciling work and family life.[16]

Increasing the number of all-day schools and expanding demand-based all-day supervision

From 2011 to 2018/19, funding options under 15a agreements were available for the expansion of all-day types of school. In 2018, the proportion of children in schools providing all-day supervision was around 26%: approx.177,600 children attended all-day schools. This will be followed by a demand-based

15 See Charlotte Bühler Institute (2009).
16 See Statistics Austria (2018).

expansion based on funds from the Bundesimmobiliengesellschaft (BIG – the public estate developer); the aim is to achieve a care rate of 40% by 2032/33.

Expanding the vocational baccalaureate for apprentices and the professional maturity examination for adults as a means for accessing study programmes

The initiative "Apprenticeship with school leaving examination" launched in 2008. The amendment to the Vocational Training Act 2015 created the possibility of prolonging the apprenticeship period on a pro rata basis while preparing for the professional maturity examination at the same time. The curricula of the professional maturity examination were adapted to the requirements of the standardised Austrian school leaving examination. Since autumn 2015, the "Coaching and Counselling of Apprentices and Training Companies" programme has also supported apprentices in all questions relating to training and in their individual career planning. In 2018, around 9,500 apprentices prepared for their professional maturity examination. In total, there are currently over 6,700 graduates of the vocational baccalaureate for apprentices.

Introducing Austria-wide educational standards and partially standardised final examinations

The educational standards[17] for pupils in the fourth and eighth grades were defined in 2009 and subject to examination for the first time in May 2012. The partially standardised final examination has been held at secondary academic schools (AHS) since 2014/15.

Furthermore, the standardised, skills-based school-leaving and diploma examination was defined in the governmental agreement in 2008 and put forward as a law in the National Council in 2010. In school year 2015/16, all secondary academic schools (AHS) and colleges for higher vocational education (BHS) held (partially) standardised skills-based new school-leaving and diploma examinations for the first time.

Further development of the school system with a view to better individual support

Within the framework of the nationwide quality focus "Individualisation of teaching", the quality initiatives "School Quality in General Education" (SQA) and "Quality Initiative for Vocational Education and Training" (QIBB) were developed. Both quality initiatives define the national quality framework for the Austrian school system in terms of individualisation, skills orientation and inclusive settings ("new upper cycle"). The two quality systems will be successively merged. The expansion of the range of diagnostic and funding instruments will serve to provide individual learning support within the framework of the new upper cycle. In this, "semester-based curricula" (curriculum materials are assigned to individual semesters) and semester-based assessment should lead to a reduction in class repetitions. If there is a risk of negative assessment, an "early warning" is issued and promotion is provided through "individual learning support".

The comprehensive implementation of the new upper cycle was originally planned for the 2017/18 school year. On the basis of feedback received from experience in the field, school management bodies were given the opportunity to postpone the launch in order to better implement planned reform measures at their school in everyday school life. By the end of 2019, the new upper cycle will be evaluated with the involvement of all target groups concerned, before it is rolled out nationwide in 2021/22, if necessary in modified form.

17 See Federal Ministry of Education (BMB) (2016).

Increasing permeability, especially in secondary education level 1

The implementation of the New Secondary School was completed in school year 2017/18. In 2018, new regulations for the introduction of two performance levels were put forward in the "pedagogical package". These will be implemented together with new curricula for 2020. Whether the "pedagogical package" can meet the intended targets will only become apparent after four years, in the summer of 2023.

Strengthening the human potential in mathematics, information technology, natural science and engineering through targeted support in school education and at university institutions

A number of projects and initiatives have been carried out over the years under this measure as follows:

- Since 2001, the *IMST* (*Innovation makes schools top*)[18] project has established nine country networks for the exchange of good practice models. Approx. 3,000 teachers participate each year. To date, a total of around 60 teaching projects for promoting the teaching of mathematics and natural science have been carried out.
- A *STEM quality seal* has been awarded to schools since 2017. By January 2019, a total of 216 educational institutions in Austria had been awarded[19] the STEM seal of quality.
- The *Yo!Tech initiative*[20] (supported by the Federal Ministry of Education, Science and Research (BMBWF) since 2005) organises events that give pupils of the upper and lower grades insights into training courses with a focus on technology and natural sciences.
- For the project "*Jugend innovativ*"[21], there are about 600 submissions per year, mainly from schools offering a high school diploma, which in some cases also apply for intellectual property rights and can point to international successes. The competition has the categories *Design*, *Engineering*, *Science*, *Sustainability* and *Young Entrepreneurs*.
- The initiative "*Science Experts*"[22] aims at raising or promoting interest in science and research at so-called "hotspot schools". Pupils of the New Secondary Schools (NMS) can also make their first contacts with own pre-science projects.
- *Girls' Day*[23] is an annual action day that motivates girls and women to take up technical and natural science occupations. *Girls' Day* thus aims at increasing the proportion of female employees in so-called "male occupations" and to counteract the shortage of skilled workers in the economy.

Sparkling Science

Another important programme for promoting human potential is the Federal Ministry of Education, Science and Research's (BMBWF) Sparkling Science programme, which focuses on research-oriented cooperation between schools and science. Further details on the programme can be found in Section 3.5.5.

Expanding career guidance and study counselling (e.g. Study Checker, Trying out Studying) already at school

Since the school year 2008/09 an educational choice and vocational orientation has taken place in the 7th/8th grade of secondary academic schools (AHS) and in the 8th/9th grade in colleges for higher vocational education (BHS). The programmes "Study Checker" and "Secondary School Graduate Advice" as well as "Trying out Studying" of the Austrian National Union of Students (ÖH) serve to support the

18 See https://www.imst.ac.at/
19 See https://www.mintschule.at/mint-landkarte/
20 See http://www.yo-tech.at/home.html
21 See https://www.jugendinnovativ.at
22 See https://bmbwf.gv.at/das-ministerium/veranstaltungen/fotos-und-nachlese/science-experts-2018/
23 See https://www.frauen-familien-jugend.bka.gv.at/frauen/gleichstellung-arbeitsmarkt/girls-day-girls-day-mini.html

choice of profession and studies. Since 2013, "Role Models" have also been presenting the possibility of atypical educational paths at Austria's largest education fair, *BeSt* in Vienna – also with the aim of getting girls and women interested in STEM subjects.

In this context, the future campaign for STEM experts also aims at creating 3,000 new training places in the STEM sector by 2023. The initiative covers measures on four levels: 1) Targeted expansion of IT training at higher technical schools; 2) Targeted expansion of the subject area "Digital Business" at commercial high schools; 3) Targeted expansion of new graduate schools for new target groups (e.g. the establishment of new IT graduate schools); and 4) Targeted expansion of the UAS degree programmes in the STEM/IT area.[24]

3.2.2 Improving the quality of university teaching

The RTI strategy 2020 noted that both, the participation rate and the graduate rate in the higher education sector, are below the OECD average. "*With a quota of academics of 34.6% – defined as the share of people with tertiary or equivalent post-secondary education in the population aged 30-34 years – Austria ranks below the EU average of 38%. In Austria, (a total of) 43% of a single age cohort study at higher education institutions or universities of applied sciences; the average for the OECD is 56%.*"[25] Another problem identified was "*a visible gender imbalance in technical/scientific education on the one hand and in linguistic/pedagogic fields on the other*"[26]. In addition, reference was made to what by international standards are unfavourable "*framework conditions for university teaching and, in particular, supervision ratios*", "*which has a negative impact on the performance of Austrian higher education institutions in the university rankings. The highly heterogeneous demand for different disciplines causes not only correspondingly different study conditions but also different opportunities on the labour market*".[27]

The RTI strategy consequently defined as a goal that the "*proportion of 30-34 year-olds who have completed a university degree or are in possession of an equivalent qualification should increase to 38% by 2020*"[28]. In order to achieve this, "*the study conditions at the higher education institutions should be markedly improved, for which new funding models for university teaching should also be established.*"[29] In addition, efforts will be made to expand career guidance and study counselling services as well as to establish flexible orientation periods in all diploma and bachelor studies.

The measures required for this[30] were:

- Develop an "Austrian model" for future distribution of university funding based on student-related functions (teaching) and research
- Improve teacher/student ratios
- Develop quality indicators for teaching activities in the higher education sector

Improving the teacher/student ratios

The measures for capacity-oriented and student-related university funding are presented in section 3.3.2. This new form of university funding is an important prerequisite for improving the teacher/student ratios. Another prerequisite for achieving this objective is the creation of new professorships in very popular fields of education. Since the adoption of the RTI strategy, successive measures have been taken in this direction. In 2011/12, investment funds

24 See https://bmbwf.gv.at/fileadmin/user_upload/Aussendung/MINT-Fachkräfte___Internationaler_Frauentag/190306_PK-Unterlage_OÖ_FH_MINT-Fachkräfte_final_AW_korrAP.pdf
25 See Federal Chancellery (BKA) et al. (2011, 14).
26 See Federal Chancellery (BKA) et al. (2011, 16).
27 See Federal Chancellery (BKA) et al. (2011, 15).
28 See Federal Chancellery (BKA) et al. (2011, 16).
29 ibid.
30 See Federal Chancellery (BKA) et al. (2011, 17).

Table 3-1: Teacher/student ratio by field of education, 2015/16 academic year

Field of education	Teacher/student ratio
Educational sciences and teacher training	1:37.4
Arts	1:20
Humanities	1:52.7
Social and behavioural sciences	1:79.6
Journalism and information science	1:124.5
Economics and administration	1:73.4
Law	1:77.2
Biosciences	1:37.2
Exact natural sciences	1:29.4
Mathematics and statistics	1:23.4
Computing	1:37.9
Engineering and technical studies	1:33.8
Manufacturing and processing	1:40.3
Architecture and building	1:58.8
Agriculture, forestry and fisheries	1:38.1
Veterinary medicine	1:19.2
Health	1:23.2
Personal services	1:81.8
Environmental protection	1:53.2
Unknown/no details given	1:21.5

Source: Federal Ministry of Education, Science and Research (BMBWF) (2017, 110).

amounting to €40 million were made available to improve teaching at universities. A total of 78 projects at 18 universities and higher education institutions were financed in this way.

In the performance agreements for 2013-2015, 95 new professorships were established as part of the quality package "Teaching" in the very popular disciplines architecture, biology, computing, pharmacy and industry. In order to increase transparency, the actual and targeted supervision ratios are also shown in the overall Austrian National Development Plan for Public Universities.

Currently, the Austrian Development Plan for Public Universities[31] for the performance agreement period 2019-2021 aims at improving the teacher/student ratio in the direction of 1:40. In the current performance agreement period 2019 - 2021, the universities are therefore also required to advertise at least 358.1 additional professorships in full-time equivalents, of which at least 287 must be so-called career positions reserved for young scientists.

Developing quality indicators for teaching activities in the higher education sector

In the Development Plan for Public Universities the importance of good teaching is defined and emphasised as having to "*meet international standards in the global competition of locations and, in addition to the evaluation of research aspects, (must) also obtain career relevance for the teaching staff (...). Another sign of quality is the extent to which research-led teaching also reflects the heterogeneity or diversity of students and the social challenges beyond the subject-specific context*".[32]

In view of this, a special working group of the Austrian Higher Education Conference on "Strengthening the Quality of Teaching in Higher Education" was commissioned to develop proposals for further developing the quality of teaching and strengthening its reputation. This have been available since the end of 2014.[33] The recommendations were adopted at the Austrian Higher Education Conference on 11 December 2014 and presented to the public in March 2015, with a distinction being made between four relevant dimensions of teaching:

- Teaching activity (with regard to the individual competence of the individual teachers):
- Teaching offer (with regard to subject, profile, location, curriculum and resources);
- Teaching (with regard to the organisational performance, support/supervision and importance of teaching);
- Teaching input and output (with regard to system efficiency).

31 See Federal Ministry of Science, Research and Economy (BMWFW) (2017a).
32 See Federal Ministry of Science, Research and Economy (2017a, 18).
33 See Austrian Higher Education Conference (Österreichische Hochschulkonferenz) (2015).

All of these dimensions have been and will be considered in the performance agreements with the universities. For example, the performance agreements 2016-2018 focused on measures in the area of study design, teaching and learning organisation as well as the further development of teaching competence within the framework of personnel development (*Teaching Competence* programmes, offers for basic qualification or further qualification for teachers as well as specific offers for the expansion of teaching competence with regard to e-didactics and the use of digital media in teaching). For the performance agreement period 2019-2021, the following thematic priorities are currently being set in addition to stabilising or improving teacher/student ratios (see section 3.2.1):

- Working towards increasing the proportion of highly qualified university staff;
- Use of *Open Educational Resources* and *Learning Analytics;*
- Improving teaching (didactics) and organisation of courses with a focus on:
  - Digitalisation, student-centred teaching and examination system;
  - Development of new (student-centred and barrier-free) digital teaching methods;
  - Appropriate consideration of didactic competences in qualification and appointment processes as well as in the training and continuing education of university staff;
  - (Structural) studying feasibility and enabling of degrees within an appropriate duration of study;
  - Assessment of teaching by students, monitoring and survey of graduates, external evaluation of studying feasibility;
- Social dimension of higher education.

Supporting measures and awards

The website "Atlas der guten Lehre" (Atlas of good teaching)[34] presents *good practice* examples in the field of teaching. Through its function as an overview instrument and for the mutual exchange of information, it should support the continuous improvement of quality in teaching and make corresponding activities visible. The target group is the interested general public and individuals involved with the further development of teaching at higher education institutions.

In order to support a more intensive exchange on teaching, the series of events "Dialogue on Higher Education Teaching" was launched alongside the website. In 2017 and 2018, the series of events comprised four events which were organised by the Federal Ministry for Digital and Economic Affairs (BMDW) in cooperation with the Austrian Exchange Service (OeAD). The events provide a platform for teachers and persons involved in the further development of teaching quality to exchange ideas and participate in a critical discussion of current challenges. The main topics of the four events in 2017 were: The importance of teaching – creating incentives for continuing development in higher education teaching, competence-oriented testing, digitalisation and digital competences in higher education teaching, as well as research-led teaching.

At many universities, the importance of good teaching is demonstrated by the awarding of tutors. Such awards express recognition through material and non-material awards and are often awarded within the framework of the so-called "Teaching Day". The recognition of particularly committed tutors also creates an incentive for researchers to regard good teaching as being an important part of their career. The awards can be general accolades for

34 See www.gutelehre.at

"excellent teaching" or "innovative teaching", such as the two awards of the same name of the Vienna University of Economics and Business, the "Lehre Plus!Preis" (Teaching Plus!Award) of the University of Innsbruck or the "Preis für exzellente Lehre" (Award for excellent teaching) of the Graz University of Technology. Some universities give out awards with annually changing thematic key areas, such as the University of Vienna with the "UNIVIE Teaching Award" or the University of Graz with the award "Lehre: Ausgezeichnet!" (Teaching: Excellent!). As agreed in the performance agreement 2016-2018, the University of Klagenfurt awarded a teaching prize (ApplAAUs! – award for outstanding teaching) for the first time in 2018 as part of the teaching and learning days.[35] The increasing importance of digital media in university teaching is also emphasised by the awarding of special prizes. Special awards in the category "E-Learning" are awarded by the University of Graz ("Digitale Lehre: Ausgezeichnet!" (Digital teaching: Excellent!)), the University of Veterinary Medicine Vienna (Vetucation® Award), the University of Innsbruck (E-Learning Award) and since 2017 also by the Vienna University of Economics and Business (E-Teaching Award).

Finally, the Federal Ministry of Education, Science and Research (BMBWF), together with the Universities Austria, the Fachhochschul-Konferenz (association of all Austrian Universities of Applied Sciences), the Austrian Privatuniversitäten Konferenz (association of Austrian private universities) and the Austrian National Union of Students, has redesigned the "Ars Docendi - State Prize for Excellent Teaching". Since 2015, the "Ars Docendi" is annually awarded to teaching staff at public universities, universities of applied sciences and private universities. In 2018, the prize was awarded in the following five thematic categories and was endowed with €7,000 each:

- Digital teaching and learning elements in combination with traditional forms of teaching;
- Concepts and examples in the field of cooperative forms of learning and work beyond higher education institutions and the higher education sector;
- Research and art-led teaching, in particular the promotion of critical thinking, dialogue orientation, methodological competence;
- Implementation of higher education internationalisation concepts in teaching;
- Outstanding supervision of scientific and artistic theses (MA, Dipl., Diss.).

In 2019, teachers at colleges of education can also receive awards for the first time.

Social dimension of higher education

In 2016, the Federal Ministry of Education, Science and Research (BMBWF) (then the Federal Ministry of Science, Research and Economy, BMWFW) working in discursive collaboration with universities, social partners and advisory bodies, developed the "National Strategy on the Social Dimension of Higher Education – Towards a more inclusive access and wider participation". This process was launched by the Bologna Ministerial Conference in Yerevan, Armenia, in 2015, where Member States agreed to develop national strategies to improve the social dimension in the higher education sector (i.e. higher education students should reflect the composition of the population in terms of access, participation and attainment). On the other hand, the government programme 2013-2018 contained corresponding objectives on the social dimension, which are also pursued in strategy documents of the ministerial department (such as the overall Austrian National Development Plan for Public Universities).

The implementation of this first overall strategy document on this topic is envisaged by 2025, including all higher education sectors and challenges higher education institutions across their entire range of services, above all in the fields of teaching, studies and social responsibility ("Third Mission"). The social

35 See https://www.aau.at/blog/applaaus-preis-fuer-herausragende-lehre-vergeben/

dimension in higher education has thus also arrived in the *mainstream* of higher education policy as a reform effort.

The "*National Strategy on the social dimension of higher education*" defines three target dimensions, each with three action lines (fields of action) and concrete measures.

- Target dimension I: "More inclusive access" primarily addresses the quality and accessibility of information and guidance services and *outreach* activities, as well as the recognition and validation of non-formal and informal competences, in order to make access easier and more effective and to ensure greater heterogeneity in access to higher education.
- Target dimension II: "Avoid drop-out and improve academic success" refers to the organisation of studies (e.g. better compatibility of studies with other areas of life), the initial phase of studies (e.g. "welcoming culture") and the quality of teaching to increase sensitivity to heterogeneity and diversity.
- Target dimension III: "Creating framework conditions and making optimum use of higher education governance" addresses higher education system issues on the one hand (e.g. further development of study legislation, monitoring of studying feasibility, increasing social accuracy in access to higher education, reviewing the impact of higher education funding on the social dimension), and on the other hand the creation of suitable *governance* structures at higher education institutions (e.g. by integrating the social dimension into higher education strategy considerations), as well as student support, which has already been significantly improved by the amendment to the Student Support Act (StudFG) 2017.

In addition, the objectives are reflected in nine quantitative targets, such as reducing the under-representation of students with parents who do not have a "Matura" school leaving examination (overall and in human and dental medicine), increasing the number of first-year students with non-traditional access to higher education or a migration background, or also improving gender relations in all fields of education.

In the context of capacity-oriented university financing (Section 12a (4) of the Universities Act (UG) 2002), it was made possible to retain up to 0.5% of the global budget (a total of around €45 million) to ensure the implementation of measures for the social dimension. For this reason, corresponding measures were agreed with the universities in all performance agreements for 2019-2021, and the release of funds is tied to the respective proof of implementation at the latest until the accompanying performance agreement discussion in autumn 2020. More than a third of the universities have decided to develop an overall institutional strategy (including the Vienna University of Economics and Business, the Medical University of Graz, the University of Veterinary Medicine of Vienna, the University of Applied Arts of Vienna, the University of Salzburg, the University of Klagenfurt, the Mozarteum Salzburg and the University of Music and Performing Arts of Graz). The other universities have amended the performance agreement to include substantial initiatives relating to *outreach* measures, monitoring of admission to studies, support for entry into higher education or during the introductory phase of studies, as well as the eligibility of non-traditional student groups for access to higher education.

3.2.3 Improved integration offers

At the time, the RTI strategy 2020 criticised that "*available potentials and qualifications of immigrants are developed too little and used too little in science and industry*"[36]. "*Migrants, even in the second and third generations, usually have significantly poor ed-*

36 See Federal Chancellery (BKA) et al. (2011, 14).

ucational levels. Language barriers complicate access to education."[37]

In order to achieve the improved integration of immigrants, "*the proportion of pupils with a first language other than German who complete the second secondary level is to rise from currently 40% to 60%*".[38]

The following measures[39] were proposed for this:

- Increased use of tutors of non-German mother tongues and employees with intercultural background
- Increased language support
- Flexible recognition and nostrification of diplomas and other qualifications

Increased use of tutors of non-German mother tongues and intercultural employees

As part of the project "*Diversity and Multilingualism in Educational Professions*", an interdisciplinary group of experts from eight university colleges of teacher education drew up recommendations for anchoring migration-related diversity and multilingualism in the Austrian education system. These recommendations relate to the fields of organisation, personnel, curricula, research and teaching.[40] In addition, a team from the University of Vienna developed a diagnostic tool for students of teaching professions to support (scientific and professional) language development in the German language.[41]

Increased language promotion with a focus on elementary and primary pedagogy as well as the training and life-long learning of educators

In order to optimise the transition from kindergarten to elementary school, various forms of cooperation between kindergartens and elementary schools were developed in all federal states. Individualised and differentiated forms of teaching, forms of alternative performance assessment and concepts of comprehensive language support are used. There are special measures for children with German as their second language, for lateral entrants and for children with language development disorders. The decision matrix for admission to the first school level is shown in Fig. 3-2.

Fig. 3-2: Decision matrix for acceptance to the first school level

	Ready for school based on "physical and mental maturity." YES	Ready for school based on "physical and mental maturity." NO
Ready for school based on mastery of the teaching language YES	Regular status 1st school level	Regular status Preschool level
Ready for school based on mastery of the teaching language NO	Special status German remedial class (1st school level) 1st school level with German support course	Special status German support class (Preschool level) Preschool level with German support course

Source: Federal Ministry of Education, Science and Research (BMBWF) (2018a).

37 ibid.
38 See Federal Chancellery (BKA) et al. (2011, 16).
39 See Federal Chancellery (BKA) et al. (2011, 17).
40 See Federal Ministry of Education, Arts and Culture (BMUKK) (2013).
41 See Knappik (2013).

National and international research findings indicate that the performance gap between children with German as their first language and children with another first language is particularly high in Austria and has even widened in recent years. In 2015, the results of the educational standards for German in the 4th grade showed that 67% of children with German as their first language meet or exceed the prescribed standards for reading comprehension, but only 39% of children with a non-German first language do so. Nearly one third of these children (27%) have difficulty with the simplest reading tasks and do not reach the educational standards; a further 35% only partially achieve the educational standards.

New curricula for intensive German language classes therefore came into force in the 2018/19 school year. Uniform and standardised testing procedures throughout Austria identify children and young people who have insufficient knowledge of the teaching language and are unable to follow the lessons. They are conferred the status of "pupils in need of special language support" and are assigned to a German language course. For the language start group, there is an increase to 15 (previously eleven) support hours in elementary school and 20 support hours in secondary school. A German support class will be set up for eight or more pupils per school. In the case of a smaller number, the pupils are taught in regular classes in line with the curriculum for the German support classes.

After each semester, there is a standardised language level check, which enables pupils to transfer to regular classes on a semester basis. Pupils who have attended a German language support course can transfer to the next school level in the following school year if they received a positive assessment in all compulsory subjects.

In German support classes and courses, diagnostic instruments must be used to record skill levels and to support children and young people systematically on the basis of these diagnostic results. For this purpose, the Federal Ministry of Education, Science and Research (BMBWF) recommends the instrument "Unterrichtsbegleitende Sprachstandsbeobachtung Deutsch als Zweitsprache" (USB-DaZ Lesson-based language level monitoring of German as a second language).

In order to better prepare the teaching staff's skills for the demands of integration, a course for the qualification of teachers and language support staff (6 ECTS) has been offered at university colleges of teacher education since 2009. The Federal Centre for Interculturality, Migration and Multilingualism (BIMM),[42] a network of 13 university colleges of teacher education with the aim of implementing language and cultural education in the migration society in teacher training, exists since 2013.

The Federal Act on the New Teacher Training Scheme was passed in 2013. Its aim is to professionalise educational occupations and to increase their attractiveness. The new training programmes are being run by the university colleges of teacher education and universities, which work in close cooperation to offer teacher training courses for secondary general education at tertiary level. Four regional higher education associations were formed to implement the new teachers training programme. The jointly established teacher training studies have been offered throughout Austria since the 2016/17 academic year.

Flexible recognition and nostrification of diplomas and other qualifications

A five-point programme to improve the professional recognition of third-country academics aims at modern professional recognition through rapid and efficient procedures. The points encompass: 1) To provide better and more comprehensive information to third-country nationals, the public profile of the existing National Academic Recognition Information Centre (NARIC) within the BMBWF was strength-

42 See https://bimm.at/

ened, and an information campaign was launched. The specially created website[43] is very popular. 2) Since it was often difficult for applicants to find out where to submit their applications, NARIC was established as a direct information and submission point. NARIC then forwards the applicants to the relevant university. 3) The maximum waiting time for processing applications was halved from six to three months. 4) Since almost half of the annual applications for nostrifications in Austria concern the medical field and thus the three medical universities of Vienna, Graz and Innsbruck as well as the University of Linz (Medical Faculty), a joint office of the three medical universities and the University of Linz should ensure more efficient processing. 5) The NARIC service is now increasingly available as an application aid. Employers can use the NARIC service to compare and evaluate the education of third-country nationals free of charge. This evaluation is unbureaucratic and usually possible within a few days. It is an official assessment but not a recognition in an academic sense (nostrification).

3.2.4 Increasing mobility

The dialogue between universities and other research institutes as well as with research and technology-intensive sectors of industry should promote the exchange of knowledge and thus increase the efficiency of all participants. Studies show that employees who have studied at foreign universities go on to earn higher incomes.[44] In the scientific literature, mobility is generally seen as a channel for the transfer of knowledge and thus contributes to economic prosperity.[45] It is assumed that employees in knowledge-intensive industries, especially researchers, can expand their knowledge through mobility by getting to know new processes and new knowledge and transferring this back home or to another location. Such a geographical spread of knowledge is also called *knowledge spillover*. The RTI strategy 2020 also explicitly mentions the goal of "*increasing mobility*"[46].

The following measures[47] were defined for this:

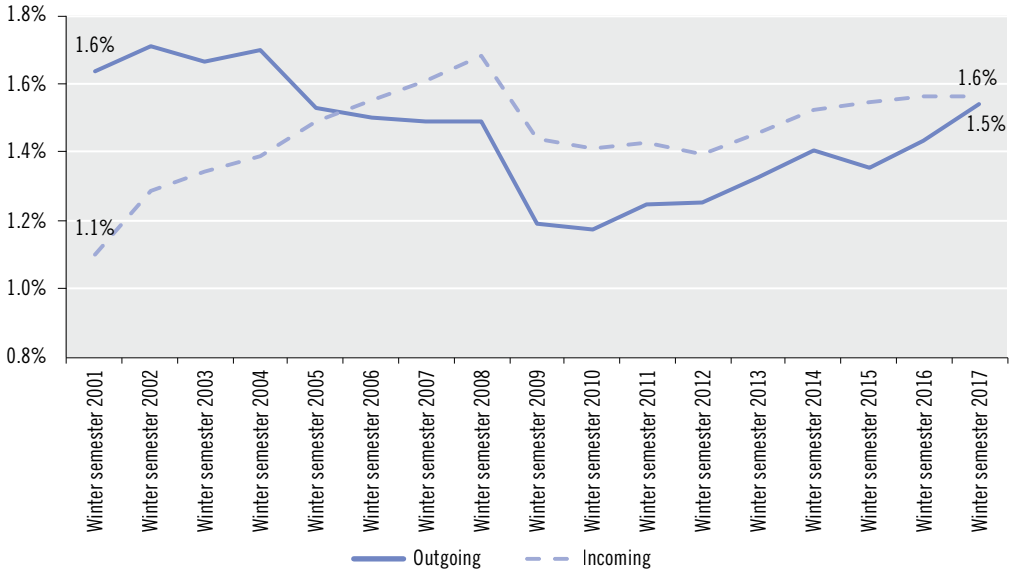
- Targeted increase in the mobility of students and graduates to selected countries
- Broadening the exchange for pupils, students and teachers at all levels with research, technology and innovation-intensive industry and with foreign countries

As Fig. 3-3 also illustrates, the development of the mobility of ordinary students at Austrian universities shows that the proportion of both *incoming* and *outgoing* students has risen slightly in recent years, so that in the winter semester of 2017 a total of around 4,300 students completed a stay abroad as part of a funded mobility programme. About the same number of *incoming* students attended an Austrian university in the winter semester of 2017.

The European Union runs a number of programmes to increase the international mobility of students. The most prominent of these is *Erasmus+*, which promotes study visits to foreign higher education institutions and study-related internships, including recent graduates. The Erasmus+ grant gives students (as well as pupils, apprentices and tutors) the opportunity to complete a funded stay abroad at an Erasmus partner university. Study achievements are recognised at the home university, provided that they correspond to the study programme agreed in advance, the Learning Agreement. In addition, guest teaching assignments as well as further and advanced training measures for higher education and general staff are funded. Although the Erasmus programme, which exists since 1987, is administered by the European Union, it has

43 See http://www.nostrifizierung.at
44 See Kratz and Netz (2018).
45 See Fornahl et al (2005).
46 See Federal Chancellery (BKA) et al. (2011, 17).
47 ibid.

Fig. 3-3: Share of *incoming and outgoing exchange students* among the regular student population at universities, 2001–2017



Source: Federal Ministry of Education, Science and Research (BMBWF), uni:data (2019), Data reports provided by universities on the respective reporting dates in accordance with UniStEV.

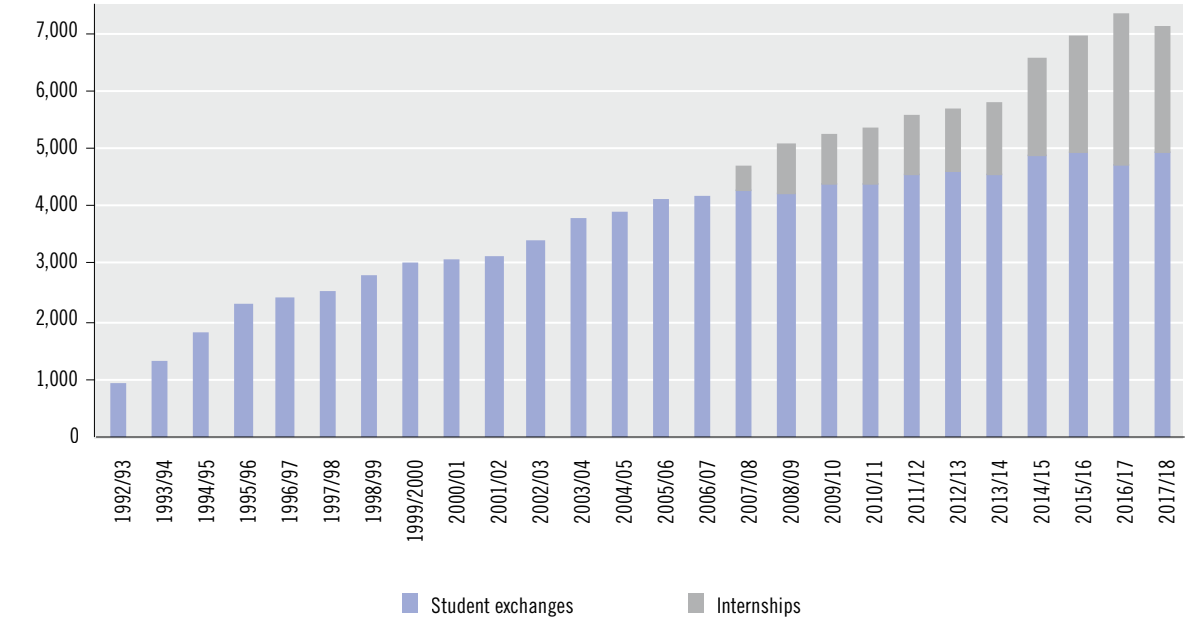
also been open to other countries outside the EU and Europe since 2014; Austria has been participated since 1992. Fig. 3-4 shows that the number of Erasmus students enrolled at an Austrian higher education institution has risen steadily. By the academic year 2017/18, more than 107,000 outgoing students from Austria had already completed an Erasmus stay abroad.

Other programmes to increase mobility and broaden exchanges are: the *Central European Exchange Program for University Studies (CEEPUS)*, which supports the mobility of students and tutors with the aim of further expanding cooperation and networking with the countries of Central, Eastern and South-Eastern Europe;[48] *ACTIONS*, the program to promote bilateral cooperation in the higher education sector with the aim of networking early stage researchers with Slovakia, Czechia and Hungary; *Marietta Blau Grants*, for which doctorate students from all disciplines can apply to spend twelve months researching abroad; *Fulbright*, a programme to promote bilateral cooperation between Austria and the USA in the field of education, science and research through the mobility of students, teachers and researchers between the two countries, co-financed by Austrian and US government contributions and third-party funding.

Other grants that promote mobility include the *Doctoral Research Fellowships*, which are awarded by the Federal Ministry of Education, Science and Research (BMBWF) in cooperation with the Austrian Centres in New Orleans, Minnesota, Alberta and Jerusalem, and cover areas such as the humanities, social sciences and cultural sciences; *Andrássy fellowships* to complete a two-year Master's programme in Budapest, *doctorate grants for the European University Institute (EHI)*, *Erwin Schrödinger Fellowships* from the Austrian Science Fund (FWF) for postdocs to gain research experience at leading research institutes worldwide, and the *Lise Meitner programme of*

48 Partner countries are Albania, Bosnia-Herzegovina, Bulgaria, Croatia, North Macedonia, Montenegro, Moldova, Poland, Romania, Serbia, Slovakia, Czechia and Hungary; additionally, universities in Kosovo.

Fig. 3-4: Erasmus student exchanges and internships, 1992/93–2017/18



Source: Austrian Exchange Service (OeAD).

the Austrian Science Fund (FWF), which is intended to bring highly qualified foreign researchers of all disciplines to Austria.

Student mobility takes the form of *Credit Mobility* or *Degree Mobility*. In addition to participating in programmes, students are also free to organise their own stays abroad. In the case of *Credit Mobility*, the study-related stay abroad is taken into account via credits for their studies at home. According to the University Report 2017, around 7,900 students completed a stay abroad as part of an international mobility programme in 2016/17. In the same academic year, 8,500 students registered at foreign universities complete a stay in Austria. Degree mobility involves completing an entire degree course or study cycle abroad. According to the University Report (Universitätsbericht) 2017, around 16,000 Austrians pursued a degree at higher education institutions in OECD countries in 2015. Conversely, in the winter semester of 2016, around 59,300 foreign students studied at Austrian universities as part of degree mobility programmes (of which around 40% of foreign degree mobility students came from Germany); in total, this makes up 78% of all regular foreign students. According to an assessment by the Federal Ministry of Education, Science and Research (BMBWF), 27% of Austrian graduates completed a study-related stay abroad during this period.

In order to improve mobility not only in quantitative but above all in qualitative terms, the Federal Ministry of Education, Science and Research (BMBWF) published a "*Higher education mobility strategy*" in 2016 to promote the transnational physical higher education mobility of students, tutors and young researchers in the sense of *Early Stage Researchers* and general staff in the higher education sector. This is currently being further developed together with the higher education institutions and expanded to include the internationalisation of teaching in the sense of an overall approach.

Mobility to selected countries targeted in the RTI strategy is being promoted by a number of programmes, with the selected countries being located primarily in North America, Europe (in addition to the European Union, especially in Central and Eastern Europe and South-Eastern Europe) and parts of Asia. In order to intensify international co-

operation in the field of research and technology, Austria began to establish a network of science-related field offices in the early 1990s. Initially, the focus of this network was on the countries of South-Eastern Europe; the so-called *Austrian Science and Research Liaison Offices (ASOs)* were operated primarily in the eastern neighbouring countries. In view of the successful intensification of bilateral relations and the accession of the host countries to the EU and their association with the EU Research Framework Programmes, the ASOs were subsequently replaced by non-European *Offices of Science and Technology Austria (OSTA)*. To intensify research and technology cooperation with important non-European research nations, an OSTA is currently being operated in Washington (founded in 2001, responsible for Canada, Mexico and the USA) and in China (founded in 2012, responsible for China and Mongolia). Both offices represent inter-ministerial initiatives. Their tasks include supporting universities and research institutes in establishing and expanding bilateral relations, initiating and implementing cooperation with institutes in the host countries and, with regard to the objectives of the RTI strategy, supporting the networking of Austrian researchers. In order to strengthen networking, the OSTA in Washington also operates the *Research and Innovation Network Austria (RINA)*, which currently comprises more than 2,700 Austrian researchers working in North America, and organises the annual *Austrian Research and Innovation Talk (ARIT)*. The OSTA in Beijing is currently working on setting up an alumni network and organised the "Austrian Alumni Session" in Beijing in 2018 for this purpose.

Alongside OSTA's RINA, the *Austrian Scientists and Scholars in North America (ASCINA)* is the second major Austrian research network in North America. The aim is to promote private and professional exchange and mutual support within the framework of stays in North America. Another form of network is the *Eurasia-Pacific Uninet*, which was set up in 2010 and comprises around 40 educational institutions from 14 countries (among other things, summer academies are organised); as is the *ASEAN-European Academic University Network (ASEA-UNINET)* from around 75 universities from 19 countries in Europe and Asia for cooperation in teaching and research with the countries of South-East Asia.

Overall, Austria is implementing a large number of measures for the purpose of increasing the mobility of students and researchers. Participation in the Erasmus programme is certainly of central importance, as the increasing number of participants in recent years has shown.

3.2.5 Improving conditions for researchers at higher education institutions

The RTI strategy aims "*to improve conditions for researchers at Austrian higher education institutions*".[49] The *Action plan for a competitive research area* summarises the situation in 2015, prior to the RTI strategy, as follows: "*Career perspectives for researchers at Austrian universities are determined by circumstances that pose challenges to maintaining stable careers, provide only narrow or delayed career perspectives and allow chosen career paths to turn into cul de sacs. The resulting lack of professional perspectives and the uncertainty with which many early stage researchers in Austria are saddled means the country ends up squandering much of this talent.*"[50]

The *Austrian National Development Plan for Public Universities* (GUEP 2019–2024) prioritises system targets related to the promotion of early stage researchers and the development of appropriate career models and career paths. This corresponds to measures applied through the RTI strategy[51]:

- Increase funding for doctoral candidates and

49 See Federal Chancellery (BKA) et al. (2011, 17).
50 See Federal Ministry of Science, Research and Economy (BMWFW) (2015a, 10).
51 See Federal Chancellery (BKA) et al. (2011, 17).

post-docs by expanding structured programme offerings
- Improve the collective agreement and the Universities Act concerning the tenure-track system (implement a career model with options for unlimited employment, dependent on performance evaluations)
- Make awarding of tenure track positions at higher education institutions transparent and performance-based

Introduction and expansion of structured doctoral programmes

During the reporting period, the doctorate at Austrian universities continued to undergo the process of change that began with the Bologna reforms and the introduction of the three-year PhD, a process that is largely complete in 2019. In 2018 the last "old" doctoral programme was phased out and it can be assumed that, aside from a small number of exceptions, there are no doctorate students at Austrian universities in the "old" programmes. The discontinuation of old courses of study in 2017 led to a slight dip in student numbers: In just one year the number of regular doctoral candidates, which has been steadily declining since 2011, decreased from 25,503 (winter semester 2016) to 22,374 (winter semester 2017), or by around 14%.[52] The number of new doctorate graduates, on the other hand, remained relatively stable up to 2015/16, with the number of graduates around 2,200. The first noticeable increase in the number of doctorate graduates – to 2,586 – was in the 2016/17 academic year. In the 2017/18 academic year the number of doctorate graduates again increased, reaching a record of 2,755; this was a 24% increase on the number for the 2015/16 academic year.

One core aspect of these efforts to reform the doctoral programme is to more firmly establish an understanding of the doctorate as the first step in a scientific career. This included the further development of quality-assured doctoral education as part of the expansion of "structured doctoral programmes"[53]. Structured programmes aim to integrate doctoral candidates as "*early stage researchers*" into the scientific community as early as possible and to ensure that doctoral education benefits from clearly regulated, transparent and objective processes and procedures. This structure is based on international models, such as the so-called *graduate schools* in the English-speaking world and Scandinavia and the German graduate research training group model.

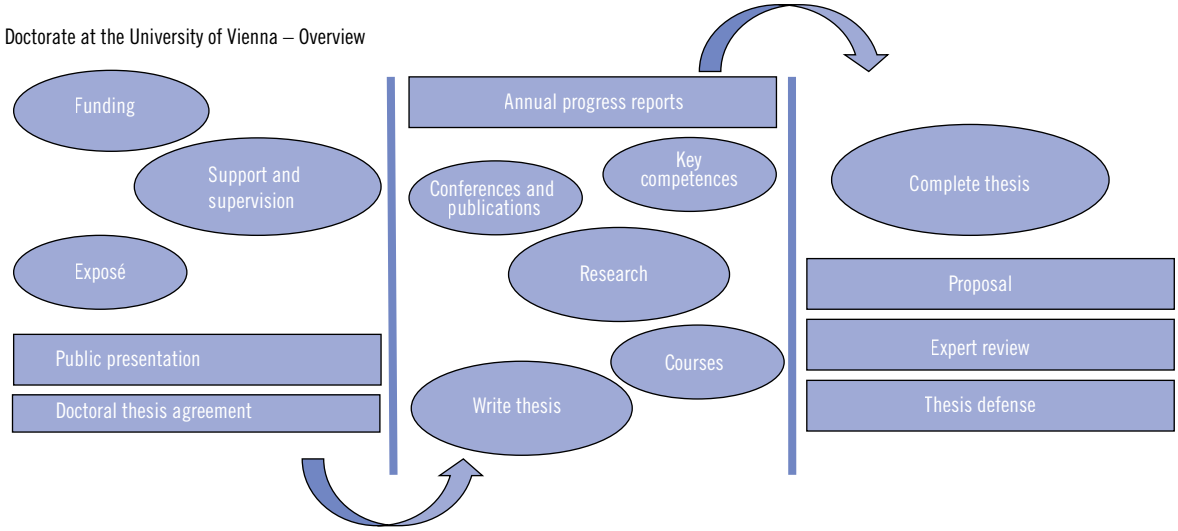
While regulations differ between individual university, structured doctoral programmes in Austria tend to base their organisational process on the following model: First a proposal is submitted, after which there is a public (or faculty-specific) presentation of the planned research project. If the scientific advisory board or similarly appointed body approves the project, a "doctoral thesis agreement" is signed that includes a schedule for the completion of the thesis and a work plan. At some universities this agreement will also stipulate the submission of annual progress reports and, sometimes, proof of research activities, such as conference attendance or publications. It may also specify training modules (e.g. related to *transferable skills)*.

Fig. 3-5 provides a schematic illustration of the process at the University of Vienna as an example.

In particular, there has been an increasing number of changes to the final evaluation stage, most evident in the increased separation between the roles of the supervisors and reviewers.[54] Similarly to the *peer-review* process in later career stages, the final evaluation of the thesis, which in earlier models was the responsibility of the supervisor, is now submitted to external examiners for assessment. In some new doctoral programmes, the supervisor is no longer in-

52 See Federal Ministry of Education, Science and Research (BMBWF) uni:data (2019).
53 See Austrian Higher Education Conference (Österreichische Hochschulkonferenz) (2015).
54 See Austrian University Conference (Österreichische Hochschulkonferenz) (2015, 9).

Fig. 3-5: Procedure for a structured doctoral programme at the University of Vienna



Source: University of Vienna: https://doktorat.univie.ac.at/doktoratsablauf/

volved in the final evaluation or in determining the final mark. This model has also resulted in changes made to the role of the supervisor, who must now account for the supervision provided. To that end, structured doctoral programmes now often include additional training for supervisors to ensure that they are adequately prepared for this (new) role.

This separation of roles is already a firmly established requirement of the doctoral funding programme of the Austrian Science Fund (FWF) (https://www.fwf.ac.at/en/research-funding/fwf-programmes/docfunds/). Only those doctoral programmes that ensure "*the separation of supervisor and examiner (if compliant with study-law regulations)*"[55] are eligible for funding from the Austrian Science Fund (FWF). Increasingly there is a move away from supervision by a single individual to supervision by a team of researchers (a new norm originating in the STEM subjects). A prominent feature of *graduate schools* too is that they embed candidates in a cohort and team of students.

This is one motivating factor behind many universities establishing so-called "*doctoral schools*" and "*doctoral academies*" in certain fields. Following a selective application process, the accepted doctorate students have a wide array of support services available to them (including financial resources, e.g. for conference travel). It should be noted, however, that acceptance into a *doctoral school* or a structured doctoral programme is not necessarily equivalent to being employed by the university. This currently applies to all structured doctoral programmes in Austria, which primarily focus on promoting more intensive supervision and inclusion in a scientific environment and a greater level of engagement among the doctoral candidates.

In this context, the federal ministry's repeated appeal for universities to increase the proportion of doctorate students with employment contracts (as formulated in system targets 2 and 5 in the Austrian National Development Plan for Public Universities (GUEP) 2019–2024) poses a challenge for the universities. According to the University Report (Universitätsbericht) 2017, in the winter semester 2016 around 8,000 doctorate students at Austrian universities had employment contracts with their university, which is equivalent to about a third of all doctoral candidates (35% or 7,869 doctoral can-

55 See https://www.fwf.ac.at/en/research-funding/fwf-programmes/docfunds/

didates with employment contracts out of 22,374 doctoral candidates).[56] Of these, about half are research assistants on externally funded research projects or are funded directly by the university as research associates. Around two-thirds (65%, 5,147) of all doctorate students with employment contracts worked a minimum of 30 hours per week in winter semester 2017. The decline of the regular doctoral model, alongside the phasing out of "old" degree courses in 2017, has also led to an increase in the number of doctorate students with employment contracts with their respective university. Their share rose from 31% in winter semester 2016 to 35% in winter semester 2017.

Properly understood, the RTI strategy not only recommends integration into a structured course of study and more engaged supervision, but it above all aims to improve funding and support for early stage researchers within the context of a doctoral programme. One method of achieving this target is to restrict admissions. In the past, universities have applied tougher selection criteria for those seeking entry to doctoral programmes. The 2017 amendment to the Universities Act (UG) allows this, implying that this could be a means of increasing the proportion of doctorate students with employment contracts in future. Within doctoral programmes, too, there is a trend towards indicating potential through an early – or earlier – decision, encouraging career decisions at an earlier point in the process and establishing a career path from the start that will help the doctoral candidate to avoid career "cul de sacs"[57] later in life. In this model, the decision about whether to pursue an academic career takes place immediately after the completion of one's first degree (i.e. before acceptance into a PhD programme).

Funding doctoral education through the Austrian Science Fund (FWF)

The Austrian Science Fund (FWF) makes significant contributions to the education of doctoral candidates at Austrian universities. This includes around 2,000 pre-doctoral positions in funded research projects and in highly selective, structured doctoral programmes called "Doktoratskollegs" (DK). The last call for applications for this particular programme was in 2015, which simultaneously laid the foundations for a new doctoral funding scheme: the so-called doc. funds scheme. The 40 "DK" doctoral programmes that are still active are not affected. Six DKs were extended for an additional four years in 2018.

This new funding instrument for structured doctoral programmes has moved away from the creation of new thematic or subject-specific programmes, as was the case for the "DK" doctoral programmes, to focus instead on supporting existing structured doctoral programmes that have already been successfully running at Austrian universities for at least two years. These must have functioning structures already in place (with respect to admissions criteria and supervision, among others – including explicitly requiring team supervision, monitoring and support and continuing education programmes for supervisors) and already be integrated into an existing research framework. Currently active DK doctoral programmes funded by the Austrian Science Fund (FWF) may only apply to the doc.funds scheme once the DK programme has ended.

The programme's ongoing evolution responds to the significant developments that have occurred at universities since its introduction. The doc.funds scheme builds on educational formats that already exist at individual institutions and encourages their further thematic development, as opposed to limiting itself to creating and expanding centrally defined

56 See Federal Ministry of Education, Science and Research (BMBWF) uni:data (2019).

57 See Federal Ministry of Science, Research and Economy (BMWFW) (2015a, 9).

structures. Finally, the new funding scheme seeks to support already existing, high-quality doctoral programmes and promising research priorities.

Structured doctoral education as an indicator of competitiveness in university funding

The Austrian Higher Education Conference's recommendations that identified criteria to promote the further development of high-quality doctoral education (2015) have led to the introduction of higher education structural resources and have been applied in the new university financing scheme (Universitätsfinanzierung Neu) and performance agreements for 2019–2021. A system of incentives was introduced with the new university financing scheme to create structured doctoral programmes and ensure a sufficient endowment with resources. In this model "structured doctoral programmes" are considered to be an "indicator of competitiveness", which means that the more successful a university is in providing structured doctoral programmes, the higher the budgetary allocation from university funding.[58] Nevertheless, this mechanism provides funding only to those programmes that offer team supervision and insist on separate thesis supervisors and examiners.[59]

The discussion on the right of universities of applied sciences to award doctorates is currently of limited relevance from a policy standpoint. This was primarily initiated by representatives of the universities of applied sciences and grew in importance in the course of the debate over the differentiation between types of higher education institutions, as well as the proposal to increase mobility between the sectors (e.g. in the context of the "Future of Higher Education" discussions). In the context of these discussions, the Austrian University Conference stated a clear preference for preserving the "unique characteristics of our traditional universities".[60] Instead, future emphasis should be placed on establishing and expanding collaboration between research-intensive universities of applied sciences and universities, such as the successful cooperation in Upper Austria between the Johannes Kepler University Linz and University of Applied Sciences Upper Austria.

The postdoc phase and new paths to a professorship

The postdoc phase, i.e. the often difficult and decisive transitional phase between finishing one's doctorate and securing a permanent university position, can be characterised as a *bottleneck* in an individual's academic career.[61] Internationally, there are (too) many PhDs for (too) few available permanent positions, particularly professorships, at universities. This can leave doctorate graduates in precarious situations personally and professionally, particularly at relatively later stages of one's life, especially those who take degrees in disciplines in which prospects for non-university positions are comparatively limited (such as in the humanities, social sciences and arts).

For this reason, a number of initiatives and provisions was enacted during the reporting period to better structure and regulate the postdoc phase, improve early stage researchers' perspectives and

58 For a definition of a structured doctoral programme in the Regulation on Intellectual Capital Reports (Wissensbilanz-Verordnung – WBV), which must include team supervision and separate supervisors and examiners, among other things, see Federal Ministry of Science, Research and Economy (BMWFW)(2017c, 93).

59 The Federal Ministry of Education, Science and Research (BMBWF) more precisely defines structured doctoral programmes as follows (see also the commentary on producing the Intellectual Capital Statements (Wissensbilanz) in accordance with the regulation on Intellectual Capital Statements, Federal Law Gazette. II No. 202/2018):
- Submission of a proposal within one year of admission to the programme
- Public presentation of the thesis proposal
- Conclusion of a doctoral thesis agreement, including a schedule and work plan
- Team-based supervision
- Separate supervisors and thesis examiners

The proposal and the public presentation of the thesis project are prerequisites for concluding a doctoral thesis agreement. See Federal Ministry of Science, Research and Economy (BMWFW) (2017c, 93).

60 See Austrian University Conference (Österreichische Hochschulkonferenz) (2015, 7).

61 See Brechelmacher et al. (2015, 17).

pathways to permanent positions and improve their ability to plan academic careers. This applies in particular to the implementation of the Austrian "career model" developed in the context of the collective agreement for university employees (Kollektivvertrag für die ArbeitnehmerInnen der Universitäten), which came into force in 2009. This is a consistent career model that creates opportunities for permanent positions dependent on positive performance evaluations, one in which it is made quite clear at an early/earlier point in time whether a time-limited appointment is likely to be made permanent.

The scheme, which is based on international models, particularly the *tenure-track* model in the United States, sets out a process that is essentially structured as follows: An international search and competitive hiring process comparable to that for professorial positions will result in the best qualified candidate being hired, with whom a so-called "qualification agreement" will be created within two years of the candidate's start date. This "assistant professor" will subsequently have four years to meet the agreed criteria, such as completing a specific number of high-impact publications or others related to teaching and supervision of students. This exceptionally comprehensive and demanding catalogue of requirements is no longer to be shaped solely by scientific criteria, but also by societal criteria of excellence (keyword "*Responsible University*"). An evaluation process – to be designed individually by each university – will take place at the end of this period to determine whether the qualification agreement has been successfully fulfilled. If the outcome is positive, the position is transformed into a permanent "associate professor" position.

During the RTI strategy reporting period the number of people in career positions more than doubled between winter semester 2011 and winter semester 2018, from 633 to 1,452. In comparison, there are some 2,600 full professors (university professors, as defined in Sections 98 and 99(1–4)) as of winter semester 2018. The proportion of career positions held by women was 36% in winter semester 2018, whilst only 25% of university professorships were held by women.[62] The proportion of permanent scientific staff represented by tenure-track positions increased from around 4% in winter semester 2011 to around 9% in winter semester 2018.[63]

Up until 2015 "associate professors" were assigned to the mid-level academic staff, not counting as members of the official body of the university's full professors ("Professorenkurie") as defined by relevant organisational laws and regulations. Until this point there was no "real" *tenure track* in the sense of a stable career path leading to a professorship. The Austrian academic career system has traditionally been characterised by a so-called "*unbridged disjunction*"[64] – a hierarchical division between full university professors and other academic staff. A full professorship remains attainable solely through a specific appointment process.

In spite of the continued special status of full university professors, preliminary efforts were undertaken during the reporting period – taking international models into account, as encouraged by the RTI strategy – to bridge this "gap" or find ways to include alternative pathways to a full professorship. With the 2015 amendment to the Universities Act, it became possible for the first time for "associate professors" who had undergone a "selection process in line with competitive international standards" to be elevated, following their successful fulfilment of a qualification agreement, to membership in the professorial curia ("Professorenkurie"). As a result, associate professors are now the equal of traditionally appointed full university professors in the eyes of institutional bylaws

62 See also Section 3.2.6.

63 Permanent scientific and artistic staff include – for the purposes of statistics – codes 11, 12, 14, 16, 21, 23, 26, 27, 28, 81, 82, 83, 84, 85, 86 and 87 as in accordance with the Austrian Education Documentation Act (BidokVUni). See Federal Ministry of Education, Science and Research (BMBWF) uni:data (2019).

64 See Ben-David (1991, 198).

and regulations (if not necessarily in terms of employment law). The two new Sections of the Universities Act (UG) introduced in 2015 – Section 99(5) on the highly competitive selection and international tendering process and Section 99(6) on elevation to the professorial curia – are mutually dependent on one another.

In addition, the newly created Section 99(4) of the Universities Act (UG) allows for a limited number of habilitated university lecturers (corresponding to what older employment law termed "Außerordentliche Professorinnen und Professoren", the equivalent of senior lecturers in the UK or associate professors in the US) and "associate professors" (that is, those holding so-called career positions) to be promoted to a full chaired professorship via a simplified appointments procedure, making them equal in terms of employment and organisational law.

Empirical data regarding the level of acceptance among university members of this "new entryway" into the professorial curia is not yet available given the negligible number of cases so far. In winter semester 2018 just 15 "associate professors" were elevated to the "Professorenkurie" via Section 99(6); 54 full professors were promoted by means of the simplified appointments procedure (Section 99(4)). The acceptance of these newly promoted professors as equal by existing members of the professorial curia will ultimately depend on the reception of the appointments procedures responsible for the new members' promotion.

In line with the targets specified in the RTI strategy, a new career system that allows for more mobility was created during the reporting period to move in the direction of a "true" *tenure track*, a career path towards a full professorship. Nonetheless, promotion to full professor is still ultimately reserved for a minority of academic staff. The overwhelming majority of scientific and artistic staff employed at Austrian universities are in "*fixed-term employment with only a few years time and limited prospects to be promoted and join the ranks of the university's permanent staff*"[65]. There are, however, other initiatives to provide researchers at higher education institutions below the level of professor improved career perspectives. One of these is the introduction, through the collective agreement, of new permanent positions, "Senior Scientist" and "Senior Lecturer", and a revision of the so-called "regulation on chain contracts". Originally Section 109 of the Universities Act (UG) was meant to protect employees from having to accept a succession of time-limited employment contracts by mandating that time-limited contracts be converted into permanent contracts after six years or (for part-time employees) eight years. This sometimes led to abrupt disruptions in researchers' university careers. Those affected had to give up their positions after the time had expired – sometimes because of the university's reluctance to make time-limited positions permanent. Legislators responded to this situation with the 2015 amendment to the Universities Act (UG) by making this regulation more flexible. Aside from the fact that time spent as a student employee is no longer included in the calculation, this also provides for the timer to be reset, so to speak, whenever an employee moves into a new position, allowing, for example, someone to move from a six-year, time-limited post-doc position to a six-year, time-limited contract as a project assistant. This is certainly a relief to many academic staff members.

3.2.6 Promoting gender equality in research

Women have represented over 50% of university graduates in Austria since 2000, but they are still under-represented in many areas of research, especially at higher hierarchical levels, in industrial research, in many natural sciences, and in most engineering sciences. The RTI strategy therefore included the goal of gender balance amongst those involved in research work.

65 See Federal Ministry of Science, Research and Economy (BMWFW) (2015a, 10).

To this end, measures[66] were proposed in a number of areas:

- Gender budgeting in all research funding measures
- Individual support measures for early stage female researchers
- Measures to improve compatibility between career and family

These measures are implemented at various levels, namely (i) at the federal budget level, (ii) in the federal funding agencies, (iii) in the research institutes and their governance, and (iv) at the individual level of female researchers. A whole series of specific measures has been developed and implemented, using both approaches, gender mainstreaming as well as the promotion of women.

Legal measures, gender budgeting and governance

With the Austrian Federal Budget Reform that came into force in 2013, gender budgeting was enshrined in law. At all budget levels, it provides objectives, measures and indicators aiming at true gender equality between women and men. Gender budgeting is implemented within the framework of outcome-oriented budgeting, impact-oriented assessment (wirkungsorientierte Folgenabschätzung) of policy measures, as well as impact controlling. In their federal budget appropriation for 2018[67], all three ministries involved in research specifically included the objective of increasing the proportion of women in their respective spheres of activity. The aim of the Federal Ministry of Education, Science and Research (BMBWF) is "*a balanced gender ratio in management positions and committees as well as among early stage researchers and artists*"[68]. The Federal Ministry for Transport, Innovation and Technology (BMVIT) is pursuing the goal of increasing the number of employees in technology and innovation in general, and "*with particular attention to increasing the proportion of women*"[69] and the gender equality objective of the Federal Ministry for Digital and Economic Affairs (BMDW) is to make better use of Austria's existing potential of skilled workers, "*in particular by increasing the proportion of women in research, technology and innovation*"[70].

Foundations for gender equality at universities, universities of applied sciences and private universities

The most important legal foundations for gender equality at universities, universities of applied sciences and private universities are now being created and refined through ongoing amendments:

In the course of two amendments to the Universities Act 2002[71] in 2015, further steps were taken to promote gender equality at public universities. Emphasis was placed on the reconciliation of work and family life (see below), the composition of committees and the promotion of scientific careers. Issues relating to gender equality are included in the performance agreements between the Federal Ministry of Education, Science and Research (BMBWF) and the universities. Accordingly, numerous projects and goals were also agreed for the 2019-2021 performance agreement period, which will strengthen the representation of women (defining potential-oriented targets for scientific/artistic leadership positions), the inclusion of the gender dimension in university structures and processes, and the inclusion of the gender dimension in research and teaching. In the past performance agreement period 2016-2018,

66 See Federal Chancellery (BKA) et al. (2011, 17).
67 See Federal Ministry of Finance (BMF) (2018).
68 See Federal Ministry of Finance (BMF) (2018, 364).
69 See Federal Ministry of Finance (BMF) (2018, 408).
70 See Federal Ministry of Finance (BMF) (2018, 399).
71 See Austrian Federal Act on the Organisation of Universities and their Studies (Universities Act 2002 – UG), Federal Law Gazette I No. 21/2015 and Federal Law Gazette I No. 131/2015.

the universities implemented goals and projects primarily in the first two priority areas.

The Quality Assurance Framework Act (QSRG) 2011[72] also explicitly obliges universities of applied sciences and private universities to ensure equality between men and women and to promote women – these requirements had previously only applied to public universities. The accreditation of these institutions is now dependent on the inclusion of appropriate regulations in this area within their development plans and statutes. They are also expected to pursue balanced gender representation in the composition of their executive bodies and committees.

Gender equality in research funding: Austrian Science Fund (FWF), Austrian Research Promotion Agency (FFG)

In its mission statement, the Austrian Science Fund (FWF) commits itself in research funding also to the principles of transparency and fairness, gender equality mainstreaming and equal opportunities – next to the principles of excellence and competition, independence and internationality.[73] The 2019–2021 multi-year programme submitted for approval by the Austrian Science Fund (FWF) to the Federal Ministry of Education, Science and Research (BMBWF) represents a clear improvement with regard to the structural anchoring of gender equality. The new Austrian Science Fund (FWF) strategy for 2019-2020 highlights gender equality and equal opportunities as cross-cutting issues and central concerns of the Austrian Science Fund (FWF) and their implementation is defined as an important management task. Moreover, the Austrian Science Fund (FWF) is fully committed to gender equality and diversity in the composition of its committees. The agency also commits itself to fair and transparent procedures as well as clearly defined objectives in the area of gender equality, including the assessment thereof (e.g. 50% female representation on the FWF Board of Trustees). The action plan envisages, among other things, the expansion of monitoring for equal opportunities, the corresponding further development of the respective programmes, special measures to increase the number of female applicants, and a cost centre for gender research in the actual programmes of the Austrian Science Fund (FWF).[74] The Austrian Science Fund (FWF) also revised its application guidelines for stand-alone projects at the beginning of 2019. The project description provided with the application must now discuss potential sex- and gender-relevant aspects of the project and how they will be implemented. Even if no gender-relevant research questions arise, this should be mentioned briefly. The corresponding adaptation of the application guidelines for all other programmes will take place in the course of this year.

In terms of gender mainstreaming, the Austrian Research Promotion Agency (FFG) has also integrated the consideration of gender and equality aspects into their evaluation of applications and reporting, similar to the practice in Horizon 2020. The Austrian Research Promotion Agency (FFG) also aims to increase the proportion of women in the decision-making bodies of RTI promotion programmes within the framework of outcome-oriented budgeting.

There is a whole series of measures to promote female early stage researchers on an individual basis. They include the fellowship programmes of the Austrian Science Fund (FWF) that are financed by the Federal Ministry of Education, Science and Research (BMBWF), the "*Herta Firnberg*" postdoctoral programme and the senior postdoctoral programme "*Elise Richter*", as well as the *L'ÓREAL fellowship* for

72 See Federal act passing a law on external quality assurance in the higher education sector and the Agency for Quality Assurance and Accreditation Austria (Act on Quality Assurance in Higher Education – HS-QSG) and a federal act on private universities (Private Universities Act – PUG), as well as the federal act amending the University of Applied Sciences Studies Act (FHStG), the Education Documentation Act, the Health Care and Nursing Act, the Midwifery Act and the Clinical Technical Services Act (MTD) (Quality Assurance Framework Act – QSRG), July 2011.

73 See https://fwf.ac.at/de/ueber-den-fwf/leitbild/

74 See Austrian Science Fund (FWF) (2018).

early stage researchers active in basic research relating to STEM subjects. In addition, measures are being implemented at the individual scientific institutions, which are also anchored in the current performance agreements with the Federal Ministry of Education, Science and Research (BMBWF).

The Gabriele Possanner Prizes awarded every two years by the Federal Ministry of Education, Science and Research (BMBWF) for "*scientific achievements that promote gender research in Austria*" also set an impulse to integrate the gender perspective into research, and should also be mentioned in this context.

Laura Bassi Centres of Expertise

The impulse programme "*Laura Bassi Centres of Expertise*" of the Federal Ministry for Digital and Economic Affairs (BMDW) which, in addition to providing funding for female researchers in the management of a research centre also aimed at establishing a new research culture, is being continued and further developed with the programme *Laura Bassi 4.0*. The focus is now on digitalisation, since the gender gap in the ICT area is virulent and there is a danger that implicit mechanisms of inequality will become more rigid in the course of digital change. The programme thus aims at shaping equal opportunities in digitalisation by supporting inter- and transdisciplinary research and innovative projects with high social relevance of consortia in which women are strongly represented and hold leading roles. In order to combat structural inequalities in science and research, the organisations involved in the funded consortia must carry out a gender analysis and then take steps to improve equal opportunities in their organisation. A network called "*Digitalisierung und Chancengleichheit*" (Digitalisation and equal opportunities) is also being set up as a supporting measure. The implicit mechanisms of inequality are addressed and worked on in the network meetings. [75]

w-fFORTE

The Federal Ministry for Digital and Economic Affairs (BMDW) sets measures for women in science and technology within the framework of the programme w-fFORTE (economic stimuli for women in research and technology)[76]. In the event series "*Im Fokus: Karriere*" (In focus: career) for female researchers, HR managers and executives from firms and research institutes, as well as in management workshops for top female researchers, career paths and leadership issues are discussed and soft skills for leadership tasks are taught.

Talents

Within the framework of the human resources promotion programme at the Federal Ministry for Transport, Innovation and Technology (BMVIT) with the funding priority on talents, the programme line "*Talente nützen: Chancengleichheit*" (Use talents: equal opportunities) focuses on women.[77] FEMtech internships for female students are designed to introduce early stage researchers to applied scientific and technical research. In order to improve the framework conditions and raise awareness about structural barriers of women in research, "FEMtech Career" supports organisations in building gender competence to improve human resource management, public relations and work-life balance in the organisation in order to bring more women into research and advance their careers. Furthermore, research projects with gender relevance are funded within the framework of FEMtech research projects in order to promote the integration of the gender perspective in research. The "*Talente entdecken: Nachwuchs*" (Discovering talents: the next generation) project for pupils supports internships with the aim of counteracting gender segregation in schools by awarding 50% of the internships to young people attending academic secondary

75 See Austrian Research Promotion Agency (FFG) (2018).
76 See http://www.w-fforte.at/
77 See https://www.femtech.at/

schools (AHS), non-technical colleges for higher vocational education (BHS) or schools for intermediate vocational education (BMS).

Reconciling work and family life

Another focus is on measures to improve the reconciliation of work and family life. The increase in the number of all-day schools implemented by the Federal Ministry of Education, Science and Research (BMBWF) and the expansion of all-day care per se will also benefit scientists and researchers with school-age children. However, in view of the specific requirements of these groups of persons, relevant interventions undertaken directly at the research institutes are also of great importance. The Amendment in 2015 to the Universities Act (UG) therefore created standards to promote compatibility at universities: Compatibility was laid down as a guiding principle to be taken into account in the performance of all university tasks. In addition, the universities were obliged to establish gender equality plans, in which, among other things, this compatibility is incorporated into the statutes. In addition, the performance agreements for 2019–2021 enshrined numerous projects and objectives on issues of reconciliation, such as the (further) development of special childcare facilities.

The same applies to the performance agreements with the Institute of Science and Technology Austria (IST Austria) and with the Austrian Academy of Sciences (ÖAW): IST Austria was certified with the audit "*berufundfamilie*" (work and family) in 2014, has successfully completed the three-year implementation phase 2015–2017 and is aiming for recertification in the current performance agreement period. An expansion of the measures to improve the compatibility of work and family life was also agreed upon in the performance agreement 2018–2020 with the Austrian Academy of Sciences (ÖAW).

Target achievement

Looking quantitatively at developments in the presence of women in R&D in recent years, the picture is mixed:

A positive development can be observed at the public universities: Among all students, the proportion of women is constantly above 50% and even higher for first qualifying degrees (2017: 57.7%), so according to the figures, women are the more successful students and they now also account for the majority of second qualifying degrees (2017: 52.5%). The proportion of women among scientific and artistic assistants has also risen significantly since 2010 to 46.2% and is almost balanced. The growth in the proportion of women among professors was particularly strong, from 15.7% (2010) to 24.4% (2017), even exceeding the 2017 impact target of 23.5%. Clear progress has also been made in achieving gender parity in committees.

In firms and in the collaborative sector on the other hand, the proportion of women in R&D is stagnating at a low level. Any future RTI strategy must continue to focus on the target of a gender-balanced RTI landscape. Continued efforts at different levels are needed to achieve gender equality in science and research. The relevant Austrian gender equality policy is embedded in the international and European context, especially taking into account the requirements of the UN Convention on the Elimination of All Forms of Discrimination against Women as well as the objectives of gender equality and gender mainstreaming in the ERA Roadmap.[78]

78 See European Research Area and Innovation Committee (2015).

3.3 Strengthening the basis of the knowledge society

The vision of the RTI strategy 2020:
"Create knowledge, promote excellence – strengthen the foundations of a knowledge-based society"

The importance of basic research in the innovation system increases as a country approaches the technological frontier and rises to become a leading country for innovation. Basic research is *per se* driven by curiosity; it expands the boundaries of scientific understanding and is the basis of new knowledge. Strengthening basic research is thus a priority objective of the Austrian RTI policy.

3.3.1 Strengthening basic research

In order to strengthen basic research, the RTI Strategy 2020 defined a number of objectives which are to "*increase investment in basic research by 2020 to the level of leading research nations*", "*implement structural reforms of the higher education system*", "*reform the university financing model*", "*expand financing in the form of third-party funding from the Austrian Science Fund (FWF)* via competitive applications, "*support the universities in establishing individual profiles by Clusters of Excellence*", as well as "*better alignment of teaching and research topics at universities and better cooperation with non-university research institutes*".[79]

The following support measures[80] will be used to strengthen basic research:

- Develop an "Austrian model" for future distribution of university funding based on student-related functions (teaching) and research
- Expand third-party financing of higher education research via Austrian Science Fund (FWF) projects evaluated in competition, with lump-sum coverage of 20% of overheads
- Increase the share of basic research at universities and at research-intensive firms through moderate and on-going funding of the Christian Doppler model (CD Laboratories and JR Centres) *or* provide sustainable support or endowment of the Christian Doppler funding model at universities
- Implement an Austrian excellence initiative by creating up to ten Clusters of Excellence by 2020
- Further develop performance agreements into an instrument for better coordination of research topics among universities and for promoting collaboration with other research institutes
- Refinance the infrastructure acquired before 2004, based on an inventory survey and partially finance new infrastructures for cooperation between university and non-university research institutes
- Reform the structure of the Austrian Academy of Sciences (ÖAW) by creating a development plan, concluding performance agreements, and introducing modernised financing and liquidity management

Develop an "Austrian model" for future distribution of university funding based on student-related functions (teaching) and research.

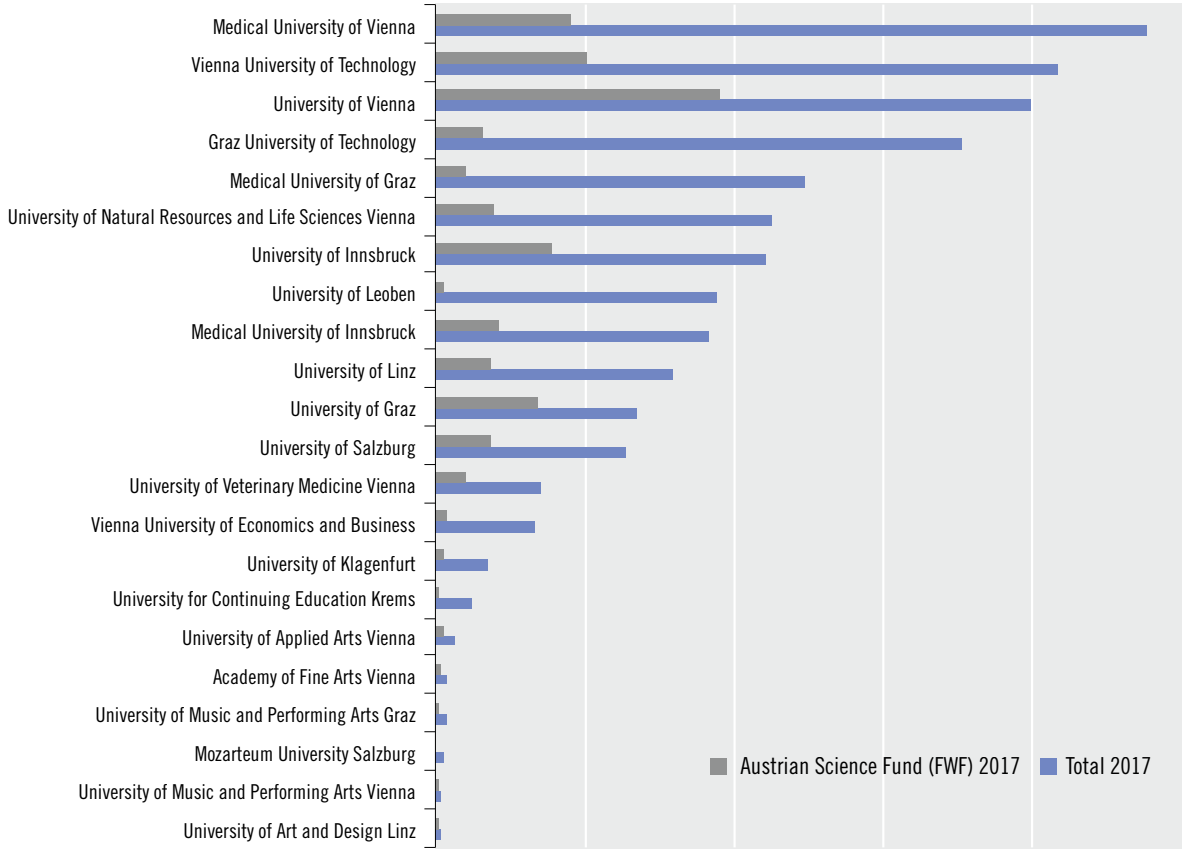
This measure is described in detail in section 3.3.2.

Expand third-party financing of higher education research via Austrian Science Fund (FWF) projects evaluated in competition, with lump-sum coverage of 20% of overheads

In 2010, the total third-party funding revenue from R&D projects at the universities amounted to €525 million, of which 23% or approximately €120.8 million of the proceeds came from the Austrian Science Fund (FWF).[81] By 2017, third-party funding revenues

79 See Federal Chancellery (BKA) et al. (2011, 21).
80 ibid.
81 See Federal Ministry of Science and Research (BMWF) (2011).

Fig. 3-6: All third-party funding revenue from R&D projects, and revenue from Austrian Science Fund (FWF) projects, 2017



Source: Federal Ministry of Education, Science and Research (BMBWF) uni:data

had risen by 28% and currently stand at €673.2 million. Of this volume, 23.5% or €158.3 million came from the Austrian Science Fund (FWF). Even though it has not been possible to increase the share of funding from the Austrian Science Fund (FWF) in the past seven years, the financial resources from the FWF have nevertheless increased in absolute numbers, demonstrating the great importance of this fund in financing cutting-edge research at universities.

As can be expected, the amount of funds granted by the Austrian Science Fund (FWF) varies considerably from university to university (see Fig. 3-6), depending not only on the size of the university but also on the respective subject areas. In 2017, the Medical University of Vienna raised €95.3 million in third-party funding, of which almost 19% (€17.9 million) came from the Austrian Science Fund (FWF). In comparison: The University of Vienna raised €79.3 million in third-party funding in 2017, a considerable portion of which came from the Austrian Science Fund (FWF) (47.7%, €38.1 million).

The Austrian National Development Plan for Public Universities also set a goal for the third-party funding to the higher education sector with the aim to *"secure balanced third-party funding that fits the university's profile by creating/further developing third-party funding strategies on the part of the universities"*[82]. This goal is to be achieved by 2024 by integrating it in university development plans.

82 See Federal Ministry of Science, Research and Economy (2017a, 16).

Implement an Austrian excellence initiative by creating up to ten Clusters of Excellence by 2020

As announced in the government programme 2017–2022, an "*Action plan for the future of research, technology and innovation*"[83] was put forward in the Austrian Council of Ministers in August 2018. In addition to the Research and Technology Funding Act (FTFG), an Excellence Initiative will also be developed and then implemented. *"The aim is to counter disciplinary bottlenecks through inter- and transdisciplinary approaches, to develop the excellence potential of national research institutes through networking and cooperation, and to develop fields of excellence at the interface between established and emerging research fields."*[84]

The Federal Ministry of Education, Science and Research (BMBWF) tasked a team of experts consisting of the Chairman of the Council for Research and Technology Development (RFTE), the Chairman of the Austrian Science Council (ÖWR), the Chairman of the ERA Council Forum Austria and the President of the Austrian Science Fund (FWF) to develop strategic considerations, basic strategy elements, modules and suitable support measures. A concept was commissioned and developed that also involves the scientific community.

All advisory bodies and the OECD recommend the implementation of an Excellence Initiative, as this also provides an important stimulus to already ongoing positive developments (increase in funding from the Austrian Science Fund (FWF) and the Austrian Academy of Sciences (ÖAW), new university funding, establishment and expansion of IST Austria).

Further develop performance agreements into an instrument for better coordination of research topics among universities and for promoting collaboration with other research institutes

The Federal Ministry of Education, Science and Research (BMBWF) concludes performance agreements with all 22 public universities for a period of three years. The instrument of the performance agreement is constantly advanced. However, in order to increase planning security and transparency, the Austrian National Development Plan for Public Universities (GUEP)[85] has been applied since 2016. This comprises two performance agreement periods and prioritises those goals that shape the further development of the universities. The current Austrian National Development Plan for Public Universities (GUEP) 2019-2024 thus also provides for numerous measures to improve coordination among universities. For example, the dialogue and cooperation between the higher education sectors (e.g. through joint study and teaching programmes) should be promoted and expanded, inter-university cooperation in small subjects systematically strengthened, joint activities promoted in the course of study information and a more active permeability management established. In addition, basic research at Austrian universities should be strengthened by helping to create the freedom for new, innovative and unconventional research as well as the further development of the competitive and project-related components of research funding.

As described in Section 3.3.4, a performance agreement was concluded with the Austrian Academy of Sciences (ÖAW) for the first time in 2012. Since

83 See Federal Ministry of Education, Science and Research (BMBWF) et al. (2018).
84 See Federal Ministry of Education, Science and Research (BMBWF) et al. (2018, 2).
85 See Federal Ministry of Science, Research and Economy (BMWFW) (2017a).

then, performance agreements have been concluded for a period of three years at a time. These help to sharpen profiles and set strategic focus in the Austrian research area. The performance agreement concluded in November 2017 for the years 2018-2020 provides for a substantial budget increase of 8% or €30 million to €363 million. This means a clear strengthening of basic research in Austria. The focus of the current performance agreement period is also on promoting early stage researchers. Within the framework of these agreements, there is a special focus on priority setting, joint appointments with the university sector, joint use of infrastructure, and stimulation of research cooperation.

A performance agreement was also concluded for the first time in 2015 with IST Austria, which was jointly founded by the Austrian Federal Government and the Province of Lower Austria in 2006. It set objectives and measures for the period 2015-2017. Monitoring takes place annually in accompanying discussions and on the basis of the agreed reporting. The IST Austria's mission statement and orientation is stipulated in the performance agreement as an institution exclusively responsible for the generation of scientific excellence, with the main priority on international competitiveness in selected fields of research (*life sciences*, *physical sciences*, *formal sciences*). A new performance agreement for the period 2018-2020 was concluded with IST Austria in January 2018. During this period, it will receive a maximum of €219 million in federal funding, €90 million of which will be allocated on a performance-related basis and linked to attracting third-party funding and the fulfilling of defined research-immanent quality criteria. Compared to the first agreement (€157 million), the budget has thus grown significantly in line with the current size and the planned expansion of the institute. The budgetary framework for joint funding by the Federal Government and the Province of Lower Austria is defined for a ten-year financing period, currently from 2017 to 2026.[86] There are many ways in which cooperation in the Austrian research area is encouraged. IST Austria researches and publishes in lively exchange with the entire Austrian research system. The research infrastructure is "open for collaboration".

The scientific evaluation carried out in 2015 shows that IST Austria started off very well, mastered the challenges associated with its creation, and thus laid a good foundation for its future development.[87]

Refinance the infrastructure acquired before 2004, based on an inventory survey, and partially finance new infrastructures for cooperation between university and non-university research institutes

In 2016, as part of the "Action Plan towards a Competitive Research Area", the public research infrastructure database[88] was set up as an information platform. In addition to information on research infrastructure cooperation, the database also offers an annually updated national inventory of research infrastructures, which is used to support performance agreements with universities, infrastructure tenders in Austria and various monitoring processes.

In 2014, the Federal Ministry of Education, Science and Research (BMBWF) (then the Federal Ministry of Science, Research and Economy, BMWFW) initiated a special construction programme for university buildings amounting to €200 million. The aim was to refurbish safety-relevant areas (e.g. fire protection) and thermal renovation. The construction of new buildings was not part of this special construction programme. The projects were financed from the profits of the Bundesimmobiliengesellschaft (BIG), a firm managing Austrian publicly owned real estate, in the

86 See Federal Ministry of Science, Research and Economy (BMWFW) and Federal Ministry for Transport, Innovation and Technology (BMVIT) (2016).

87 See Kornberg et al. (2016).

88 See https://forschungsinfrastruktur.bmbwf.gv.at/de

period 2013–2017.[89] Following the special construction programme for university buildings from 2014, a new special construction programme was implemented also in February 2017. In addition to renovations, this time also new buildings and extensions were financed in order to optimise the infrastructure at the universities. A total of €150 million was invested in twelve construction projects, which, as in 2014, were financed from the profits of the Bundesimmobiliengesellschaft (BIG). [90]

Further measures for the expansion and further development of research infrastructure are described in Section 3.3.5. In spite of the extensive efforts, according to the research infrastructure database, approximately 20% of the research infrastructure stock was acquired before 2004. Efforts will therefore also be needed in the future to keep research infrastructures up to date.

Reform the structure of the Austrian Academy of Sciences (ÖAW) by creating a development plan, concluding performance agreements, and introducing modernised financing and liquidity management

As described in Section 3.3.4, a performance agreement between the Austrian Academy of Sciences (ÖAW) and the Federal Ministry of Education, Science and Research (BMBWF) (then the Federal Ministry of Science and Research, BMWF) was concluded for the first time in 2012. It defined organisational and structural reforms, such as the transfer of institutes from the Austrian Academy of Sciences (ÖAW) to universities.[91] Since then, a performance agreement has been concluded every three years, defining key indicators for the further development of the Austrian Academy of Sciences (ÖAW).

3.3.2 Financing universities under the new funding model

According to the RTI strategy,*"the circumstances for university teaching and in particular supervisory relationships (...) are unfavourable in international comparison, which has a negative effect on the placement of Austrian institutions of higher education in university rankings. The very different rush to disciplines not only brings with it correspondingly different study conditions, but also different opportunities on the labour market"*.[92] The "*development of an "Austrian model" for future distribution of financing to universities based on student-related functions (teaching) and research*"[93] will address this deficit.

In the first half of 2017, a model for determining university-related and country-wide university admission slots was developed in the context of the "University Student Funding" reform steering committee of the Federal Ministry of Education, Science and Research (BMBWF) (formerly the Federal Ministry of Science, Research and Economy (BMWFW)) in coordination with Universities Austria and the inclusion of the Federal Ministry of Finance (BMF). In August 2017, a corresponding draft law for capacity-oriented, student-related university funding was sent out for review, and in January 2018 the new budget model was adopted by the National Council. The most important target is the improvement of teacher/student ratios in very popular disciplines.

Budget pillars and subject weighting

The new university funding plan takes into account the expected number of students and supervisory relationships when calculating the total amount of

89 See Federal Ministry of Science, Research and Economy (BMWFW) (2014).
90 See Federal Ministry of Education, Science and Research (BMBWF) (2017).
91 See Federal Ministry of Science, Research and Economy (BMWFW) and Federal Ministry for Transport, Innovation and Technology (BMVIT) (2016)
92 See Federal Chancellery (BKA) et al. (2011, 15).
93 See Federal Chancellery (BKA) et al. (2011, 17).

funds to be provided to universities out of the federal budget. The minimum number of places for first-year students per academic year and field of education or degree programme to be offered throughout Austria is determined for particularly popular degree programmes. The total budget is divided into three budget pillars for university budget areas: (a) teaching, (b) research and the advancement and appreciation of the arts (EEK), and (c) infrastructure and strategic development.

The **budget for the teaching pillar** comprises the following amounts in accordance with Section 12 of the Universities Act (UG):

- A "*minimum number of student places to be offered throughout Austria in the individual subject groups.*" [94] The number of these student places in the individual subject groups are determined on the basis of those degree programmes in which students are actively taking exams in regular bachelor's, master's and diploma degree programmes. Courses in which students are actively taking exams are those degree programmes with students who complete a minimum of 16 ECTS or 8 hours per semester week of successful exams per academic year.
- An "*amount that shall be calculated on the basis of at least one competition-oriented indicator and may amount to a maximum of 20 per cent of the budget for the teaching pillar.*"[95]

The **budget for the pillar entitled research/advancement and appreciation of the arts** consists of the following amounts in accordance with Section 12 of the Universities Act (UG):

- An "*amount for the minimum number of persons (full-time equivalents) to be employed in the individual subject groups throughout Austria in selected usage groups.*"[96] This deals specifically with academic and artistic staff.
- An "*amount that shall be calculated on the basis of at least one competition-oriented indicator and may amount to a maximum of 20 per cent of the budget for the research/advancement and appreciation of the arts pillar.*"[97]

The **budget for the infrastructure and strategic development pillar** includes in particular funds for:

- Existing contractual obligations that are not covered by the budgets for the teaching or research/advancement and appreciation of the arts pillars (e.g. building infrastructure, additional clinical expenditure),
- *Incentives* in research/advancement and appreciation of the arts and teaching that should be funded directly, such as digital campaigns or the social dimension,
- Necessary complete financing and the economic security of existing services at the universities.

The individual subject groups are weighted, with consideration paid to various equipment needs and actual cost structures. Funding rates are determined for the distribution of funds. The funding rates for teaching result from the total amount available for this budget pillar and the minimum number of student places that must be offered throughout Austria in the individual subject groups, taking into consideration the weighting of the individual subject groups. The funding rates for research/advancement and appreciation of the arts result from the total amount available for this budget pillar and the minimum number of staff that must be employed throughout Austria in the individual subject groups taking into consideration the weighting of the individual subject groups.

94 See Austrian Federal Act on the Organisation of Universities and their Studies (Universities Act 2002 – UG).
95 ibid.
96 Ibid
97 ibid.

Three-stage procedure

The new university funding plan follows a three-stage procedure consisting of (a) planning, (b) implementation, and (c) analysis.

The planning process

The Austrian National Development Plan for Public Universities (GUEP) governs the planning process and defines the targets and framework parameters that will shape the further development of universities.[98] The Austrian National Development Plan for Public Universities (GUEP) includes two performance agreement periods and ensures planning security and transparency. The university budget for the upcoming performance agreement period is set every three years, in coordination with the Federal Ministry of Finance (BMF), on the basis of the Austrian National Development Plan for Public Universities (GUEP) and taking into consideration the budgetary situation of the federal government. Following the three-pillar model, the total amount is divided among the areas of teaching, research/advancement and appreciation of the arts, and infrastructure and strategic development. Furthermore, the shares of the funds to be allocated according to competitive indicators and the weightings for the seven subject groups in teaching and research/advancement and appreciation of the arts, are set down in the university funding directive. The universities' development plans must be oriented towards the objectives in the Austrian National Development Plan for Public Universities (GUEP). The development plans include information on the planned and continuing research projects/advancement and appreciation of the arts (EEK), university operations, and objectives related to continuing education activities and social aims. The social aims include the impacts of universities on industry and society, sustainability, the third mission, and measures for improved social mobility, the social dimension in teaching, and the inclusion of under-represented groups in higher education.

Implementation process

In the course of the implementation process, the overarching Austrian targets and contributions are transferred to the individual universities, and the performance agreements are negotiated and concluded whilst taking into account university-specific priorities. The universities receive a global budget for implementation, the amount of which is calculated primarily by means of specific indicators for teaching and research/advancement and appreciation of the arts (as depicted earlier).

Analysis process

Monitoring of the targets, projects and measures enumerated in the performance agreements happens on an ongoing basis in the semi-annual meetings between the university and the Federal Ministry of Education, Science and Research (BMBWF). Developments in the basic indicators are also analysed in this context. All of the findings and analysis results then serve as an input for optimising the planning process for the next performance agreement period.

Admission regulations and the determination of student place numbers

Parallel to capacity-oriented university funding, universities are to be given admission regulations, both at the federal and university level, if the course-specific support and supervision values are exceeded. This is done by means of the university admissions directive, stating which fields of education and degree programmes are particularly popular according to statutorily defined criteria, and what minimum number of student places are available for first-year students. An Austria-wide specification of student place numbers for first-year students takes place if:

- The country-wide average value for teacher/student ratios in the last five years exceeds by 1.75

98 See Federal Ministry of Science, Research and Economy (BMWFW) (2017a).

times the supervisory guideline value for a field of education,
- More than 1,000 students who are actively taking exams were recorded in this field of education on average in the last five years throughout Austria, and
- The capacity problem exists at least two universities.

According to Section 71b of the Universities Act of 2002, a minimum number of student places is being specified currently in the following disciplines[99]:

Architecture and urban planning	2,020
Biology and biochemistry	3,700
Educational science	1,460
Foreign languages	3,020
Computing	2,800
Management and administration/economics and administration, general/economics	10,630
Pharmacology	1,370
Public relations and communications science	1,530
Law	4,300

The allocation of the total available student places to individual universities is incorporated in the performance agreements, taking account of any factors specific to each university (capacity, demand on the labour market, research strength, and previous number of student places). In the affected fields of education and/or degree programmes, the rectorate is authorised to regulate admission to such a programme, either by means of a selection procedure before admission, or by the selection of students up to one semester after admission at the latest. Obligatory registration of programme applicants is then stipulated within a period to be determined by the rectorate in the admission or selection procedure. The procedure can only be performed if the number of registered programme applicants exceeds the specified number of student places.

The following standards are decisive for the admission or selection procedure:
- An assessment of performance-based criteria for the educational requirements relevant to the course of study;
- The admission or selection procedure cannot lead to discrimination on the basis of gender or social origin;
- The examination content must be made available on the university's homepage in a timely manner and free of charge;
- The admission or selection procedure must be designed in a multistage manner; oral components alone cannot constitute the sole criterion for successfully completing the admission or selection procedure.

3.3.3 Expansion of third-party funding

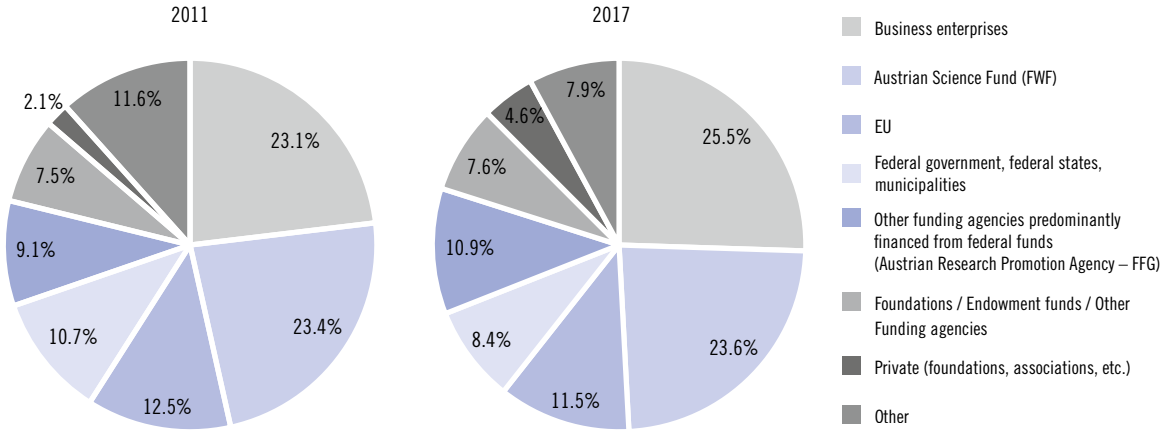
In order to strengthen basic research in Austria, the RTI strategy articulates the following aims: "*expand third-party funding for higher education research through projects evaluated in competition by the Austrian Science Fund (FWF) with a flat-rate coverage of overheads of 20%*" and "*to support priority-setting at universities through the establishment of Clusters of Excellence.*"[100]

Increased acquisition of competitive funds

The objective of the RTI strategy to increase the share of competitive funding in research funding at higher education institutions and thereby to emphasise the acquisition of research projects was further refined in the general Austrian university development plans (2015–2017 and 2019–2024): Austrian National Development Plan for Public Universities (GUEP) system target 2c ("*Further development of*

99 See Austrian Federal Act on the Organisation of Universities and their Studies (Universities Act 2002 – UG).
100 See Federal Chancellery (BKA) et al. (2011, 21).

Fig. 3-7: Sources of university income from R&D projects and projects for the advancement and appreciation of the arts, 2017



Source: Federal Ministry of Education, Science and Research (BMBWF) uni:data, Table 7.6; graphic: WPZ Research.

competitive and project-related components in research funding") specifically calls upon universities to develop third-party funding strategies and to create innovative third-party funding concepts that, among other things, also include competitive elements within the university. Furthermore, the universities are instructed "*to promote, fund, and provide the circumstances necessary for researchers to participate in international and national excellence programmes.*"[101] These standards were subsequently incorporated into the performance agreements and are being implemented on an ongoing basis.

The Federal Ministry of Education, Science and Research (BMBWF) will also in future organise the funding of research even more strongly throughout Austria by means of competition guided by international standards, which will ultimately also amount to strengthening the funds allocated via the Austrian Science Fund (FWF), as called for within the framework of the RTI strategy. As a result, the Austrian Science Fund (FWF) budget has been further increased within the framework of the Federal Financial Framework Act 2018-2022, thus contributing to further orientation towards quality in research funding.

In fact, the proportion of third-party funding, i.e. the share of the universities, total research budget from externally funded research projects, has increased since 2011 from around 28.3% to 29.1%. Revenues from externally funded research projects at Austrian universities have risen by 22.6% since 2011. In 2011 they amounted to around €549 million, in 2017 they already reached around €673 million.[102]

During the same period, the universities' research budget, i.e. the federal government's research-related university expenditure, increased by around 18%, from around €1,388 million in 2011 to around €1,638 million in 2017.[103] Thus, university research financed by third-party funds increased slightly more strongly than the global budget for research and development at universities in the reporting period. However, the strategic objective of the RTI strategy to focus more on competitive funding remains valid.

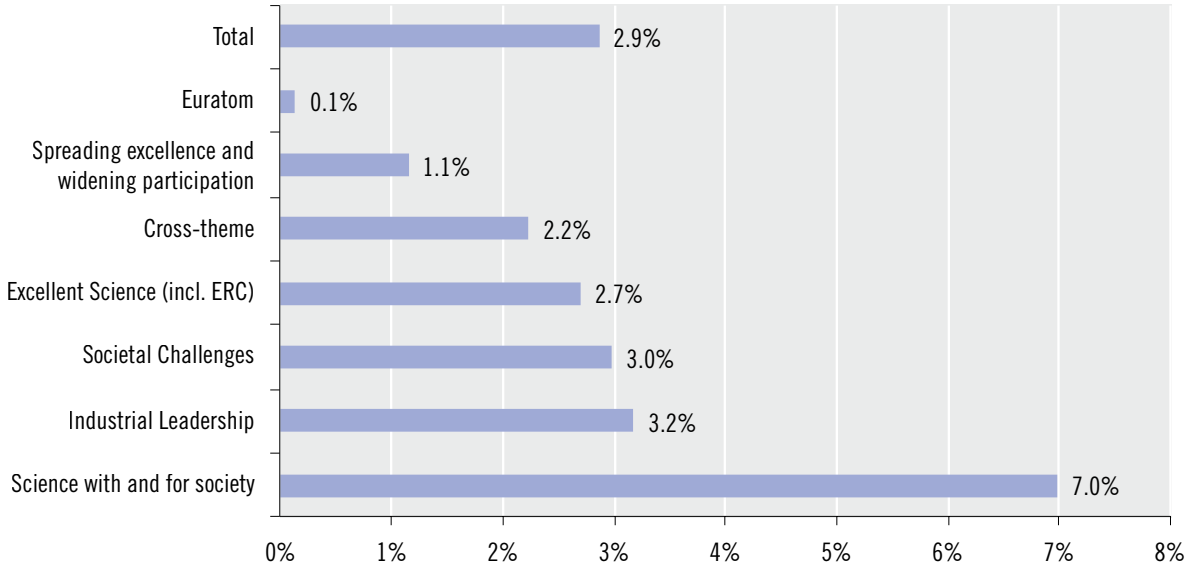
If we take a closer look at the sources of funding,

101 See Federal Ministry of Education, Science and Research (BMBWF) (2017, 17).

102 See Federal Ministry of Education, Science and Research (BMBWF), uni:data, Table 7.6.

103 Source: Statistics Austria: General research-related university expenditure by the federal government from 2000 to 2019: "General University Funds" on the basis of Supplements T of the Working Aids and "Detailed Overviews of Research-relevant Uses of Funds by the Federal Government" to the Federal Finance Acts.

Fig. 3-8: Share of EU research funding (Horizon 2020) allocated to Austria, as of 06/2018



Source: Federal Ministry of Education, Science and Research (BMBWF) uni:data, Table 7.5

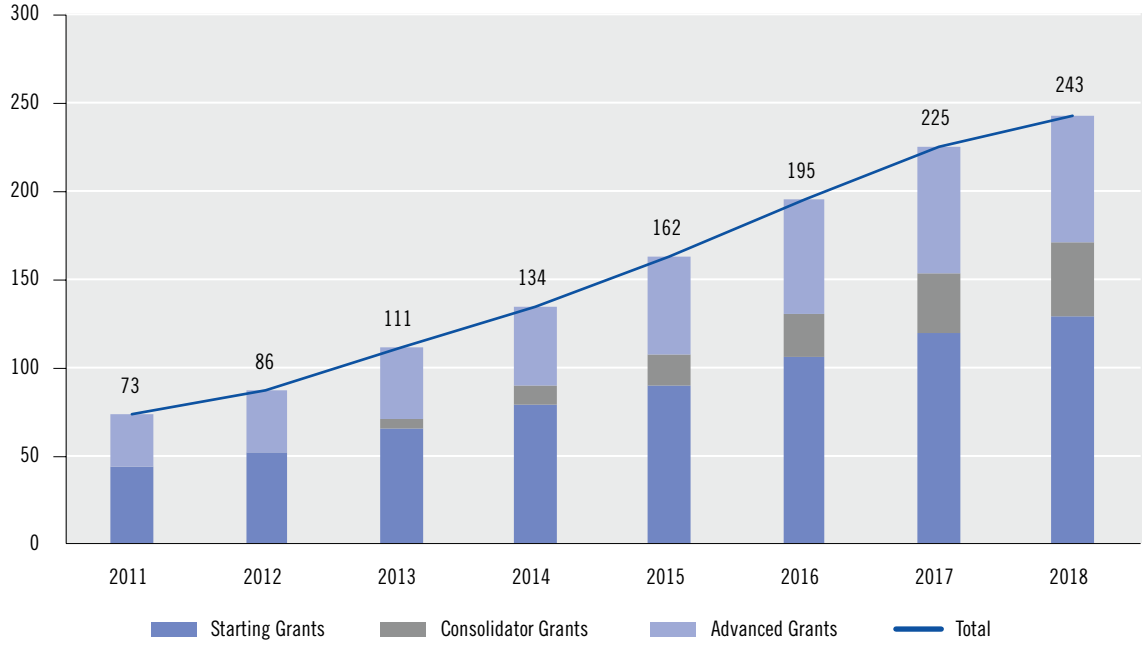
i.e. the origin of university revenues from R&D projects, around one third of research projects are financed by private funds and around two thirds by the public sector (including the EU). Fig. 3-7 shows a breakdown of the origin of university revenues from R&D projects in 2017. In the period under review (2011–2017), the share of research projects funded by firms and private individuals increased in particular. The share funded by the Austrian Research Promotion Agency (FFG) has also risen from about 9% to 11%. Likewise, Austrian Science Fund (FWF) funding increased slightly on a pro rata basis, whereas "federal, state and local government" funding and EU funding have declined slightly on a pro rata basis since 2011.

In absolute figures, however, the project funding gained by the universities from EU programmes increased in the same period from €68.7 million (2011) to €76.6 million (2017). Researchers from Austria have achieved above-average success in raising funds within the framework of the Horizon 2020 EU Research Framework Programme and its predecessor, FP7 (2009-2013). Fig. 3-8 gives an overview of Austria's share of funds distributed in various programme areas within the framework of Horizon 2020 (total share by 2018 approximately 2.9%). For comparison, Austria's share of the EU budget in 2017 was around 2.5%; Austria has 1.7% of the population of the EU-28).[104]

In the topic area "*Science with and for Society*", Austria scored very well with around 7% of all funds distributed by the EU in this topic area. Overall, the returns rate in the research area is positive. Austria returns from competitively distributed, project-based EU research budget exceeds its contribution, so the country is one of the net beneficiaries in the research field: while Austria contributed around 2.5% of the EU budget in 2017, 2.8% of EU research funds went to Austria.[105] In a European comparison, Austria occupies a respectable ninth place in absolute figures for the EU funds raised, and tenth place in relation to the funds paid in.[106] In terms of the success rate, i.e. the approval of submitted research projects, Austria even ranks second.

104 Source: European Commission – Eurostat, Federal Ministry of Finance (BMF).
105 Federal Ministry of Education, Science and Research (BMBWF), uni:data, Table 8.9; Federal Ministry of Finance (BMF).
106 In 2016, see Federal Ministry of Education, Science and Research (BMBWF) (2018b, 103ff).

Fig. 3-9: Austria: Number of ERC grants received for pioneering research (total since 2007)



Source: ERC, https://erc.europa.eu/projects-figures/statistics, cumulative graphic from WPZ Research; note: The new Advanced Grants received in 2018 are not included.

Austrian researchers were also highly successful in the field of cutting-edge European research during the reporting period. The successful acquisition of *ERC Grants*, i.e. funding from the European Research Council, is to be interpreted as a "seal of quality" for research achievements, as it is the most renowned, most sought-after and internationally most visible elite research funding in the EU[107] (see Fig. 3-9). With a total of 243 grants for pioneering research up to 2018, Austria ranks ninth in the solid midfield within the EU in an international comparison, and even sixth in relation to population size within the EU (approximately 27.5 ERC grants per million inhabitants).[108]

In recent years, numerous measures have been taken to make the best possible use of European programmes and structures in order to ensure maximum returns. This includes the further development of the Horizon 2020 advisory system by the Austrian Research Promotion Agency. In addition, excellence-related measures at the universities were promoted in particular by means of performance agreements, or with the establishment of numerous Christian Doppler laboratories or related incentive systems, and the universities were encouraged to develop appropriate third-party funding strategies. In addition, success at the European level is also based on strong national research funding in the competitive field. For example, 80% of the researchers with an *ERC Advanced Grant* had previously received funding from the Austrian Science Fund (FWF). National and European research funding is complementary and interdependent. Strong national funding and a correspondingly strong research landscape are prerequisites for success at the European level. Thus, national investments are partly co-financed by increased success at the European level.

107 See Federal Ministry of Education, Science and Research (BMBWF) (2018b, 101f).

108 Including ERC proposals in 2018, excluding Advanced Grant 2018. Source: Eurostat: ERC: https://erc.europa.eu/projects-figures/statistics (last accessed on 13 February 2019).

The performance agreement with the University of Vienna for 2019–2021 states, for example, that the framework conditions conducive to project-oriented research must be further improved. This includes, for example, "*Optimisation of internal service structures in third-party funding*". The university also plans to implement a "third-party funding structure strategy", which includes measures at both the institutional level and at the level of researchers and can sometimes provide a temporary relief in the field of teaching for the duration of high-calibre third-party funding projects (e.g. ERC, SRA).

The University of Innsbruck can be regarded as an example of planned activities and strategic objectives in the field of third-party fundraising. In its performance agreement, the University of Innsbruck defines far-reaching life-long learning and support services in order to increase participation in EU research framework programmes: for example, an annual training programme for Horizon 2020, as well as the implementation and ongoing further development of a comprehensive ERC mentoring concept with subsequent efficiency measurement.

The University of Vienna is also striving to strengthen its position in application-oriented research. Thus, a "diversification of funding" is intended, i.e. the stimulation of the acquisition of non-basic third-party funding projects. This is to be achieved by improving the linkages between technology transfer and application activities as well as through participation in the European Innovation Council (EIC).

Increasing the funds awarded by the Austrian Science Fund (FWF)

As already mentioned previously, the RTI strategy aimed at achieving reforms in the funding for universities for the purposes of awarding funds based more on competition. In Austria, this relates in particular to the role and endowment of the Austrian Science Fund (FWF) as the most important funding instrument for basic research. Increasing the funds awarded by the Austrian Science Fund (FWF) is also recommended by the OECD's *Review of Innovation Policy* 2018 for Austria. The report points to the low amount of funds awarded in the competition for basic research in Austria as compared internationally: "*The comparatively low funding of the Austrian Science Fund (FWF) […] is an impediment to excellent research [in Austria]*"[109].

In line with the strategic targets, the budget of the Austrian Science Fund (FWF) increased from €490 million in the period between 2013–2015 to around €552 million for 2016–2018, corresponding to a budget increase of approximately 12.5%. In 2011, projects involving third-party funding at the universities were financed by the Austrian Science Fund (FWF) amounted to €128 million, in 2017 this figure was €158 million; this represents an increase in funding of approximately 23%.[110]

However, the covering of overhead costs could not be implemented by the Austrian Science Fund (FWF), instead the funding of research overhead costs will be taken into account as part of the new university financing scheme (Universitätsfinanzierung Neu). The new model provides for the introduction of competitive indicators in research funding, one such indicator relates to "revenues from R&D projects/projects involving advancement and appreciation of the arts". According to current estimates the universities will receive an additional 25–27 cents from the Austrian Science Fund (FWF) each year from this "competition pot" for each euro taken[111]. These funds go into the global budget and can also be used by the universities as compensation for overheads to cover direct administrative and infrastructure costs for Austrian Science Fund (FWF) projects. Previous to the new funding model,

109 See OECD (2018a, 29).

110 See Federal Ministry of Education, Science and Research (BMBWF), uni:data, Table 7.6.

111 According to Federal Ministry of Education, Science and Research (BMBWF) internal information.

indirect costs/expenditures for research projects were considered as part of the universities structural funds (under the "knowledge transfer" indicator) for the 2013–2015 and 2016–2018 performance agreement periods.

Setting up clusters of excellence

Implementation of an Austrian excellence initiative by establishing up to ten clusters of excellence by 2020 was a further measure announced in the RTI strategy. The OECD also highlighted the importance of such a project for Austria as a place for research in its *Review* 2018. See section 3.3.1 for further details.

3.3.4 Structural reform for non-university research

In addition to the higher education sector, Austria has also a highly diverse non-university research sector that receives around one-third of public expenditures on research and development. The R&D survey from Statistics Austria makes a distinction between four sectors: firms (independent research institutes focussing on applied research ("Kooperativer Bereich") and company in-house R&D), higher education institutions, the government, and the private non-profit sector. According to this, the independent research institutes conduct applied research for public agencies and for businesses on a regular basis. It primarily consists of members of the Austrian Cooperative Research (ACR) network, the Austrian Institute of Technology (AIT), Joanneum Research and the competence centres from the COMET programme lines. According to Statistics Austria, these independent research institutes ("Kooperativer Bereich") accounted for 61 survey units in 2017. These invested more than €825 million in research and development and employed more than 5,300 FTEs.[112]

In the area of structural reforms for non-university research, three targets were set as part of the RTI strategy 2020, i.e. *"the development of clear role models along defined performance targets for the different institutes in the non-university research sector", "the reinforcement of internal structures for research institutes through reforms and by adjusting to new requirements",* and *"optimisation of the overall structure for the non-university research sector through improved coordination"* [113]

The following measures were set out in the RTI strategy for this purpose[114]:

- Structural reforms of individual institutes as well as continuation of the international strategic positioning of the Austrian Institute of Technology (AIT)
- Funding for non-university institutes in the form of fixed-term performance and funding agreements that feature publications or patents for instance as criteria
- Flexible designs for research structures with incentives for (re)integration of non-university institutes into the universities or other larger research structures
- Establishment of non-university research bases primarily in the form of non-permanent R&D institutions
- Renewal and harmonisation of the legal bases through revisions to the Research Organisation Act (FOG)

Positioning of Austrian Cooperative Research (ACR)

Boosting and considering competitiveness and innovative potential among SMEs has been an overriding goal since the initial technology policy approaches, given the small-scale structure of the Austrian industry. This applies more than ever today, during times of increasing internationalisation and globalised pro-

112 See Statistics Austria (2015).
113 See Federal Chancellery (BKA) et al. (2011, 22).
114 See Federal Chancellery (BKA) et al. (2011, 23).

duction conditions. Austrian Cooperative Research (ACR) plays an important role here as a network currently involving 18 cooperative, non-university and non-profit research institutes[115].

Austrian Cooperative Research (ACR) is a network that was set up to coordinate interests in the area of non-university R&D together with R&D of relevance to individual sectors, industries and the economy. Consequently it focuses on a very specific part of the Austrian innovation system, namely that covered by its members, the ACR institutes, sometimes in cooperation with other institutions and with industry. As a network of private research institutes that conduct R&D primarily for businesses, their demand-oriented services are tailored to meet the needs of SMEs, to support their innovation efforts.[116] The Austrian Cooperative Research (ACR) institutes currently have around 800 highly-qualified employees (with approximately 30% of these women working in RTI, and the proportion of academics amounts to more than 70%). The ACR institutes provide two thirds of their services to SMEs. The total revenues of the ACR institutes grew by 4.7% in 2017 to a total of €64.4 million, with €56.7 million of this revenue being service-related.[117]

An evaluation from 2015 shows that in addition to building a bridge between basic research and SME innovations in niches, the ACR institutes are also important players between larger firms and SMEs, where the larger firms set the pace, and the SMEs can learn from the partnerships. The ACR institutes can in turn create a benefit for the Austrian SME landscape by also collaborating with larger firms.[118]

ACR formulated the current research strategy in 2015 for the period until 2020. The RDI core competencies of the ACR institutes form the basic foundation for the strategy. Future topics covering different focal points are defined that address industrial as well as societal challenges. A funding programme for "Strategic projects" was launched in addition to topic-based beacon projects (such as innovative procedures for characterisation, digitalisation & structural change, etc.). The funding programme aims to support the institutes more effectively in building up common knowledge and expertise and to improve their infrastructure on a continuous basis. The funding is awarded as part of a competition. The long-term target for the programme is to support firms with the best possible infrastructure and expertise in developing and introducing marketable products and services.[119]

Restructuring of the Austrian Institute of Technology (AIT)

The Austrian Institute of Technology (AIT) underwent an organisational restructuring effective 1 January 2017. The five former departments were transferred to the new structure with eight centres (i.e. Digital Safety & Security; Energy; Health & Bioresources; Innovation Systems & Policy; Low-Emission Transport; Mobility Systems; Technology Experience; as well as Vision, Automation & Control). The reorganisation was developed as part of a strategic process aimed at accommodating the bundling of topics accordingly. Collaboration across different departments was also evaluated and reorganised for the 2018–2021 strategic period. The system now provides for collaboration in business cases that are under the supervision of a centre.[120] The organisational reforms aim at strengthening the internal structures at the Austrian Institute of Technology (AIT) and at ensuring the adjustment of the structures to new requirements, such as the "Grand Challenges".

Key Performance Indicators were already set out

115 See https://www.acr.ac.at/acr-institute/
116 See Austrian Cooperative Research (ACR) (2018).
117 See https://www.acr.ac.at/ueber-uns/
118 See Convelop (2015).
119 See Austrian Cooperative Research (ACR) (2018).
120 See AIT (2018).

in the framework agreement for 2014–2017 for continuous benchmarking, in order to ensure that public funds are used as efficiently as possible by continuously increasing AIT's performance output. These performance indicators include for instance the number of patents and publications as well as the number of doctoral candidates. The indicators have seen a very positive development since 2010: while 16 patents were granted in 2010, this figure was more than doubled in 2017 at 37. The number of publications in peer reviewed journals with impact factors also nearly doubled from 138 to 243. The number of doctoral candidates also rose from 103 in 2010 to 229 in 2017; the share of doctoral candidates from abroad increased by six percentage points to 34% in 2017.[121] Thereby, the development of the key indicators shows that the continuation of the international strategic positioning of the Austrian Institute of Technology (AIT) has been successful.

Funding for non-university institutes in the form of fixed-term performance and funding agreements

The Federal Ministry for Transport, Innovation and Technology (BMVIT) enters into fixed-term framework or funding agreements with the Austrian Institute of Technology (AIT), Joanneum Research and Salzburg Research on an ongoing basis with clearly defined targets. Some of these agreements should be governed by the Research Funding Act in future[122].

Flexible designs for research structures with incentives for (re-)integration of non-university institutes into the universities or other larger research structures

The Austrian Academy of Sciences (ÖAW) and the Federal Ministry of Education, Science and Research (BMBWF) entered into a performance agreement for the first time in the 2012–2014 period. Structural and organisational adjustments were one particular priority for this initial period: the number of research institutes was reduced by more than half, from 63 to 28. Numerous institutes were transferred from the Austrian Academy of Sciences (ÖAW) to universities to encourage priority setting and to ensure optimal framework conditions for excellent basic research.[123] The primary objective of the performance agreement with the Austrian Academy of Sciences (ÖAW) was to enhance the ÖAW's own strengths. The basic budget of the ÖAW was increased in light of this and it was able to increase its third-party funding by two thirds in five years.[124] Focus was also placed on digitalisation in the sciences (e.g. by continuing and expanding the *Austrian Centre for Digital Humanities*).

The path of institutional renewal was also pursued in the subsequent performance agreement periods. In the recently concluded performance agreement for the years 2018-2020, the budget was increased by 8% to €363 million and the thematic focus was above all on the promotion of young scientists. Important performance indicators are documented and reviewed as part of a monitoring process. It can therefore be concluded that measures to make research structures flexible with incentives for the (re) integration of non-university institutions into universities or other larger research structures have been successfully implemented.

Establishment of non-university structures mainly in the form of temporary institutions

Numerous programmes in the area of science-industry cooperation have clear time limits. Table 3-2 shows the duration of all programmes, and clearly illustrates that the measure involving setting up non-university structures primarily in the form of

121 See AIT (2018) and AIT (2011).

122 See Chapter 1.

123 See Federal Ministry of Science, Research and Economy (BMWFW) and Federal Ministry for Transport, Innovation and Technology (BMVIT) (2016).

124 See https://www.oeaw.ac.at/oesterreichische-akademie-der-wissenschaften/die-oeaw/article/mahrerzeilinger-spitzenpositionen-staerken-innovation-foerdern/

Table 3-2: Duration of science-industry cooperation programmes

Programme		Duration (in years)
COMET Competence Centre Programme	COMET Module	4
	K1 Centre	max. 8
	K2 Centre	max. 8
	COMET Project	3–4
CDG	CD Laboratories	7
	JR Centre	5
BRIDGE		max. 3
COIN Cooperation & Innovation	COIN Network	1–3
	COIN Capacity Building	2–5
Research Studios Austria		4
AplusB Centres	AplusB Programme	10
	Austria Wirtschaftsservice (aws) AplusB Scale-up	5
Laura Bassi Centres of Expertise		7
Innovation Voucher		max. 1
Spin-off Fellowships		max. 1.5

Source: Austria Wirtschaftsservice (aws), CDG and Austrian Research Promotion Agency (FFG).

temporary institutions was fully implemented. Details on the programmes can be found in section 3.4.3.

Only in December 2018, Silicon Austria Labs GmbH (SAL)[125] was founded as a further non-university research institution. As a centre for cutting-edge research for *Electronic Based Systems* with sites in Graz, Villach and Linz, its focus is on four key technologies: 1) sensor systems, 2) power electronics, 3) high-frequency technologies and 4) system integration. The aim is to ensure research along the entire value chain as a research partner for science and industry. The Republic of Austria is the main shareholder in Silicon Austria Labs via the Federal Ministry for Transport, Innovation and Technology (50.1%). By the end of 2023 the aim is to have approximately 400 employees working at the three sites, thereby making Silicon Austria Labs the third-largest research centre in Austria. For this purpose, €140 million have been raised by the federal government and the regional governments of Styria, Carinthia and Upper Austria, and a further €140 million has been provided by the electronics industry. An interim evaluation of activities is planned once the pilot phase is completed in 2023.

Renewal and harmonisation of the legal bases in the context of the Research Funding Act (FOFINAG)

The harmonisation and renewal of the legal bases will be reflected in the Research Funding Act where relevant, with this Act planned for the 2017–2022 government programme and announced at the Austrian Council of Ministers in the summer of 2018 (see also Chapter 1).

3.3.5 Expansion and further development of research infrastructures

With respect to research infrastructures the RTI strategy also stipulated the specific targets that "*aim to ensure coordinated expansion of the research infrastructures in Austria as a basis for excellent research and for international positioning of Austrian research*" and "*aim to guarantee optimum coverage related to the strengths and synergy effects for the*

125 See https://silicon-austria-labs.com

use of research infrastructures for priority setting at universities and non-university research institutes [as sponsors of research infrastructures]"[126].

A competitive infrastructure for research institutes and access to international infrastructures are essential prerequisites for an attractive research location. The following measures[127] were defined in order to achieve the target:

- Development of a binding "National roadmap for research infrastructure"
- Incentives to link infrastructures in order to reach critical masses, such as funding for major infrastructures in accordance with coordinated use concepts (e.g. for high-performance computers)
- Expanding cooperation between research institutes and firms based on shared use of infrastructures
- Austrian participation in European and international infrastructures as part of the ESFRI roadmap
- Development of the legal framework conditions for the use of infrastructures, such as biobanks and statistical databases

Development of a binding "National roadmap for research infrastructure"

Competitive research infrastructures are a key factor in operating ambitious research, achieving significant technological progress and thereby meeting the challenges of the future. Based on the RTI strategy, the "*Austrian research infrastructure action plan*" was thus developed and addresses the challenges in the field of basic research-driven and application-oriented research infrastructures.[128] Both, in the fields of basic research and application-oriented research infrastructures, the status quo is ascertained and targets for further development are defined. The research infrastructures in Austria should be expanded in a coordinated manner as a basis for excellent research. The priority setting at universities and non-university research institutes as sponsors of research infrastructures should also ensure optimum coverage of strengths and synergy effects in the use of research infrastructures. The "Austrian research infrastructure action plan" provides the basis for research infrastructure policy until 2020, and also takes European initiatives and strategies into account. The action plan was recognised by the European Commission as an ex ante conditionality (submission of a *roadmap*) for the potential use of funds from the European Regional Development Fund (ERDF) from 2014 onwards.

Incentives to link infrastructures in order to reach critical masses, such as funding for major infrastructures in accordance with coordinated use concepts (e.g. for high-performance computers)

As part of the university structural funds €63 million were made available as start-up funding for cooperation projects for the first time in 2013 for the 2013–2015 performance agreement period. The funds were awarded competitively, conditional on participation of at least one further institute from the area of science, higher education, the arts/culture or industry. This aims at contributing towards a higher education and research area aligned in teaching and research on the one hand, and on the other at strengthening the permeability and cooperation between the educational institutions and between science and industry. Cooperative research infrastructures were funded, such as the high-performance computer at the Vienna Scientific Cluster at Vienna University of Technology, or the MACH supercomputer at Johannes Kepler University Linz.

Also the Higher Education Sector Structural Funding for cooperation was increased to €97.5 million in the 2016–2018 performance agreement period. The proposal procedures for the areas of teaching, research/advancement and appreciation of the arts

126 See Federal Chancellery (BKA) et al. (2011, 23).
127 ibid.
128 See Federal Chancellery (BKA) et al. (2014).

and administrative innovation were implemented separately to address the specific requirements in a more targeted manner. A total of 56 projects were selected, including 43 cooperation projects aimed at improving the R&D infrastructure at universities, and 13 cooperation projects in the area of "unconventional" research or innovative *arts-based* research. For instance €42 million were spent to improve the R&D infrastructure and €8 million to support research cooperation projects that promote excellence and at the same time develop relevant structures. Project topics included e.g. new approaches to therapy aimed at investigating metabolic disorders, or the preparation for the digital revolution in Austria.[129] Coordinated usage and concepts for future research infrastructures were also set out in the universities' 2016–2018 and 2019–2021 performance agreements.

Expanding cooperation between research institutes and firms based on shared use of infrastructures

The public *Research infrastructure database*[130] was also set up in 2016 as part of the "Action plan for a competitive research area". The public research infrastructure database makes it possible to find and also offer research infrastructures for new cooperation projects. As of February 2019 more than 1,300 research infrastructures from almost 100 research institutes and firms in Austria were recorded in the public database. Since high acquisition, operating and follow-up costs of research infrastructure frequently require its usage by multiple institutes, the research infrastructure database can be seen as an important stimulus for cooperation in research and development. It also enables firms and research institutes to gain crucial insights into the infrastructure of the Austrian research landscape, and thereby also facilitates partnerships between science and industry.[131] The OECD lists the Austrian research infrastructure database as a *Best Practice* model of a digital platform for research infrastructure partnerships, serving as an example for many other countries.[132]

Cooperation is also being expanded between research institutes and firms based on common use of infrastructures within the scope of COMET (see section 3.4.3). The Federal Ministry for Digital and Economic Affairs (BMDW) has also funded RTI infrastructures acquired jointly at Austrian Cooperative Research (ACR) institutes since 2012, and in association with this the development of new cooperation partners, particularly SMEs (see section 3.3.4). Silicon Austria Labs with sites in Graz, Villach and Linz is another example of successful cooperation between research institutes and firms based on a common infrastructure (see section 3.3.4). The Federal Ministry of Education, Science and Research (BMBWF) and the Federal Ministry for Transport, Innovation and Technology (BMVIT) have also funded a few major research infrastructures, such as the "Zentrum am Berg" at the University of Leoben and the hydraulic engineering laboratory and pilot factory for Industry 4.0 at the Vienna University of Technology.[133]

These developments indicate that the expansion of the research infrastructure sought by the RTI strategy is being implemented systematically and that promotion of partnerships between the research stakeholders has been successfully implemented and will be continued in future.

Austrian participation in European and international infrastructures as part of the ESFRI roadmap

Research infrastructures are increasingly being funded and operated jointly by multiple governments as a result of the increasing complexity and very high amounts of investment involved. The "*European*

129 See Federal Ministry of Education, Science and Research (BMBWF) (2017).
130 See https://forschungsinfrastruktur.bmbwf.gv.at/de
131 See Federal Ministry of Science, Research and Economy (BMWFW) (2015a).
132 See OECD (2017).
133 See Federal Ministry of Science, Research and Economy (BMWFW) and Federal Ministry for Transport, Innovation and Technology (BMVIT) (2016).

Strategy Forum on Research Infrastructures" (ESFRI) was launched in 2002 in order to develop an independent research infrastructure strategy for Europe.[134] ESFRI aims at identifying new research infrastructures of European interest in order to maintain Europe's appeal and competitiveness as a research location. This is why a roadmap was first created in 2006 for the most important projects and that is intended to cover all areas of science globally for the first time. ESFRI published a revised and updated version of this roadmap each year in 2008, 2010 and 2016, and then most recently in 2018 under Austria's presidency of the European Council. This roadmap currently includes 18 projects and 37 "ESFRI Landmarks" (research infrastructures already implemented or allocated funding).

EU governments and other associated governments in the EU Research Framework Programme use ESFRI as a platform for discussion and coordination for research infrastructures. Although ESFRI has no funds of its own, it still plays a major role in the European decision-making process with respect to establishing the next generation of major research facilities. No country participates in all ESFRI infrastructures, not even any of the large countries. The diversity of the specialist areas, the different scientific communities and their needs mean that participation in each individual project requires a separate decision. Austria participates in a total of 13 ESFRI infrastructures as of 2019:

The biomedical research infrastructure BBMRI ERIC (Biobanking and Biomolecular Resources Research Infrastructure) is so far the only ESFRI infrastructure in Austria, located in Graz. Since February 2019 Austria has also participated in Euro-BioImaging, an imaging research infrastructure in the area of *life sciences* and medical research. The University of Linz is the Austrian coordinator of SHARE ERIC (Survey on Health, Ageing and Retirement in Europe), a research infrastructure that collects panel data on health, working life and ageing. The Austrian Academy of Sciences (ÖAW) takes part in CLARIN ERIC (Common Language Resources and Technology Infrastructure) and DARIAH ERIC (Digital Research Infrastructure for the Arts and Humanities), two infrastructure consortia in the areas of digital language resources and the humanities, via the Austrian Center for Digital Humanities (ACDH) and in cooperation with Austrian universities. Austria also takes part in the European Social Survey (ESS ERIC) via the Institute for Advanced Studies (IHS), and in the Consortium of European Social Science Data Archives (CESSDA ERIC) via the Austrian Social Science Data Archive (AUSSDA). In terms of materials sciences within the scope of existing scientific memberships, Austria participates in the upgrades of the synchrotron radiation source ESRF and neutron source ILL. In astronomy, Austria funds the E-ELT as part of its ESO membership and the preparations for the Cherenkov Telescope Array (CTA) research infrastructure, organised by the University of Innsbruck. Austria also makes major contributions to the HL-LHC at CERN as part of Austria's participation in its oldest major research project in the field of physics. Austria is involved in the ESFRI infrastructure on High Performance Computing (PRACE) via the Austrian Academic Computer Network.

The federal government's RTI strategy 2011 involved the development of an Austrian research infrastructure action plan 2014–2020, which forms the basis for participation in further ESFRI infrastructures, with future memberships reviewed strictly in line with needs and subject to budgets. Due to a constant budget, new memberships will also raise questions related to the termination of existing memberships in future.

In addition to the ESFRI initiatives, Austria is also involved in eight further major research infrastructures of pan-European interest; these include CERN, EMBL, ESO, ESRF, etc. Overall, the number of memberships related to international research within the

134 See http://ec.europa.eu/research/infrastructures/index.cfm?pg=esfri

remit of the Federal Ministry of Education, Science and Research (BMBWF) amounts to 38. This involvement is also aimed at ensuring that research is enshrined internationally and remains competitive, and that access to the most modern research institutes and the most recent data (collections) are guaranteed for Austrian researchers.

Development of the legal framework conditions for the use of infrastructures, such as biobanks and statistical databases

The *Data Protection Adjustment Act 2018 – Science and Research (Datenschutz-Anpassungsgesetz 2018 – Wissenschaft und Forschung – WFDSAG 2018)* was passed by the National Council in 2018. This provides inter alia preconditions for the following:

- Creation of the prerequisites for register research
- Guarantee of operations for biobanks and other scientific archives
- Streamlining of project approvals and data protection impact assessments
- Removal of obstacles to innovative technologies and partnerships
- Clarification of the processing of personal data at the international level[135]

Further developments for improved access to information on publicly funded research is provided in section 3.5.5.

3.4 Increasing the utilisation of knowledge and added value

The vision of the RTI strategy 2020:
"Utilising knowledge, increase added value – enable the potential for innovation"

The performance capabilities of the innovation system were addressed on a broad scale in the RTI strategy under the vision of "*Utilising knowledge, increasing added value*". This takes a broad approach to innovation as a starting point that includes technological, research-driven and non-technological innovations, both in manufacturing as well as in the services sector, and also includes ecological and social innovations or innovations in the public sector.

In this context the RTI strategy refers to the fact that Austria primarily pursued a supply-based approach during the catching-up process before the strategy was created. Demand-based stimulation of innovation has increasingly been an issue since this point. This addressed the arrangements for public procurement, standards and standardisation, and the regulatory framework for the economic operators that have a significant influence on the demand for innovative solutions, and are able to boast the size of the markets for innovative products.

Despite the significant catching-up process during the 2000s, the strategy plan has some shortcomings, both on the input side (research intensity overall, share of funding for research intensity by industry) as well as on the output side (particularly the share of added value in the research, technology, education and knowledge-intensive industries in the business enterprise sector, the proportion of revenues for new-to-market products, the proportion of knowledge-intensive services, the technology content of export products and services, as well as the labour share in the medium-tech and high-tech areas of manufacturing).

Against this background following target was formulated in the RTI strategy *"increasing added value in Austria by accelerating research-intensive industry and knowledge-intensive services, and thereby increasingly using demand-based instruments in procurement, regulation and standardisation to stimulate innovations"*. For this purpose *"the number of firms systematically operating research and development should be increased by around 10% overall by 2013 and by around 25% overall by 2020"* , *"the leading Austrian firms that are successful internationally should be bolstered in their role of supporting the*

135 See https://www.parlament.gv.at/PAKT/VHG/XXVI/I/I_00068/index.shtml#tab-Uebersicht

innovation system, and SMEs should be mobilised in their research and innovation output", and *"the appeal of Austria as a location for research and technology-intensive firms"* should be improved even further. Furthermore *"the level of innovation in firms should be raised over the long term by increasing the proportion of radical innovations"* and the *"product and service structure should be improved by increasing the knowledge and innovation intensity in firms"*.[136]

3.4.1 Enabling and increasing corporate research

General as well as specific measures were defined in the RTI strategy, aimed at promoting corporate research in Austria. The specific measures were supplemented in each case by unplanned de facto development:

General measures in accordance with the RTI strategy	Specific measures
Expansion of direct funding and its optimal alignment with indirect funding as a means of initiating and increasing corporate research and the innovation performance of business enterprises	Strengthening of bottom-up funding (e.g. thematically open Christian Doppler model) in order to broaden the basis for innovation through Innovation Vouchers etc. Further development of indirect (tax incentive-based) R&D funding
Improvement of the framework conditions for and the intensification of various efforts in order to attract additional research-intensive firms and establish headquarter functions	**Forschungsplatz Österreich** ("Research Centre Austria") international marketing initiative launched by ABA – Invest in Austria Merger of the Competence Headquarters and Frontrunner programmes in 2017

Expansion of direct funding and its optimal alignment with indirect funding as a means of initiating and increasing corporate research and the innovation performance of business enterprises

The input from the public sector, i.e. the budgetary development aimed at "funding to enable and increase corporate research and innovative output of firms" was already presented in section 1.2.2. The budgets put forward by the Federal Ministry for Transport, Innovation and Technology (BMVIT) and the Federal Ministry for Digital and Economic Affairs (BMDW) are particularly relevant here, and do indicate a positive development. Reference can be made in particular to the Austrian Research Promotion Agency's portfolio in terms of the distribution of direct funding for applied corporate research (Austrian Research Promotion Agency; see Chapter 2.2). The Austrian Research Promotion Agency (FFG) focuses in particular on widening the basis of innovation at Austrian firms using a bottom-up approach in the area of general funding. Yet the structural programmes with the network character of their funding approaches are also suitable in terms of addressing firms with little research experience. The area of "Thematic programmes" occupies a special place with its priority areas, and this can develop a knock-on effect for corporate research through the specific thematic orientation.

The target of *enabling corporate research*, i.e. motivating firms that had previously not or only barely been active in research to start their (own) R&D activities cannot be achieved with research funding alone. As with the other targets, a combination of measures is required to achieve this. They need to address educational and infrastructure activities that will also potentially be effective in the medium term, as well as the legal and organisational framework (e.g. support for business creation). Based on this, different formats for research funding can be used to facilitate the entry into research, thereby broadening the research base in Austria

136 See Federal Chancellery (BKA) et al. (2011, 26).

(Austrian Research Promotion Agency, to some extent also in the Austria Wirtschaftsservice (aws) and the regional governments).

Progress in achieving this target can primarily be mapped using the R&D statistics from Statistics Austria. Although a certain amount of vagueness is unavoidable with the figures determined[137], the R&D statistics reveal that the number of firms actively involved in research is on an upward trend. This development has been observed since the R&D survey first started (2002: 1,942; 2007: 2,521).

The number of firms with internal R&D expenditure in the respective years increased by almost 13% between 2009 and 2013, and by more than 22% between 2009 and 2015 (see Table 3-3). This includes firms driving R&D on an on-going basis as well as on an ad hoc basis, both should be seen as firms "systematically" driving R&D for the purposes of the RTI strategy. From this point of view, or allocated funding of a 25% increase by 2020 appears very realistic.

The contribution of direct research funding in order to widen the basis for research in firms can be approximated by the administrative data of the Austrian Research Promotion Agency as the most important stakeholder in applied research funding. Table 3-4 shows the number of first-time funding recipients since 2011 at the level of the Austrian Research Promotion Agency areas or one level below. The Innovation Vouchers are stated separately within the "General Programme" area as a result of their explicit

Table 3-3: Number of firms with their own research operations in Austria, 2009–2015

	2009	2011	2013	2015	Change 2009–13	Change 2009–15
Less than 10 employees	908	1,191	1,135	1,283	*25.0%*	*41.3%*
10 < 50 employees	831	941	930	1,038	*11.9%*	*24.9%*
50 < 250 employees	780	818	805	833	*3.2%*	*6.8%*
250 < 1,000 employees	357	361	384	379	*7.6%*	*6.2%*
1,000 and more employees	70	73	72	78	*2.9%*	*11.4%*
Total	**2,946**	**3,384**	**3,326**	**3,611**	***12.9%***	***22.6%***

Source: Statistics Austria, R&D survey, 2009–2015, company R&D sub-sector ("Firmeneigener Bereich") and institutes' sub-sector ("Kooperativer Bereich").
Graphic: Austrian Institute for SME Research.

Table 3-4: Number of initial funding recipients (firms) and the percentage of funding they represent

Categories of the Austrian Research Promotion Agency (FFG)	2011	2012	2013	2014	2015	2016	2017	2018
BP without Innovation Vouchers	174 (25%)	165 (25%)	157 (23%)	130 (20%)	178 (26%)	281 (37%)	410 (41%)	361 (36%)
Innovation Vouchers	367 (66%)	299 (64%)	255 (62%)	235 (57%)	192 (58%)	163 (56%)	154 (50%)	186 (53%)
SP without talents	84 (29%)	168 (32%)	125 (32%)	287 (33%)	33 (29%)	144 (29%)	159 (32%)	189 (33%)
Talents	38 (15%)	43 (12%)	72 (20%)	64 (17%)	38 (13%)	56 (17%)	52 (15%)	30 (11%)
TP incl. ALR (without broadband initiative)	144 (29%)	121 (29%)	118 (27%)	175 (31%)	128 (24%)	181 (30%)	137 (27%)	214 (31%)

Source: Austrian Research Promotion Agency (FFG), as of 21 January 2019; definition of initial funding recipient: initial funding of a firm by the Austrian Research Promotion Agency (FFG) since its establishment in 2004. EIP cannot be depicted. BP without Innovation Vouchers category: from 2016 also with the newly introduced Patent Voucher, which led to a high number of initial funding recipients. TP incl. ALR: Thematic programmes incl. Aeronautics and Space Agency. Graphic: Austrian Institute for SME Research.

137 See Schiefer (2017, 884).

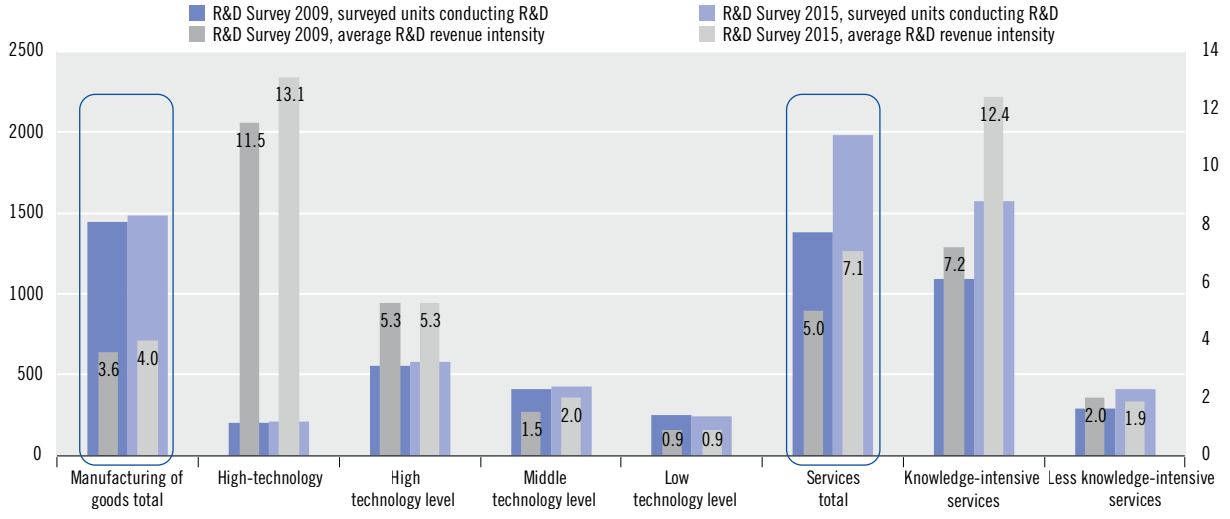
target of broadening the basis for research. The "Talents" programme is stated separately in the "Structural Programmes" areas (including the COMET centres) as a result of its specific focus on personal promotion of early stage researchers that is not representative of the structural programmes.

The Innovation Vouchers play a special role in terms of firms entering the Austrian Research Promotion Agency (FFG) portfolio. The most recent evaluation of the Innovation Vouchers[138] revealed that in the period between 2007–2016, up to 68% of the recipients were first-time clients at the Austrian Research Promotion Agency; 25% of the first-time funding recipients launched R&D follow-up projects as a result of this. This potential widening of the basis for innovation is also to some extent reflected in the R&D survey from Statistics Austria. The evaluation concluded that approximately 21% of the firms newly captured in the R&D surveys in the period 2007–2013 received an Innovation Vouchers.

Since 2016, the newly introduced Patent Voucher has provided a further boost to the numbers for first-time funding in the scope of the General Programme. Otherwise the areas "Structural Programmes" (not including Talents) and "Thematic Programmes" would show higher rates of first-time funding recipients (these continue to fluctuate at around 30% approximately 14 years after the founding of the Austrian Research Promotion Agency).

The target of *Increasing corporate research*, whereby firms that are already more or less active in research make their R&D activities a permanent part of their activities or amplify these, is also retained by the RTI strategy. This is based on the assumption that the target of increasing the R&D intensity will be achieved more easily if R&D activities are made permanent in firms that perform research on at least an ad hoc basis. A recent study for Germany also comes to this conclusion, specifying this as follows: Frietsch et al. identified medium-sized firms that are either operating in the research and knowledge-intensive sectors, or that have already been investing in R&D for longer periods, as those offering the greatest potential for or allocated fundinged 3.5% R&D intensity in Germany, if funding is used to make R&D activities permanent in firms involved in re-

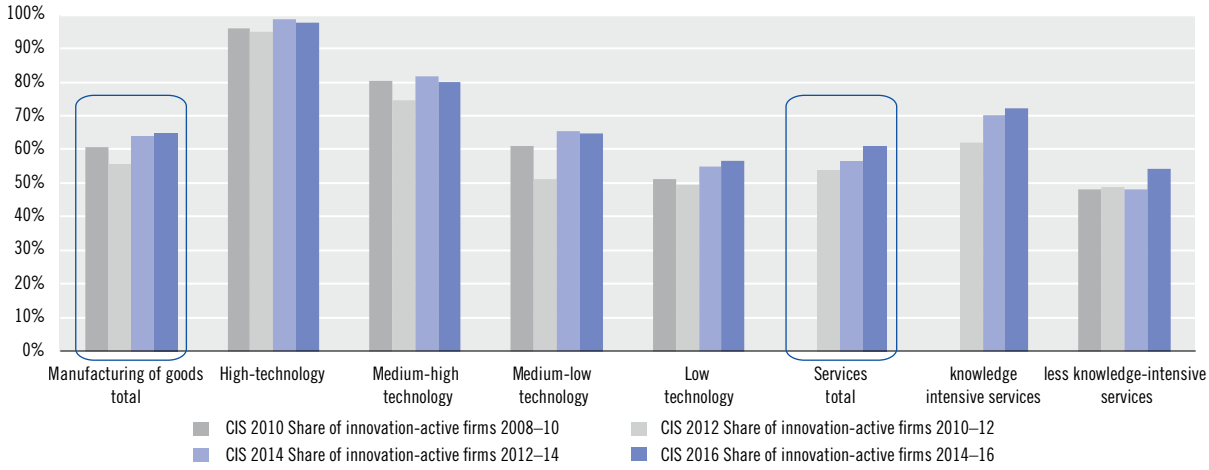
Fig. 3-10: Number of R&D-active firms and their R&D revenue intensity over time (on the basis of the technology and knowledge intensity of the economic sub-sectors in question – OECD definition)



Source: Statistics Austria, R&D survey, 2009 and 2015, company R&D sub-sector ("Firmeneigener Bereich"); graphic: Austrian Institute for SME Research.

138 See Jud et al. (2017).

Fig. 3-11: Share of innovation-active firms over time (on the basis of the technology and knowledge intensity of the economic sub-sectors in question – OECD definition)



Source: Statistics Austria, Community Innovation Survey 2010-2016. Note: Knowledge-intensive services are not shown for 2010, as these were defined differently that year. The OECD classification of the economic sub-sectors is more broadly formulated in the R&D statistics than in the Innovation Survey. Graphic: Austrian Institute for SME Research.

search activities on an occasional basis or with varying levels of intensity.[139]

Progress in achieving the target of increasing corporate research in Austria can also be discussed in the context of the R&D statistics from Statistics Austria. As already outlined in section 1.2, funding for research and experimental development carried out by the business enterprise sector in Austria continued to rise nominally in the period 1981–2017. However, this does not yet provide any detailed information about distribution of the R&D activities. An indication of this is provided by the overview of the development of the number of firms and of the R&D revenue intensity according to the following assessment from the R&D survey (presented in Fig. 3-10). For a better overview, only the findings from the R&D surveys from 2009 and 2015 are compared. The framed bars show the aggregated results for manufacturing and the service sector, with the services sector being primarily responsible for the increasing number of R&D active firms, in particular due to knowledge-intensive services. These also show a strong increase in the average share of R&D expenditure as a proportion of revenues (R&D revenue intensity). In manufacturing, the highest dynamics can be observed by the share of R&D expenditures in firms in the high-technology industries.

The innovation output of the Austrian economy is now increasingly based on research and development, even if the interim conclusion is that higher R&D inputs are not yet adequately realised on the market (see section 3.6). Fig. 3-11 provides an insight into this, showing the development of the share of firms actively involved in innovation as a proportion of all Austrian firms, based on the findings of the last four innovation surveys. The framed areas in the figure overall show a higher level of firms active in innovation in manufacturing as compared to services. The detailed examination of the OECD classification for technology and knowledge intensity shows that the propensity to innovate increases with the technology and knowledge intensity categorisation of the respective industries. Overall, the tendency towards innovation has recovered from the economic crisis, and has indeed increased in particular among those firms featuring

139 See Frietsch et al. (2019).

lower levels of technology. The breakdown also shows that the dynamic among services is attributable in particular to the knowledge-intensive area.

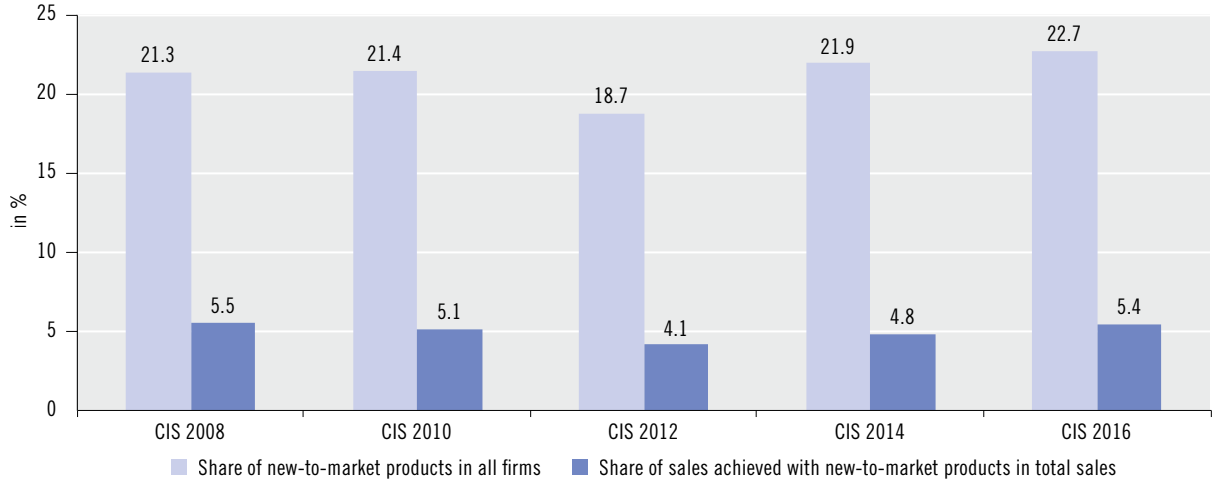
The RTI strategy also aims to achieve a sustainable increase in the *share of radical innovations* that are new to the market, but without measures.[140] As already stated[141], the concept of radical innovation used in the Oslo Manual is located at the output level and defines the degree of innovation novelty of different types of innovation. Radical innovation may result in financial success, although this is not a requirement. Various surveys (including the CIS, the Impact Monitoring for the Austrian Research Promotion Agency funding, etc.) support this approach to the extent that product innovations that are seen as new for the organisation's own market or for the international market result in tangible revenues with considerably greater frequency.

Fig. 3-12 shows the development of new-to-market products based on innovation surveys from the last ten years. The impact of the economic crisis is also evident here, as is reflected in particular in the 2012 survey. However, in total the numbers point to a structural challenge, as the revenue shares for new-to-market products recovered after the crisis only with a delay relative to the share of new products, and only achieved the pre-crisis levels in 2016. As such the lever towards a sustainable increase in the shares of radical innovations does still appear to be capable of improvement.

Indirect R&D funding (through tax) has been raised multiple times over the last few years: from 8% to 10% in 2011 to 12% in 2016 and to 14% in 2018. The research tax premium is significant in that it has been the only tax instrument used for funding R&D in Austria since 2011 that is also available to all firms on an equal basis. The research tax premium in particular supports firms operating R&D on an on-going basis and is relevant in terms of securing the future for international research-intensive firms.[142]

"The planned tax reforms also provide for additional extensions and simplifications (see submission to the Austrian Council of Ministers 55/15 from 2019). The intention is that start-ups and small firms will receive better support in future by taking into

Fig. 3-12: Firms with product innovations and new-to-market products



Source: Statistics Austria, Community Innovation Survey 2008-2016. Graphic: Austrian Institute for SME Research.

140 Since there is no (internationally comparable) objective measurement process available, the Europe-wide standardised Community Innovation Survey (CIS) serves as a basis for discussion in approaching the topic, with the patent statistics used rather less frequently.

141 See Federal Ministry of Science, Research and Economy (BMWFW) and Federal Ministry for Transport, Innovation and Technology (BMVIT) (2017):

142 See Ecker et al. (2017).

account a notional employer's salary in the basis for assessment. The plans also include eliminating the existing connection between the application for the premium with the income or corporation tax declaration, and allow for a partial payment of the premium so that firms are able to access the premium more rapidly."

The aim is to ensure comprehensive alignment between direct and indirect research funding as addressed in the RTI strategy. The planned development related to improved access to registry data (amendments to the Federal Statistics Act, merger of registry data) would support improvements in data availability in this context.

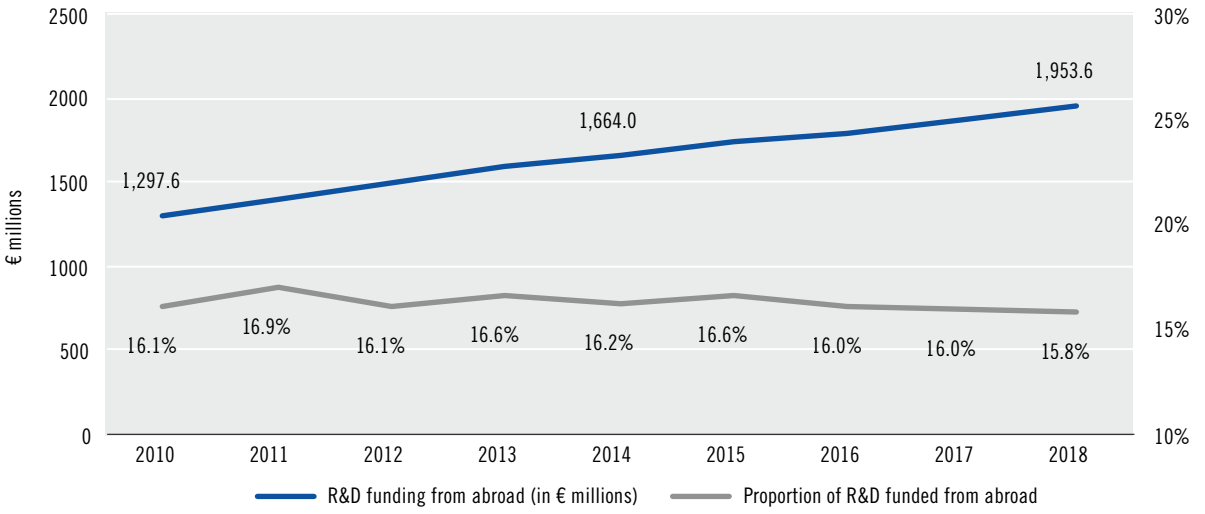
Improvement of framework conditions for and intensification of efforts to attract additional research-intensive firms and establish research headquarters

The Federal Ministry for Digital and Economic Affairs (BMDW) provided approximately €7.8 million in funds between 2008 and 2018 in order to attract additional research-intensive firms. The Austrian Business Agency (ABA) has implemented 188 R&D-related settlement projects so far, involving the creation of 3,414 new jobs and total investment of €978.2 million (source: ABA).[143] The ABA's activity portfolio consists of a combination of PR, networking, concrete new business acquisition measures and investor events with the involvement of the Federal Ministry for Digital and Economic Affairs (BMDW).

The merger of the Competence Headquarters and Frontrunner programmes in 2017 resulted in simplification of the funding landscape, which is seen as a positive step. The results of the evaluation recently completed for the Frontrunner initiative were positive, with recommendations for increased diversification strategies in firms in the future in order to promote structural change.[144]

R&D funding developments provide a quantitative insight into the structure of R&D expenditure. The fact that the dynamics of R&D expenditures have been strongly driven by the business enterprise sector in recent years has already been discussed in Chapter 1.2. Fig. 3-13 highlights that the proportion of foreign funding is falling slightly despite continu-

Fig. 3-13: Development of R&D funding from abroad



Source: Statistics Austria, global estimate 2018; 2016-2018: Estimates made by Statistics Austria. Graphic: Austrian Institute for SME Research.

143 See ABA (2019).
144 See Warta et al. (2019).

ous increases in R&D expenditure from abroad, as Austrian firms feature even greater momentum in this regard.

A recent study on the motives "for locating R&D entities in Vienna" as compared with other international locations once again highlights the importance of a broad mix of factors.[145] These include the availability of innovative talents, educated at excellent institutions, and efficient administration with an international focus (with work permits a key factor). While the availability of highly-qualified human resources, the research environment, and cooperation with research institutes and universities and universities of applied sciences represent the most important determining factors for R&D-oriented location decisions, the advantages of the cost structures and availability of funding,, as well as the quality of life, are not being communicated sufficiently in the form of a consistent settlement policy. The authors of the study see a need for development, specifically with respect to designing more attractive educational options at higher education locations (in particular in the area of ICT and its interdisciplinary linkages), to enhancing the research location profile, and for more focused marketing which emphasises these aspects..

3.4.2 Demand-side stimulation of innovations by the public sector

Demand-based innovation policy is understood as demand-side political action which addresses inefficiencies in innovation processes and/or innovation systems. A distinction is generally made between three types of demand-based innovation policy: regulation (standardisation, legislation, norms), promoting private demand and the public procurement of innovative goods and services. Public procurement, i.e. the purchase of goods and services by government organisations or public sector firms, is key in this context simply as a result of the actual volume of demand (approximately 14% of GDP on average among all EU countries). Beyond strategic purchases, the government can also actively influence the demand for new and innovative products and services, for instance by defining product requirements and creating direct purchasing incentives and/or subsidies.

Implementation of the PPPI guiding concept

The *Guiding concept for public procurement promoting innovation (PPPI)*[146] was developed in 2012 based on the federal government's RTI strategy (or specifically the increased use of demand-side instruments in procurement, regulation or standardisation to stimulate innovation), under the direction of the Federal Ministry for Economic Affairs, Family and Youth (BMWFJ), now the Federal Ministry for Digital and Economic Affairs (BMDW) and the Federal Ministry for Transport, Innovation and Technology (BMVIT), and with relevant stakeholders included, as well as in cooperation with the federal public procurement firm (BBG). The measures proposed in this concept have now almost all been implemented – including all the operational and regulatory measures, and most of the strategic measures, at least to a large extent. The required political support exists, albeit with varying levels of depth and breadth; evidence of this includes the consideration of PPPI in strategic documents, particularly the legislative programme for the current coalition government (including a 2% target for PPPI from the central procurement budget). The PPPI guiding concept is implemented by coordinating ministerial departments. There are also partnerships, and communication and discussion channels, with the Federal Ministry for the Civil Service and Sports (BMÖDS) and the Federal Ministry for Sustainability and Tourism (BMNT). Coordinators for PPPI activities have also been appointed in the federal minis-

145 See Lasinger et al. (2019).

146 See Austrian Federal Ministry of Economy, Family and Youth (BMWFJ) et al. (2012).

tries, and their work constitutes a crucial element in the federal government's coordination responsibilities; they were already mentioned in the original guiding concept as procurement coordinators. The PPPI guiding concept recently underwent a comprehensive evaluation.[147]

Innovation strategies and procurement and implementation plans should also be developed for public consumers according to the PPPI guiding concept from 2012. These PPPI plans do not yet exist at present. One of the reasons for this lies in the inadequate basis for information and data related to procurement volumes and the subject matters for procurement plans. Nevertheless, various preliminary tasks and preparations have already been completed. Strategic advice about PPPI services is available from the PPPI service office. However, this instrument has so far not been used much by the ministerial departments.

The PPPI guiding concept proposed that a *PPPI service office* should be established to provide operational support. This began operating as of 1 September 2013. In addition to internal training within BBG, basic and advanced seminars were also held at the federal government's administration academy. Specific training was also conceived for new employees at BBG on the topics of innovation, SMEs and social and ecological sustainability.

The *PPPI service network* currently includes the following organisations: the IÖB service office, the PPPI competence centres (Austria Wirtschaftsservice (aws), Austrian Research Promotion Agency (FFG), the federal real estate firm (Bundesimmobiliengesellschaft), the Austrian Energy Agency and the Austrian Association for Transport and Infrastructure), the PPPI contact centres (representation of the regional governments, Austrian Federal Economic Chambers, Federation of Austrian Industry, municipal department 23 of the City of Vienna and Salzburg's innovation centre ITG). The Austrian Institute of Technology (AIT) supports the process of implementing the PPPI guiding concept in Austria as a scientific institution. A strategic realignment process is currently underway for the service network and the PPPI advisory council as its coordinating body.

Measures and instruments

The project competition and the initiation and implementation of pilot projects are key measures implemented in connection with the PPPI initiative (independent of any involvement with the ministries in charge or the PPPI service office). The project competition provides a financial incentive for the implementation of innovation-promoting procurement projects despite their increased effort, and reinforces the signalling effect within the public sector. PPPI projects can be submitted by procuring bodies once the concept phase for the project competition is completed. A total of 28 projects were selected from participants in the period 2013–2018; some of these have already been completed, and some are still in the implementation phase. A total of 35 pilot projects were launched or implemented between 2013 and February 2019 with a total value of €19.8 million achieved so far. As there is no generally applicable definition of a pilot project, a total of at least 40 to 50 pilot projects can be assumed to be at various stages of implementation.

The instrument "Challenges" and "Marketplace Innovation" were implemented as part of the efforts to establish the online platform "innovationspartnerschaft.at"[148] and are used for the purposes of initiating PPPI projects directly. "Challenges" was proclaimed by the PPPI service office in order to address the needs of a procurement body in search of an innovative solution that is not yet known. Purchasers can submit these Challenges on the online platform, which are subsequently reviewed by the PPPI service office. Once a Challenge is declared,

147 See Ruhland et al. (2018).

148 See https://innovationspartnerschaft.at/ or from April 2019: https://www.ioeb-innovationsplattform.at/

firms have the option of presenting solutions, which can be uploaded directly via the platform. This means that purchasers can learn more about potential solutions on offer in advance of a proposal without much effort and above all without any commitment ("market research"). Purchasers also obtain specific indications of potential solutions and the costs involved as a result of the solutions submitted. The proposed solutions received are evaluated by representatives of the procuring body (project managers, heads of department, etc.) as part of a jury, with the winners selected from among the proposed solutions submitted. These can then be incorporated further into the later stages of the procurement process and ideally form a part of a concrete offer. Between September 2013 and January 2019 a total of 19 "Challenges" were declared with subsequent orders totalling €311,000 to date. A precise estimate of the procurement volumes is not possible at present due to the long lead time for the Challenges before actual procurement projects are implemented and/or the lack of feedback mechanism for the (budgets for) projects initiated specifically via the Challenges.

Procurement bodies and consumers can find out more about innovative solutions from firms at "Marketplace Innovation". The innovative nature of the solutions offered there are reviewed by the PPPI service office and by representatives from the competence and contact centres as well as from industry in the form of juries as part of a *review* process. As of February 2019 there are 132 products and services suitable for PPPI purposes on the Marketplace. In general, anyone can access the Marketplace, and can thus contact the innovation providers via the contact details stated there. The public procurement firm BBG systematically accesses "Marketplace Innovation", i.e. the Marketplace is used on the one hand as part of market research, and on the other a total of six Marketplace solutions suitable for PPPI purposes have already been incorporated into BBG's standard range. However, there is no option currently for the PPPI service office to record directly the number of contacts made and any procurement projects arising from these.

PPPI is currently only partially taken into account in funding programmes, particularly for the Austrian Research Promotion Agency (FFG) and Austria Wirtschaftsservice (aws). Firms that develop innovative solutions within the scope of funded projects are advised by both federal funding agencies of the options for participating in the public procurement process in general, as well as of PPPI and the corresponding online offers from the service office (i.e. primarily "Marketplace Innovation"). However, there is no information regarding the extent to which this happens systematically and comprehensively. The federal funding agencies act primarily as expert advisers and contacts for purchasers in this context. The agencies do not, however, have the ability to examine funded projects for relevant solutions following a request from purchasers and consumers.

A key element in the (more) systematic use of PPPI was the creation of a corresponding foundation by including innovation as a secondary procurement objective in the Austrian Public Procurement Act (BVergG). This was implemented in 2013 at the point proposed in the guiding concept (now BVergG 2018 section 20 (7)).

Public procurement law was amended accordingly in 2018 in order to implement the innovation partnership as a procurement instrument (EU Directive 2014/24/EU). This facilitates the procurement of innovative solutions not available on the market. The new public procurement procedure enables the development and subsequent acquisition of innovative services in one procurement process. A corresponding proposal is currently underway.[149]

In collaboration with Austria Wirtschaftsservice (aws), the PPPI service office supports purchasers as part of the new "aws IPPP Toolbox" funding programme (funded from the Austria Fund). This provides support to public clients with planning and im-

149 See https://www.ffg.at/fue-Innovationspartnerschaft_asfinag2018

plementing PPPI Challenges and with innovative procurement projects. A submission for one of the two modules is possible as of April 2019: PPPI Transfer (investment funding for innovative procurement projects with a maximum funding amount of €100,000 or of 50% of the project costs eligible for funding) or PPPI Prepare (funding for the costs of consultation for designing and implementing PPPI Challenges with a maximum funding amount of €15,000 or of 100% of the project costs eligible for funding).

Monitoring

In addition to participation in international benchmarking and in the *Mutual Learning Exercise (MLE)*, monitoring and benchmarking also includes the progress reports from the service office as well as the set-up and management of a database with *Good Practice* projects. Austria is ranked second among 30 countries in the latest "Benchmarking of national innovation procurement policy frameworks"[150] from the European Commission. This highlights in particular that Austria has one of the most detailed and clearest action plans for public procurement and has established well-structured monitoring and incentive systems.

The monitoring of the observable procurement volumes has been tested as part of a pilot survey by Statistics Austria, with crucial momentum derived from this for further development of the impact measurement. However, there is currently no system available for measuring the proportion of PPPI in public procurement. Work is taking place on the implementation of PPPI monitoring via existing e-public procurement platforms.

3.4.3 Reinforcing and expanding science-industry cooperation

Cooperation between science and industry is an important determinant of innovative capabilities. On the one hand, new knowledge from basic and applied research is made available to firms, thus creating the opportunity for economic exploitation. On the other hand, science also receives impulses from industry, which in turn can give rise to new research activities.

Cooperation between firms and research institutes can take place in many different ways and requires political support through various instruments due to barriers to cooperation. Austria already has a comprehensive portfolio of instruments for the promotion of science-industry cooperation, which the portfolio is being adapted on an ongoing basis. The development of cooperation intensity has shown an upward trend since the 1990s; as a result, Austria counts as one of the leading EU countries in the field of science-industry cooperation. To a large extent, this process was initiated and promoted by political measures.[151] The reorganisation of Christian Doppler Society (CDG) in 1995 and the introduction of the present COMET programme in 2008 are some of the milestones on this path. The COMET programme offers various formats, organises the bundling of scientific and economic competences in centres or large-scale projects and has, in this way, contributed to the institutionalisation of internationally competitive cooperative research at a high scientific level in the Austrian innovation system.

The RTI strategy already assessed the development of the science-industry cooperation in Austria as very positive in 2011. In order to further strengthen cooperation relations in the future, objectives have been set for the expansion of cooperation relations. According to this, "*the cooperation intensity of Austrian firms will be further increased and the strategically oriented cooperation between science and industry strengthened – with a special focus on excellence and sustainability*"; in this context, it is therefore also necessary to *"remove the barriers and threshold fears among firms, in particular SMEs, in respect of cooperation with science/research and to facilitate the access of innovative firms to external*

150 See https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=55186

151 For a more comprehensive description of the policy mix to promote science-industry cooperation, see Ecker et al. 2018.

resources" as well as *"to support firms so that they can expand their technological leadership and advance to top positions in innovation"*.[152]

The six measures generally formulated in the RTI strategy are shown in Table 3-5 together with a selection of specific measures assigned to them by the federal government (as of January 2019). The specific measures comprise highly diverse instruments and funding intensities. In monetary terms, the programmes implementing measure (1) spend the most money, with the COMET programme receiving the highest financial endowment.[153]

The large number of measures has contributed to the further expansion and strengthening of cooperation between science and industry in Austria. The extent to which the objectives were achieved will be discussed below, using a number of indicators and an international comparison. A causal explanation of the

Table 3-5: Measures for promoting science-industry cooperation in the RTI strategy and funding instruments used by the Federal Ministry for Transport, Innovation and Technology (BMVIT), Federal Ministry for Digital and Economic Affairs (BMDW) and Federal Ministry of Education, Science and Research (BMBWF)

General measures in accordance with the RTI strategy	Specific measures (selection)
(1) Further development of support measures for research partnerships, networks and strategic alliances with a focus on excellence and sustainability (e.g. COMET, Bridge, COIN) and further development of models for thematically oriented basic research (e.g. CDG)	• BRIDGE • Christian Doppler Laboratories • COIN networks • COMET – Competence Centres for Excellent Technologies • Laura Bassi Centres of Expertise • Endowed professorships • Josef Ressel Centres • Networks of the Knowledge Transfer Centres
(2) Strengthening of the leverage and transfer functions of clusters and intermediaries	• AplusB programme • Jumpstart • National Austrian Cluster Platform • COIN Capacity Building
(3) Identification of fields of strength for pooling resources and exploiting synergies, as well as support for the development of research and development (leading) topics (between industry and scientific/research institutes)	
(4) Support for the creation of "links" between Austrian firms and scientific/research institutes and the EU and international programmes	• ERA NET • European and international programmes offered by the Austrian Research Promotion Agency (FFG) • Joint programming
(5) Support for firms with their efforts to safeguard, protect and exploit intellectual property	• NCP-IP national contact office for intellectual property (including the Intellectual Property Agreement Guide) • EU Community Patent • EUREKA • Financial support for international EU-ERA and INCO Net projects • Austria Wirtschaftsservice (aws) IP programme (IP coaching, IP licence and IP market) • Patent Voucher • Implementation of the National IP Strategy (2017) • Knowledge transfer centres and IPR exploitation
(6) Expansion of initiatives to strengthen human potential in applied research and improve inter-sectoral and international mobility	• AIT graduate school • Talent programme • Research expertise for business and industry • "Jugend Innovativ" (youth innovation competition) and Austria Wirtschaftsservice (aws) First

152 See Federal Chancellery (BKA) et al. (2011, 28).

153 For example, the total federal government funding volume for COMET for the period 2008-2018 amounted to around €575 million (excluding regional governments). See Ecker et al., 2018.

Table 3-6: Indicators of science-industry cooperation from the *European Innovation Scoreboard* (most recently available figures from EIS 2018): Austria, EU and the Innovation Leader

	Co-financing of public R&D expenditure by business enterprise sectors (% of GDP)			Co-publications (public research institutes and firms) per million inhabitants		
	2008	2011	2015	2010	2011	2017
AT	0.04	0.04	0.05	72.68	71.88	82.30
DK	0.03	0.03	0.03	156.83	162.21	162.82
EU-28	0.05	0.05	0.05	40.16	42.61	40.93
FI	0.08	0.08	0.05	89.32	89.48	85.40
Innovation Leader*	0.05	0.05	0.04	94.10	97.85	94.77
LU	0.01	0.02	0.01	35.85	33.21	25.40
NL	0.13	0.09	0.08	102.81	110.77	99.35
SE	0.05	0.04	0.04	118.94	127.34	130.56
UK	0.03	0.03	0.02	60.82	64.10	65.11

**Innovation Leader* is the unweighted arithmetic mean of the *Innovation Leaders*.

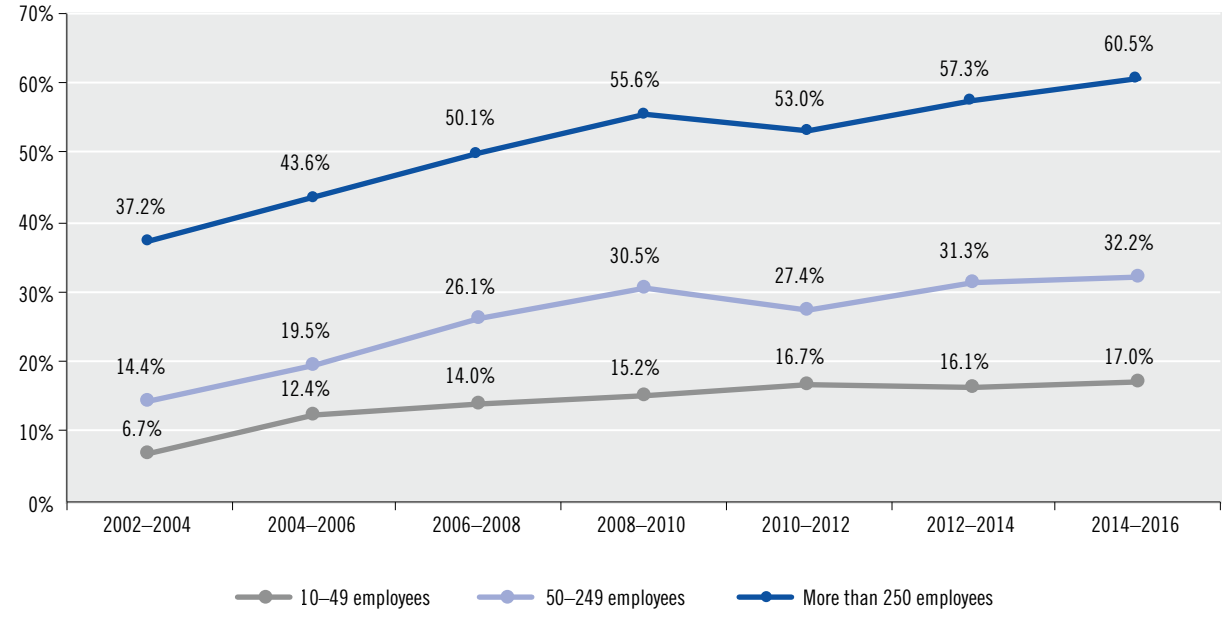
development of the indicators due to the impact of individual measures is not possible.

Table 3-6 provides an overview of the two indicators of science-industry cooperation which are included in the *European Innovation Scoreboard* (EIS). These two indicators can be used primarily to measure the extent to which the cooperation intensity of Austrian firms has further increased or strengthened. Together with the share of SMEs that cooperate on innovation, these two indicators form the sub-dimension "*Linkages*" in the EIS. In this sub-dimension, Austria was able to significantly improve its position in the period 2011-2017 by jumping from ninth to third place and is now only behind Belgium and the Netherlands. In detail, the indicators in Table 3-6 also show a positive development. The share of public R&D expenditure co-financed by firms as a percentage of GDP rose from 0.04% to 0.05%, which is also higher than the *Innovation Leader* average. The share of funding accounted for by firms declined in the same period. Austria also shows a positive trend in co-publications; the corresponding value rose by approximately 15% from 71.88 in 2011 to 82.30 in 2017. In contrast, development stagnated for the EU-28 as well as the *Innovation Leaders*. Although Austria is still below the level of the *Innovation Leader* average, as an interim result and on the basis of the indicators recorded in the EIS, it can thus be stated that the objective of the RTI strategy to further expand science-industry cooperation in Austria has been achieved: It was possible to both increase the intensity of cooperation and reduce the distance to the *Innovation Leaders*.

The first analysis addresses the business enterprise sector as a whole; the next step is to examine whether the intensity of cooperation between science and industry has improved, especially among SMEs. This evaluation can be carried out by analysing the evolution of cooperation activities between firms and research institutes. For this purpose, the firms are divided into various classes according to their size.

Fig. 3-14 shows this development among the academic cooperation partners universities, universities of applied sciences and other higher education institutions from 2002-2016. There is an increase in the share of firms with science-industry cooperation for all enterprise sizes. This also applies to the period following the introduction of the RTI strategy in 2011. Large and medium-sized enterprises grew significantly faster than enterprises with fewer than 50 employees. Throughout the period from 2002 to 2016, the tendency to cooperate increased most among small enterprises and least among large enterprises. This finding is also confirmed in principle if, instead of tertiary educational institu-

Fig. 3-14: Share of product and process innovators participating in innovation cooperation projects with universities, universities of applied sciences or other institutes of higher education, in%



Source: Statistics Austria, CIS 2004, CIS 2006, CIS 2008, CIS 2012, CIS 2014, CIS 2016.

tions, "other government or public research institutes" are regarded as cooperation partners. This includes the Austrian Institute of Technology (AIT) and Joanneum Research. It should be noted, however, that SMEs (firms with fewer than 250 employees) have shown slight decreases in their cooperation intensity since 2010-2012. In an international comparison for the period 2012-2014, Austria even ranks first ahead of all *Innovation leaders* in an evaluation of public and private research institutes as cooperation partners. [154]

After all, the RTI strategy also set the objective of more firms achieving technological leadership and advancing into innovation peaks. In order to check the achievement of these objectives, the performance reports of the Council for Research and Technology Development (RFTE) analyse the patent applications according to PCT relative to GDP.[155] Accordingly, Austria was able to increase patent applications according to the PCT per billion of GDP from 4.4 to 4.7 in the period from 2008 to 2015. However, there has been a decline from 5.13 to 4.70 since 2011. The Austrian value in 2015 was about 85% of the average value of the *Innovation Leaders*. Austria has thus managed to catch up for the period 2008-2015, although the momentum has slowed since 2011.

In addition to the patent analysis, the data from the *European Industrial R&D Investment Scoreboard* which annually covers the 1,000 EU firms with the highest R&D expenditure, will be used for further consideration later on. The selection of firms – recorded by the *European Industrial R&D Investment Scoreboard* – can be seen as the European front-runners of innovation and the number of Austrian firms among these 1,000 firms as an indicator for the achievement of top positions. During the period from 2011 to 2017, the number of Austrian firms represented in the *European Industrial R&D Investment Scoreboard* increased from 27 to 32. By way of example

154 See Ecker et al. (2018).

155 This indicator is also included in the EIS and serves as one of three measures of the sub-dimension "*intellectual assets*".

and comparison, Sweden, with 77 firms, still has significantly more firms in top positions than Austria in 2017.

Overall, the objective of increasing the number of firms with technological leadership appears to have been only partially achieved. It should be noted, however, that the highly innovative and niche specialist SMEs of Austrian industry are only inadequately represented by the two measures used.

In summary, the findings for the achievement of the objectives – and thus also for the implementation of the measures as a whole – are positive for science-industry cooperation. There has been an increase in cooperation intensities and Austria can be classified as a leading country in this area.

3.4.4 Strengthening entrepreneurship at universities

In order to increase the interaction between science and industry, the knowledge and technology transfer between these two sectors and, last but not least, the entrepreneurial spirit and the number of innovative enterprise creations from higher education institutions, the RTI strategy 2011 laid out two measures in particular[156]:

- Strengthen finance competence and *entrepreneurship* at universities, including the establishment of knowledge transfer centres.
- Develop new funding models with venture capital investment for leveraging university *intellectual property rights (IPR)*, and establishing university-related venture investment firms.

In order to improve the coordination and development of support measures to promote knowledge and technology transfer, enterprise creation, etc., the working group "*Knowledge transfer and new enterprises*" was set up within the framework of the *RTI Task Force*.

IP National Contact Point (NCP-IP)

The **National Contact Point for Knowledge Transfer and Intellectual Property (NCP-IP)** was established jointly by the Federal Ministry of Education, Science and Research (BMBWF), Federal Ministry for Digital and Economic Affairs (BMDW) and Federal Ministry for Transport, Innovation and Technology (BMVIT) following a decision by the federal government from 2 March 2010 based on a recommendation by the European Commission ("IP Recommendation"). The operational implementation is carried out by the Austria Wirtschaftsservice (aws) and by the Austrian Research Promotion Agency (FFG) via coordinated annual work programmes. The objective of the NCP-IP is to further strengthen the cooperation between science and industry, public research institutions and interministerial coordinated measures. Its aim is also to support universities and firms in dealing with intellectual property (e.g. through workshops, trainings, sample contracts) and to represent Austria in relevant European bodies.

So far, the pioneering project *Intellectual Property Agreement Guide (IPAG)* has been implemented. It provides research institutes and firms with online access to sample contracts in the area of technology transfer (in German and English), free of charge. The IPAG project confirms the high demand for a sound legal basis in knowledge transfer (approximately 25,000 hits since it was launched). As part of the implementation of the federal government's Open Innovation Strategy, starting from the end of 2019 onwards, firms and research institutes will be able to support the creation of fair Open Innovation processes with another new interactive toolkit. In order to improve networking between stakeholders in the Austrian innovation system, more than 50 events have been organised since the establishment of the NCP in 2010 with the aim of further intensifying the exchange between the representatives from science and industry and to strengthen mutual trust. Addi-

156 See Federal Chancellery (BKA) et al. (2011, 30).

tionally, the new NCP-IP website was launched[157] with comprehensive information regarding knowledge and technology transfer.

Knowledge Transfer Centres and IPR Exploitation

The programme "Knowledge Transfer Centres and IPR Exploitation" (2013-2018) created incentives for increased regional cooperation between the knowledge and technology transfer units of Austrian universities within the framework of the Knowledge Transfer Centres East, South and West and for the establishment of the thematic Knowledge Transfer Centre *Life sciences*. Approximately €11.25 million of investment volume was available for the project. All Austrian universities participated in the regional centres with 16 cooperation projects. In particular, the programme aims to strengthen the synergy potentials of the universities' knowledge and technology transfer units, especially when it comes to expanding and building up skills in knowledge and technology transfer, intensifying linkage between higher education institutions, research institutes and business enterprises, as well as increasing and improving the ways in which these potentials can be exploited. In the process, both technical and medical fields of study as well as those of humanities, social and cultural sciences and the arts were included throughout Austria.

As part of the funding of patent costs totalling €5 million until the end of 2018, up to November 2018 (= submission deadline) a total of 738 applications were received from the universities, 99.4% of which have so far been approved.

In the course of PRIZE prototype funding, an international jury of experts selected promising projects for funding in 2014, 2015, 2016 and 2017. In total, the Federal Ministry for Digital and Economic Affairs (BMDW) provided around €4 million to develop patentable prototypes.

An external interim evaluation and the monitoring report of the Federal Ministry of Education, Science and Research (BMBWF) and Federal Ministry for Digital and Economic Affairs (BMDW) within the framework of the outcome-oriented impact assessment (WFA) were positive and show that the strategic and operational requirements of the programme could largely be implemented. Building on this, the *Community Building* of the knowledge transfer centres and their successful projects are to be continued within the framework of the performance agreements 2019-2021. In April 2019, the Austria Wirtschaftsservice (aws) invited tenders for the "Impulse Programme for Austrian Knowledge and Technology Transfer" financed by the 'Austria Fund' (Österreich-Fonds) in the amount of €6 million, which is intended to offer additional incentives for the expansion of existing university networks through universities of applied sciences, schools, kindergartens and firms, especially in the STEM field, while taking into account new priorities such as the increased involvement of universities of applied sciences. In addition, there is patent funding for universities and universities of applied sciences as well as prototype funding for promising scholarly research projects.[158]

Spin-off Fellowships

The "Spin-off Fellowships" programme was also launched as part of the federal government's Gründerland Initiative (Start-up Country Initiative)[159]. The so-called spin-off fellowships are intended to provide an additional incentive to transfer research results from the higher education sector into business ideas and to drive these forward to the creation of a new enterprise. It is aimed at students and researchers at universities and research institutes who have already achieved research results that are ready for the market. With a spin-off fellowship, they are given the opportunity to work on their business idea at the re-

157 See https://www.ncp-ip.at/en/

158 See www.aws.at/foerderungen/wissenstransferzentren/, www.aws.at/patentfoerderung and www.aws.at/foerderungen/prototypenfoerderung/

159 See https://www.ffg.at/en/spin-off-fellowships

spective higher education institution or research institute for a maximum period of 1.5 years (exempt from obligations such as teaching and research) to subsequently establish an academic spin-off. 15 projects have been launched since the start of the programme. The Spin-off Fellowship programme will run until 31 December 2021. In the case of enterprise creation, funding programmes such as AplusB, Seed or PreSeed can offer subsequent support.

AplusB programme

AplusB centres support start-ups from universities, universities of applied sciences and non-university research institutes. From 2002 to 2017, the AplusB programme was administered by the Austrian Research Promotion Agency (FFG) on behalf of the Federal Ministry for Transport, Innovation and Technology (BMVIT). During this period, newly-founded academic enterprises and spin-offs were supported and promoted in seven (at times nine) AplusB centres throughout Austria. By April 2018, 829 projects had been managed, of which 710 had started a firm. A total of over 3,000 jobs (mainly for highly qualified professionals) were created.[160] Since 2017, the programme has been continued under the name "AplusB Scale-up" and the processing has changed from the Austrian Research Promotion Agency (FFG) to the Austria Wirtschaftsservice (aws).[161] The focus of funding has also changed. The new "AplusB Scale-up" programme is now intended to support RTI start-ups with high growth potential or a high propensity to grow.[162]

Anchoring entrepreneurship at universities

Austria's universities are not only the main providers of basic research, they also play a central role in enhancing the location as far as developing fields of expertise and focus are concerned.[163] Similar to firms, a "lead institution initiative" was therefore developed for Austrian universities and implemented in three successive performance agreements and in the Austrian National Development Plan for Public Universities. Recorded in the initiative is also the motivation for university activities which promote or include *entrepreneurship*-oriented thinking in teaching and research (e.g. through special courses). In the performance agreement period 2016-2018, targeted support was therefore given to projects that included measures for personnel development and further qualification of university staff – including the training of *entrepreneurship*skills.[164]

Projects of the regional knowledge transfer centres such as "Ideen Garten" (Ideas Garden), "Skinnovation", "Gründungsgarage" (Start-up Garage) or award events such as "Von der Innovation zur Wissenschaft" (From Innovation to Science) have also contributed noticeably to an increased motivation for creating start-ups and to an enhanced *entrepreneurial spirit* at Austria's universities.[165] Professorships for entrepreneurship were also established at the universities of Klagenfurt, Linz and Vienna. In addition, Austria is currently participating in a HEInnovate country study conducted jointly by the European Commission and the OECD – not least to motivate higher education institutions to incorporate and strategically implement *entrepreneurship* and innovation in all dimensions of their fields of activity.

3.4.5 Supporting enterprise creation and strengthening venture capital financing

In the RTI strategy, the significantly below-average share of young, fast-growing firms compared to other countries is highlighted as a deficit of

160 See https://www.ffg.at/aplusb-academia-plus-business
161 See https://www.aws.at/foerderungen/aws-aplusb-scale-up/
162 See https://www.bmvit.gv.at/innovation/zentren/aplusb/index.html
163 See Janger et al. (2017a).
164 See Federal Ministry of Education, Science and Research (BMBWF) (2017).
165 ibid.

Austria's innovation system.[166] In fact, the most recent *European Innovation Scoreboard* shows that Austria fell further behind in 2017 compared to 2010 in the category *"employment in fast-growing enterprises"*.[167] Although the performance of the EU as a whole has also deteriorated, Austria has lost even more shares, meaning that Austria has fallen back both relative to the EU and to itself. This trend is also responsible for the identification of the innovation dimension "*employment impacts*" next to "*sales impacts*" in the current *European Innovation Scoreboard* as Austria's greatest weakness.[168] One indicator of Statistics Austria, namely that of "knowledge- and research-intensive enterprise births", shows a strong increase for the last available year (2016) after years of stagnation.[169]

In order to improve its employment situation in fast-growing firms, first of all Austria needs firms that have the potential to grow in the future. Firms that grow fast are usually those that are innovative. They need investors to finance their projects, as their founders seldom have the necessary equity at their disposal. Therefore, the RTI strategy also emphasises the need for the availability of venture capital to finance growth-oriented firms. The predominant form of corporate financing in Austria through bank loans is proving to be a weakness, as banks – due to their business model – are rarely willing to take the high risk inevitably associated with entrepreneurial innovation, especially in the early stages. The RTI strategy therefore sees the strengthening of the risk capital market as a challenge specific for Austria, i.e. the objective of the RTI strategy mentions "*Increasing the volume of venture capital*"[170] which is available to Austrian start-ups for funding.[171]

Against this backdrop, the RTI strategy has the following measures in place[172] to support innovative and technology-based firms and to stimulate venture capital financing:

- Developments in supply and demand of venture capital
- Establishment of a legal framework to strengthen the equity capital of young, technology- and growth-oriented firms
- Strengthen the venture capital initiative to stimulate early stage investment, taking into account developments to date
- Optimisation and completion of existing support measures for technology-based and innovative newly created businesses, especially measures for the founding phase (see PreSeed, Seed Financing, Business Angels, Technology Marketing etc.)

Developments in supply and demand of venture capital

Fig. 3-15 shows the venture capital investment volume as a percentage of GDP for Austria and the *Innovation Leaders* from the Innovation Scoreboard 2018 for the observation period from 2007 to 2017: Denmark, Sweden, the Netherlands, Finland, Luxem-

166 See Federal Chancellery (BKA) et al. (2011, 29).

167 This indicator is defined as the proportion of employees in the upper half of the most innovative sectors ("*number of employees in high growth enterprises in 50% 'most innovative' industries*"). For reasons of data availability, the data contained in the *European Innovation Scoreboard* is from the previous year. In the most recent *Innovation Scoreboard* for 2018, most of the data originated from 2017, and the data for the indicator "Employment in fast-growing enterprises" therefore originated in 2015.

168 See European Commission (2018b, 69).

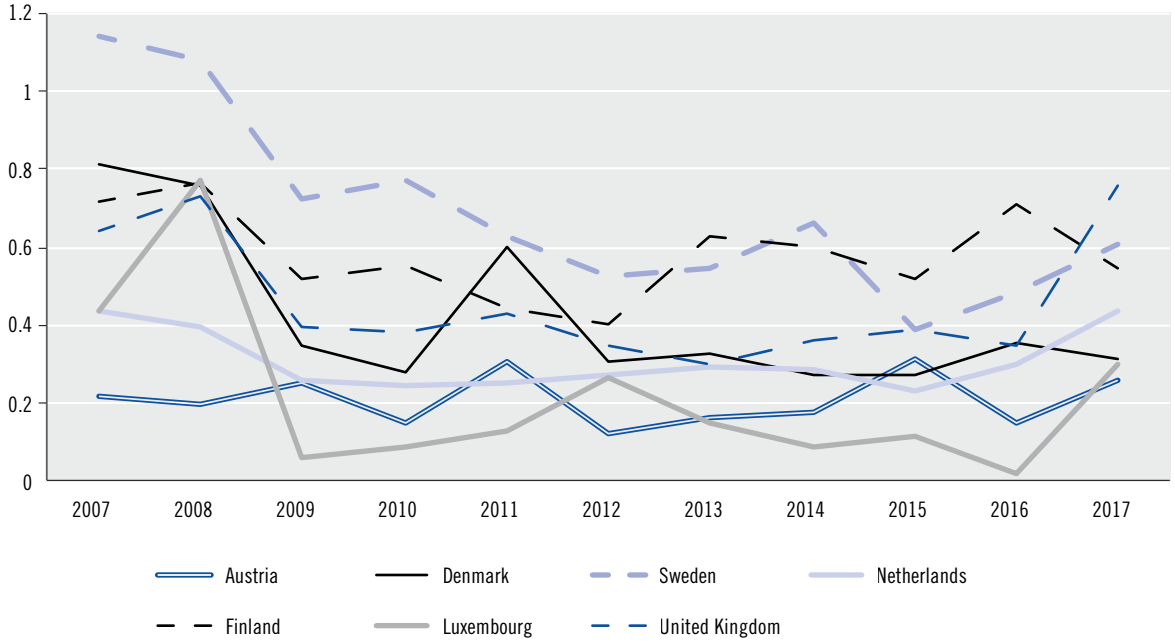
169 See Statistics Austria Business demography; the figures for 2016 were "provisional" when this report went to press.

170 See Federal Chancellery (BKA) et al. (2011, 29) and Federal Ministry of Science, Research and Economy (BMWFW), Federal Ministry for Transport, Innovation and Technology (BMVIT) (2016,71).

171 A start-up is a young firm that produces a product with intense research and is characterised by a high level of risk. *Venture capital* refers to private or government equity capital that is invested in start-ups in order to resell the firm after a certain period of time, if possible at a profit. Venture capital is thus a special form of private equity that is specifically invested in start-ups. The term venture capital sometimes refers to private equity including venture capital, sometimes to venture capital only. As risk capital always means venture capital in RTI strategy, these terms are also used synonymously here.

172 See Federal Chancellery (BKA) et al. (2011, 30).

Fig. 3-15: Venture capital investment in selected countries (by location of the portfolio firm), 2007–2017, as a percentage of GDP



Source: INVEST Europe (investment) and Eurostat (GDP), calculation and graphic: WPZ Research

bourg, and the United Kingdom.[173] Austria may have been in the last or next-to-last position in most years, yet has made continuous progress in catching up to the *Innovation Leaders*: While the ratio of Austria's share to the mean value of the shares of *Innovation Leaders* was still well below one third in 2007 and 2008, since 2013 it has consistently been more than two fifths; in 2015 Austria was even almost on a par, and in 2017 the ratio was just over half.[174]

Even more significant is the fact that Austria is the only one of the seven countries to show an upward trend, albeit a slight one, during the observation period.[175] While the volume of venture capital invested in Austria was not noticeably affected by the financial and economic crisis, all other six countries surveyed have still not recovered from this shock and reported a downward trend over the entire period.

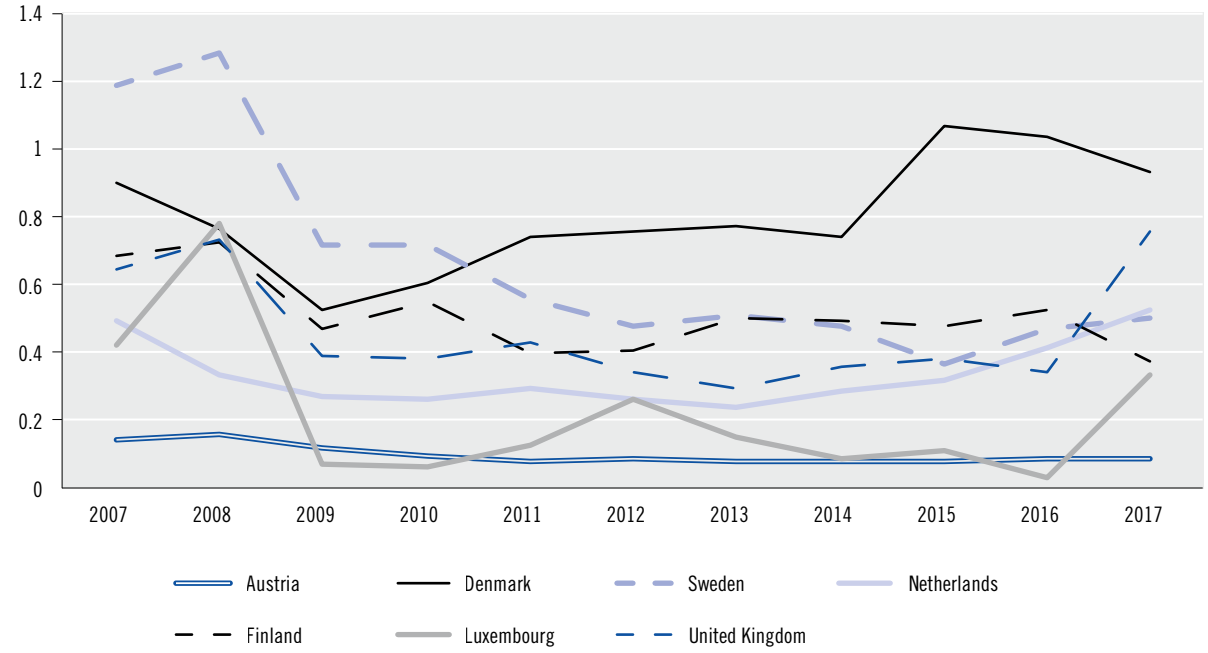
Fig. 3-16 shows the volume of venture capital investment by domestic private equity firms, again as a ratio of GDP for the same countries. Capital does not necessarily have to be invested in domestic start-ups, but empirical evidence shows very clearly that geographical distance is a crucial determinant: usually, private equity firms invest in start-ups in their own country, often even in their own region, at most in neighbouring countries. Against this background, it is all the more remarkable that the volume

173 It should be noted that Austria's gap is much smaller than stated in the RTI strategy. The latter (p. 29) gives a value of 0.03% for Austria in 2010 and 0.23% for Sweden. This discrepancy is probably due to the fact that the values from the then current Innovation Scoreboard were adopted in the RTI strategy. However, in addition to venture capital in the narrower sense (seed phase, start-up phase, "*later stage venture*"), these also include growth capital, rescue and turnaround capital, and replacement capital, which are usually classified as private equity but not venture capital. Secondly, as in the Innovation Scoreboard, the RTI strategy is likely to be based on average values from the previous three years. In this report, venture capital (and thus also risk capital) is always understood to mean venture capital in the narrower sense, and annual data refer to the year actually reported.

174 The individual values are: 2007: 0.31; 2008: 0.26; 2009: 0.66; 2010: 0.38; 2011: 0.74; 2012: 0.34; 2013: 0.44; 2014: 0.47; 2015: 0.99; 2016: 0.40; 2017: 0.53.

175 Calculations using the least squares estimator; for more details see Keuschnigg and Sardadvar (2019).

Fig. 3-16: Venture capital investment in selected countries (by location of the private equity firm), 2007–2017, as a percentage of GDP



Source: INVEST Europe (investment) and Eurostat (GDP), calculation and graphic: WPZ Research.

invested *by* Austrian venture capital funds is much smaller each year than the volume invested *in* Austrian start-ups. It follows that the demand for venture capital in Austria is greater than the available supply.

Establishment of a legal framework to strengthen the equity capital of young, technology- and growth-oriented firms

One possible reason for Austria's clearly visible gap with regard to the establishment of private equity firms in Fig. 3-16 is the lack of legal certainty. However, this uncertainty does not affect the legal form of the private equity firms as much, since the legal form of "*Limited Partnership*", which is customary for venture capital firms internationally, is comparable to the limited partnership possible in Austria.[176] For example, the Medium-sized Financing Companies Act (MiFiGG) provides for limited partnerships as a legal form; the Alternative Investment Fund Manager Act (AIFMG) determines who may operate a venture capital fund with public funds. However, all this has to be viewed independently of the question as to whether there is an appropriate legal framework for venture capital funds in Austria. The real problem is rather that there is a lack of legal certainty regarding taxes in Austria. In fact, there is no legal basis defining the criteria that a venture capital firm has to meet.

With regard to crowdfunding, a legal framework was created in 2015 in cooperation with the Federal Ministry of Science, Research and Economy (BMWFW) (now: Federal Ministry for Digital and Economic Affairs (BMDW)) and the Austrian Federal Ministry of Labour, Social Affairs and Consumer Protection (BMASK) (now: Federal Ministry of Labour, Social Af-

176 A "*Limited Partnership*" consists of a "*General Partner*" who also manages the business and represents the firm to the outside world. Investors represent *Limited Partners* by participating as shareholders (or limited partners). As with a limited partnership, at least one partner has unlimited liability for the firm's liabilities (general partner, or Komplementär in Austrian law) and at least one other partner has limited liability (limited partner, or Kommanditist). The rights of co-determination and control of *Limited Partners* tend to be more limited than those of Kommanditists, although there are differences here both in Anglo-Saxon and German-speaking countries.

fairs, Health and Consumer Protection (BMASGK)), which also includes equity instruments and is aimed in particular at young and innovative firms.[177] On this basis, international models for legal framework conditions for measures to strengthen equity capital are analysed against the background of European framework conditions and tested for feasibility in Austria.

Strengthen the venture capital initiative to stimulate early stage investment, taking into account developments to date

The implementation of a venture capital initiative was formulated in the government programme for 2008-2013.[178] Implementation is primarily within the remit of the Austria Wirtschaftsservice (aws). The Austria Wirtschaftsservice (aws) equity initiatives expand the available financial instruments, mobilise private venture capital, and improve the overall medium and long-term financing structure of SMEs. These include the "*Venture Capital Initiative*", which is funded by the National Foundation for Research, Technology and Development,[179] and through which the Austria Wirtschaftsservice (aws) currently participates in ten funds, of which three (as of December 2018) are in the investment phase: 1) Speedinvest II EuVECA GmbH & Co KG, a fund based in Vienna and Silicon Valley, which invests in early stage firms in the field of information technologies (Internet, e-commerce, mobile applications, financial technology); 2) APEX Ventures EuVECA GmbH & Co KG, which invests in technology-based enterprises in all industries; and 3) SHS IV Medtech Investments GmbH & Co. KG ("SHS IV"), which invests in high-growth enterprises in the fields of medical engineering, diagnostics, applied technologies and industrial biotechnology in German-speaking countries. The Speedinvest I fund, founded in 2011, is considered a role model. It is very successful and the public sector holds a 28 percent stake as the lead investor; in addition, private investors and employees also participate in this fund. This fund had some very successful "*exits*" (i.e. profitable sales of investments in investment management firms) and was therefore able to mobilise several times more private venture capital in its second run.

The aws equity capital initiatives also include the Austria Wirtschaftsservice (aws) "*Business Angel Fund*", a co-investment programme that doubles direct investments by business angels and has been in existence in Austria since 2013 as part of the "European Angels Fund" initiative of the European Investment Fund (EIF). Austria was one of the first countries to enter into such cooperation with the EIF. Another programme of the equity initiative is the Austria Wirtschaftsservice (aws) "*Start-up Fund*", a venture capital fund that invests in Austrian firms in their establishment and growth phases.[180] Although the "*SME Fund*" of the Austria Wirtschaftsservice (aws) explicitly excludes investments in start-ups, it finances growth projects (e.g. for the development of new products or processes, sales development and market development, etc.), follow-up financing and co-investments with domestic and foreign partners. As part of the "*Cleantech Initiative*", the Austria Wirtschaftsservice (aws) is involved in a Swiss investment firm which in turn invests in cleantech firms

177 See https://www.bmdw.gv.at/EUundInternationaleMarktstrategien/Wirtschaftsrecht/Seiten/Alternativfinanzierungsgesetz-.aspx

178 See BKA (2017, 42).

179 The National Foundation for Research, Technology and Development serves the following objectives: (i) the sustainable funding of research projects; (ii) the orientation towards long-term objectives in research and technology policy; and (iii) excellent international positioning of Austrian research and technology development. It serves as a financing tool without creating new administrative and processing structures. The Foundation's funds are not distributed directly to applicants for funding, but to funding institutions supported by the federal government, which then pass on the funds to individual applicants for funding within the framework of their funding guidelines.

180 With a fund volume of €68.5 million and an investment volume of €100,000 to €3 million, the Start-up Fund of the Austria Wirtschaftsservice (aws) is the most important fund in terms of volume. It was described in the Austrian Research and Technology Report 2016 and should not be confused with the Austria Wirtschaftsservice (aws) SME Fund, which explicitly excludes investments in start-ups.

in Austria (in the fields of renewable energies, energy efficiency, energy storage, etc.) with the aim of promoting the growth and expansion of such enterprises. In addition, start-ups have been brokered to interested investors since 1997 via the "*i2 Business Angels*" program.

Optimisation and completion of existing support measures for technology-based and innovative new enterprise creations, especially measures for the founding phase (see PreSeed, Seed Financing, Business Angels, Technology Marketing, etc.)

The programmes of the Austria Wirtschaftsservice (aws) mentioned in the previous section are also relevant in this area; in addition, the "*aws JumpStart*" programme promotes incubators and accelerators as well as start-ups under their supervision. The Austrian Research Promotion Agency (FFG) also provides support for the establishment of innovative enterprises through the "*Spin-off Fellowship*" programme, which aims to stimulate higher education institutions and research institutes to increase the number of spin-offs. The aim is to exploit intellectual property by setting up a firm at a very early stage. The "aws First" funding programme also applies at a very early stage. The aim of "aws First" is to promote entrepreneurial spirit in Austria and to support young people in the development and implementation of innovative ideas.[181]

Further measures concern the empirical recording of start-ups. In the context of a workshop, the definition of innovative, technology-oriented and research-intensive start-ups was defined in 2014 and then implemented with the amendment of the Business Demography Statistics Ordinance of 2015. Thereafter, in 2018, the "*Austrian Startup Monitor*" was published, which summarises the empirical facts.[182] The "*Phoenix*" start-up prize honours the best start-ups, spin-offs and prototypes in five categories. Special attention is also paid to women in start-ups and as founders.

In 2018, JumpStart also sponsored an incubator led by a female team called "Female Founders". This incubator focuses specifically at female founders and aims to incorporate women more firmly in the founding scene. In fact, the proportion of women among the founders is very low, and empirical evidence shows that a higher proportion of women in management reduces a firm's chances of being risk-financed.[183]

All in all, Austria paints a picture in which a lively start-up scene, supported by a variety of initiatives, is confronted with a financing gap. This means that due to a lack of capital an unknown number of potentially profitable projects will not be realised. The "*Business Angel Fund*" and the "*Start-up Fund*" of the Austria Wirtschaftsservice (aws) are two examples of how a mix of public and private funds fills this gap, at least in part, through a government initiative. The Austria Wirtschaftsservice (aws) Business Angel Fund has contributed to the professionalisation of the Austrian business angel scene by targeting business angels with experience and expertise in the relevant investment area. Private funds are doubled by the government, which in practice means that the government relies on private judgement for its own investments. The Austria Wirtschaftsservice (aws) Start-up Fund, on the other hand, is an example of a professionally managed venture capital fund that is predominantly financed by government funds, but is operated according to the common, market-oriented principles of comparable private funds.[184] And with success: The Austria Wirtschaftsservice (aws) Start-

181 In 2018, twelve teams with a total of 42 participants aged 18 to 26 were supported in the Austria Wirtschaftsservice (aws) First programme. Of these teams, three have already created a firm with their project idea.

182 See Leitner et al. (2018).

183 See Sardadvar (2018).

184 The Austria Wirtschaftsservice (aws) Start-up Fund is endowed with €65 million in federal funds and €3.5 million in private funds (Erste Bank). The Austria Wirtschaftsservice (aws) Start-up Fund usually invests together with other (private) investors in start-ups.

up Fund has a high level of mobilisation of private venture capital at the firm level, so that €1 million from the aws Start-up Fund can mobilise around €4.4 million in private funds.

In summary, the supply of venture capital available in Austria is not yet sufficient to meet the corresponding demand. However, in contrast to the *Innovation Leader* states, Austria did not show a downward trend in the volume of venture capital invested in domestic firms during the 2007-2017 observation period. However, Austria is still lagging behind in this area. As experience in states that are leaders in venture finance shows, targeted government investment usually stands at the beginning of a vibrant start-up environment. The public funds (the Start-up Fund and the Business Angel Fund of the Austria Wirtschaftsservice (aws)) and the support of private (national and international) funds in the context of the aws venture capital initiative at least make it possible to mobilise the risk capital market, whereby in future it will be necessary to build up or exploit even more potential here.

3.4.6 Improvement of competitive framework conditions

It is generally accepted that competition has a positive effect on innovation.[185] As studies show, competition policy has a particular impact on the commercialisation of innovations and their diffusion. Competition policy also has the function to correct and balance out unequal weights in relation to other instruments of RTI policy. This applies in particular to the intellectual property system, which provides incentives for innovation via temporary monopolies and thus a reduction in competition. However, the topic of standards and standardization processes must also be mentioned here. In principle, this also stimulates innovation, but can also be used indirectly to create cartels and thus block market access (and innovation). Finally, direct impacts on innovation are to be expected, since successful competition policy aims not only to ensure reasonable prices but also to improve the quality of goods and thus to promote innovation. That is why a functioning competition policy with correspondingly powerful institutions that ensure competition is also necessary.[186]

Under the objective "*Improvement of the competitive environment*"[187], the RTI strategy subsequently includes four measures[188] relating to competition policy:

- The measure "*Reduction of administrative barriers in the areas of business start-ups and service regulation*" focuses above all on competition-increasing changes in the framework conditions, in particular with regard to facilitated opportunities to set up new businesses.
- The other three measures deal with institutional aspects, specifically with the organisation and design of the Federal Competition Authority *("Reform of the Federal Competition Authority (tasks, powers, resources)"*, *"Carrying out sector-specific analyses (e.g. fuel market, food)"* and *"Review of competition policy regulations with regard to obstacles to innovation"*).

Reduction of administrative barriers in the areas of enterprise creation and service regulation

In line with the objectives of the RTI strategy, a variety of measures should be taken to make it considerably easier to set up a business and to reduce the financial burdens involved. Central elements here are

185 See Shapiro (2002).

186 Nevertheless, it should be noted that major innovation-relevant agendas of competition policy are anchored at the EU level or at the EU Commission. According to Article 102 TFEU, the EU Commission can regulate the behaviour of firms that abuse their market power or can intervene directly in the case of market-distorting structures and concentrations that arise, for example, from certain mergers and have an EU-wide dimension (Regulation EC 139/2004). Overall, there is a wider division of labour in this area between the European Commission and national competition authorities within the framework of the European Competition Network (ECN).

187 See Federal Chancellery (BKA) et al. (2011, 31).

188 See Federal Chancellery (BKA) et al. (2011, 31).

the requirements of the enterprise-creation process itself and the question of the requirements for business registration.

Business Services Portal (USP)

In 2017 and 2018, the implementation of several easements for founders in the sense of reducing bureaucracy already took place. It has already been possible for sole proprietors to set up a business via the Business Services Portal (USP) since 31 July 2017; since 1 January 2018 this possibility has also existed for one-person GmbHs. From business registration to tax office registration to social security registration, the entire enterprise-creation process can be carried out electronically. For private limited companies (Ltds) with a single managing director (who is also shareholder), there are also plans for allowing the declaration of the establishment of the firm and the application for entry in the commercial register to be submitted via the USP.[189] The majority of all new businesses founded in Austria as one-person enterprises should benefit from this. Team foundations (that are particularly high-growth enterprises and new ventures that are much more attractive to investors) are currently excluded from this. Using the USP portal for creating one-person limited liability companies is currently only possible, however, if these can manage with the minimum statutes. For new innovative enterprises, even one-person enterprises, however, there are too many needs for adjustments to the minimum statutes in order to benefit from them. Furthermore, adjustments to an originally used minimum statute, e.g. due to *Intellectual Property Rights (IPR)* or the admission of further shareholders, result in the founder having to go through the entire original process again.

Changes to legal frameworks

The trade regulations have also been revised in several respects in recent years. Not least on the basis of the corresponding Council of Ministers presentation of July 2016 concerning the "*Modernisation of trade regulations and simplifications in industrial plant law*" and as a result of the parliamentary resolution to amend trade regulations on 5 July 2017, there have been numerous changes in this regard[190], which were aimed at relieving the burden on firms. These include, among other things, the exemption of the trade procedure from federal fees and administrative levies, in particular for trade registrations and all currently fee-based and chargeable procedures in professional law and the establishment of the principle of "consulting instead of penalties" in the law on industrial facilities.

The introduction of trading licences on 1 May 2018 was central to the modernisation of the trade regulations. In addition to the trade licence (right to carry on a trade), a personal trade licence (right to practise a trade) was thus created.[191] The trade licence covers all trades including ancillary rights. The first trade licence must always be registered (regardless of whether it is regulated or a free trade). If a trade licence already exists, further regulated trades must be registered as before, additional free trades only have to be reported. The extension of ancillary rights has also meant that under certain conditions no separate registration or display is necessary.

A currently unsolved problem is the unclear data basis for estimating the duration of such procedures. In the meantime, a process monitoring system has been created to distinguish between urban and rural areas.

Under certain conditions, founders can claim tax exemptions on the basis of the New Enterprise Promotion Act (NeuFöG[192]), i.e. essentially the elimina-

189 See https://www.usp.gv.at/Portal.Node/usp/public/content/gruendung/egruendung/269403.html
190 See https://www.help.gv.at/Portal.Node/hlpd/public/content/171/Seite.1710834.html
191 See Gewerbeordnung 1994 – GewO 1994 Section 38.
192 See federal law which promotes the creation of new enterprises and their development into SMEs (New Enterprise Promotion Act – NeuFöG).

tion of stamp duties and federal administrative levies, the real estate transfer tax for the contribution of real estate on the basis of articles of association, court fees for entries in the commercial register, etc. In addition, the minimum corporate tax rate for newly established limited liability companies (GmbHs) is reduced in the first ten years.

One of the prerequisites for the registration of a limited liability firm in the commercial register is the conclusion of written articles of association[193], which require the form of a notarial deed. In the enterprise-creation process, the time and financial expenditure for the legally prescribed involvement of notaries is often regarded as disproportionately high. In order to reduce the time required and the financial costs, experts are calling for the requirements of the mandatory notarial deed and notarial certification to be removed from firm law or at least severely restricted.[194] At least the type of settlement will be supplemented or extended with the Electronic Notarial Form Foundation Act[195], effective from 1 January 2019 so that electronic means of communication can replace personal appointments.

Competition Law and the Federal Competition Authority

A key objective of the RTI strategy was the reform of the Federal Competition Authority (BWB). This measure was implemented with the reform of the competition law of 1 March 2013. The Federal Competition Authority (BWB) – which was only launched in 2002 as part of a comprehensive institutional reform – was subsequently granted further powers of investigation, which must also be set in relation to changes in substantive law (keyword: collective market dominance or provisions for *private enforcement*). Nevertheless, changes in the organisational structure were also considered. Since August 2017, there have been two departments – a legal department and a litigation department – which is a response to a long-standing demand for the creation of modern organisational structures and departments.[196]

Since the Federal Competition Authority (BWB) was founded (as of the end of 2017), more than 140 house searches have been carried out, more than 4,600 national mergers have been examined, 536 cartel cases have been handled and €196 million in fines have been imposed.[197] These revenues must be compared with accumulated costs of €33 million. The Federal Competition Authority (BWB) has grown from 17 to 40 employees (as of the end of 2017).

The measure on sector-specific analyses postulated in the RTI strategy has also been implemented (and will be implemented on an ongoing basis as required). Here the Competition Act provides for the possibility of a general investigation of an economic sub-sector by the Federal Competition Authority (BWB) if the circumstances suggest that competition in the economic sector concerned is restricted or distorted. To date, seven such analyses have been carried out.[198]

With regard to the measure mentioned in the RTI strategy concerning the review of competition policy rules with regard to obstacles to innovation, it should first be noted that such a review is carried out on an ongoing basis within the framework of evaluation and impact assessment procedures, also with a view to achieving the aforementioned general objective of obtaining high(er)-quality goods (which often requires innovation activities beforehand). Further im-

193 See the Law of 6 March 1906 regarding limited liability companies (GmbH-Gesetz – GmbHG) Section 4 para. 3.
194 See Ruhland et al. (2017).
195 Federal law amending the GmbH Act and the Notarial Regulations (Electronic Notarial Form Foundation Act - ENG).
196 See Federal Competition Authority (2018).
197 ibid.
198 Cash machine fees, electricity and gas, fuel, food, cement and concrete, mobile communications, pharmacy market (source: https://www.bwb.gv.at/branchenuntersuchungen/).

provements in substantive law, e.g. with regard to collective market dominance, meaning a situation in which several firms dominante the market collectively, even if each firm does not meet the definition of dominance individually, are also relevant for start-ups and "newcomers" as these improvements facilitate market entry.

Thus, those points that deal with the Federal Competition Authority (BWB) as part of the RTI strategy can be regarded as completed or implemented on an ongoing basis. Nevertheless, there is a need for improvement with regard to the question of further reforms, e.g. with regard to merging the competences of the Federal Competition Authority and the cartel attorneys[199], which is also addressed in the current government programme.

3.5 Improvements in governance and strategic measures

The vision of the RTI strategy 2020:
"Give direction, define a framework – efficiently organise political governance"

A system's effectiveness and intelligence are closely linked to its governance. The topics of education, science, technology and innovation have become increasingly broad and complex in recent years. More and more responsible bodies have been set up for the purpose of coordination and more and more stakeholders and actors have been involved in this issue. Good coordination and avoiding unnecessary duplication while setting clear targets and maintaining independence are thus the major strategic objectives.

3.5.1 Improving governance structures

In the area of governance structures, the 2020 RTI strategy set itself four central goals, namely a clearer definition of competencies for the responsible ministries through efficient coordination mechanisms, optimisation of the *"distribution of tasks between ministerial departments and funding agencies [...] through higher operational independence of the agencies with, at the same time, increased strategic control"*, elimination of duplications at the level of the federal funding agencies and increase of "*system effectiveness and system intelligence [...] through enhanced target and output control"* [200].

Due to its historical development, the Austrian RTI system has a considerable number of stakeholders who interact with each other in a variety of ways. At the same time, current economic and societal developments increasingly call for coordinated concepts that transcend fields of action in order to achieve the objectives defined in the RTI strategy. The underlying analyses[201] of the RTI strategy have identified some weaknesses in the governance system, the causes of which are seen in too many "pillars" and "fragmented structures".

Various federal ministries are currently responsible for the areas of RTI policy. These include the Federal Ministry of Education, Science and Research (BMBWF), the Federal Ministry of Transport, Innovation and Technology (BMVIT), the Federal Ministry for Digital and Economic Affairs (BMDW) [202] and the Federal Ministry of Finance (BMF). The Federal Chancellery (BKA) has a coordinating function in this area.

The Austrian Council for Research and Technology Development (RFTE) is the main strategic consultancy body for the federal government as regards questions related to RTI policy. The Council for Research and Technology Development (RFTE) makes proposals for the medium to long-term strategic orientation

199 See Böheim (2008).
200 See Federal Chancellery (BKA) et al. (2011, 34).
201 See Federal Chancellery (BKA) et al. (2011, 32).
202 In the past legislative period, the Federal Ministry of Science, Research and Economy (BMWFW) united the competences for science and applied economic research in one institution. However, the two policy areas were located in separate administrative units within the ministerial departments.

of RTI policy and gives individual recommendations and opinions on (ongoing) initiatives and measures. The Austrian Science Board advises the Federal Minister of Education, Science and Research, the Parliament and universities on issues of science policy and the arts. The ERA Council Forum advises the responsible Federal Minister on issues relating to the European Research Area and Horizon 2020. According to the government programme for 2017-2022, the aim is to bring these three councils together.[203]

The various RTI policies are implemented on behalf of ministerial departments through a number of agencies (e.g. the Austria Wirtschaftsservice – aws, Austrian Research Promotion Agency – FFG, Austrian Exchange Service – OeAD), associations (e.g. Christian Doppler Gesellschaft – CDG) and promotion funds (the Austrian Science Fund – FWF, Climate and Energy Fund – KLIEN, etc.) as well as financing tools such as the National Foundation and the Austria Fund. The organisations created over time have undoubtedly increased the effectiveness of RTI policy, but at the same time they also place increased demands on the strategic and operational controllability of the system. In this context, the federal ministries play the role of the owner or the supervisory authority of these institutions on the one hand, but on the other hand the ministries also play the role of the clients of the respective research and technology programmes; at the National Foundation, the federal ministries are represented on the Foundation Council.

Against this background, the RTI strategy therefore explicitly refers to the objective of a better division of labour between ministerial departments and agencies. The extent to which the agencies carry out the tasks of strategy development and the *Agenda Settings* is too large. This is perceived as problematic, as the responsible ministerial departments are not present enough in this area; in contrast, the ministerial departments' involvement in the detailed control of the implementation of measures is too great. The latter has a particularly negative impact on the administrative workload; all in all, such governance diminishes the efficiency of the system.

In view of this, the following measures[204] were set out in the RTI strategy:

- A high-level Task Force was established for Research, Technology and Innovation, with the following responsibilities: Supervising, defining and coordinating the implementation of the RTI strategy; strategic and system-oriented reconciliation and coordination of individual ministerial departments' activities; dealing with the recommendations of the Council for Research and Technology Development.
- The Council for Research and Technology Development is the federal government's strategic consultancy body for questions related to RTI policy. The council works closely together with the ministerial departments on recommendations for the medium- to long-term orientation of this policy field. To this end, the Council for Research and Technology Development provides an annual work programme.
- Strategic management of funding agencies via performance agreements based on output and impact objectives
- Increasing system efficiency for the Climate and Energy Fund (KLIEN) by enhanced exploitation of synergies, as well as further development and coordination of the existing instrument portfolio

Establishing a Task Force for Research, Technology and Innovation (RTI Task Force)

This measure has already been successfully implemented. The Task Force meets several times a year – for the most part at the department management level – ensuring a transparent and smooth exchange of information on the activities of the respective ministerial departments. The Task Force has also proved

203 See Federal Chancellery (BKA) (2017).
204 See Federal Chancellery (BKA) et al. (2011, 34).

to be a suitable instrument for strategic management. This committee is currently carrying out the conceptual work for the preparation and implementation of the RTI strategy 2030. The RTI Task Force thus fulfils it s duty of coordinating RTI policy at the federal government level very well.

Annual work programme of the Austrian Council for Research and Technology Development (RFTE) as the federal government's strategic consultancy body for questions related to RTI policy

Also this measure has been successfully implemented as part of the RTI strategy. Ongoing discussions and exchanges take place both in council sessions and on an ad-hoc basis in Task Force's joint meetings with members of the Council for Research and Technology Development (RFTE) . These activities are a response to the high coordination demands and the need for consistent strategic planning in this policy area. A central element in this connection is the *Report on Austria's Scientific and Technological Performance Capability*. This describes Austria's progress annually in relation to the federal government's RTI strategy on the basis of indicators and thus forms an essential basis for the ongoing assessment of measures taken and, if necessary, for adaptations.

The acceleration of technological change in the recent past has particularly affected the areas of digitalisation, artificial intelligence and robotics. As a reaction to this rapid development, the Federal Ministry for Transport, Innovation and Technology (BMVIT) established the *Austrian Council on Robotics and Artificial Intelligence (AI)* in 2017. The council prepares frequent statements on questions of robotics and artificial intelligence through an interdisciplinary committee of experts who can take a technological, economic, societal and legal standpoint. This is accompanied on an ongoing basis by recommendations and proposals for suitable implementation measures relating to the topic.

The establishment of the Council on Robotics and Artificial Intelligence can also be seen as an example of the successful timely adaptation of the Austrian RTI strategy to current technological and societal trends.

Strategic management of funding agencies via performance agreements based on output and impact objectives

Despite substantial progress which has been achieved in the governance of funding agencies, further improvements are still needed. With the Austrian Research Promotion Agency (FFG) and the Austria Wirtschaftsservice (aws), the federal government has two agencies at its disposal for the implementation and ongoing management of research and business development programmes for public-sector clients. The Austrian Research Promotion Agency (FFG) and the Austria Wirtschaftsservice (aws) were created by merging four (the former) and three (the latter) organisational units in research and business development in 2002. With the consolidation of institutional structures in this area, RTI policy has become much more effective. But as a result of this organisational structure specific demands have also arisen regarding distributing and resuming political leadership, and the division of labour between federal ministries and agencies.[205]

In the course of implementing the FTI strategy, the responsible departments of the Austria Wirtschaftsservice (aws) and the Austrian Research Promotion Agency (FFG), the Federal Ministry for Transport, Innovation and Technology (BMVIT) and the Federal Ministry of Science, Research and Economy (BMWFW, now Federal Ministry for Digital and Economic Affairs – BMDW), standardised the control requirements for the Austrian Research Promotion Agency (FFG). This was achieved through topic management, which defines uniform instruments, proposals and procedures.

The strategic guidelines for the Austrian Research

205 See Fraunhofer and Austrian Institute for SME Research (2017).

Promotion Agency (FFG) and the Austria Wirtschaftsservice (aws) were derived from the RTI strategy and are formulated in concrete terms in the agencies' respective multi-annual programmes and work programmes. Both the Austrian Research Promotion Agency (FFG) and the Austria Wirtschaftsservice (aws) now have framework agreements which run for several years and help improve strategic management.

A further aspect of improved strategic management is its embedding in the *outcome-oriented impact assessment (WFA)* embedded in budgetary law. In the meantime, the indicators at the programme document level for the Austria Wirtschaftsservice (aws) and the Austrian Research Promotion Agency (FFG) from the owner and client departments have been agreed upon with the Federal Ministry of Finance (BMF).

The Austrian Exchange Service GmbH (OeAD) has also implemented a corresponding multi-year programme for an annual work programme that is coordinated with the outcome-oriented impact assessment (WFA) of the consequences by the responsible Federal Ministry of Education, Science and Research (BMBWF). The Austrian Science Fund (FWF) is also managed by the Federal Ministry of Education, Science and Research (BMBWF) via a multi-year programme and the approval of the annual work programmes.

In order to identify potentials for further improvement in the management of the agencies Austria Wirtschaftsservice (aws) and Austrian Research Promotion Agency (FFG), the owner departments have recently commissioned an evaluation from Fraunhofer and the Austrian Institute of SME Research. The findings of the 2017 study confirm that the Austria Wirtschaftsservice (aws) and the Austrian Research Promotion Agency (FFG) are highly professional and effective. Accordingly, in the already relatively large organisational units *"numerous processes and structures have been developed and implemented in order to ensure a high level of professionalism, service orientation, effectiveness and efficiency, which have generally proved their worth."*[206] However, structural deficits in the area of agency management were also identified. For example, the authors of the study note that the agencies' governance system is characterised by a persistently high degree of complexity. The high number of performance agreements and the lack of a uniform and coordinated management line on the part of the owners are regarded as critical. Accordingly, the agencies reacted to the changed circumstances and gained strategic intelligence, influence and autonomy. However, the development of a suitable management understanding at the departmental level has not happened. According to the study, three reform options are presented, whereby in the ambitious variant the transition to results-oriented management by means of global budgets is recommended. This is intended to transfer more decision-making authority and responsibility to the agencies, while the ministerial departments focus more on politically strategic aspects, the minimisation of information asymmetries and the controlling function.

The results of the evaluation form the basis for a reform process of the strategic management of the agencies by the ministerial departments. This reform process has been coordinated with the preparation of the Research Funding Act.

Increasing system efficiency for the Austrian Climate and Energy Fund (KLIEN) by enhanced exploitation of synergies, as well as further development and coordination of existing instrument portfolio

The RTI grants of the Climate and Energy Fund (KLIEN) were integrated into the theme management of the Federal Ministry for Transport, Innovation and Technology (BMVIT) and are implemented accordingly by the Austrian Research Promotion Agency (FFG). At instrument level, standardised funding instru-

206 See Fraunhofer and Austrian Institute for SME Research (2017, 2).

ments and processes are now applied, so that the Climate and Energy Fund (KLIEN) is integrated in coordination talks with the specialist departments of the Federal Ministry for Transport, Innovation and Technology (BMVIT) and within the framework of the work programme of the Austrian Research Promotion Agency (FFG).

Overall, in the area of governance, the objectives of the RTI strategy have been largely met. The task of improving coordination of the complex structures of the RTI landscape in Austria was fulfilled by means of the measures taken. The current evaluation of the Austria Wirtschaftsservice (aws) and the Austrian Research Promotion Agency (FFG) shows, however, that there is still a need for further improvement in order to increase the effectiveness and efficiency of the processes. On the basis of the available findings, the current measures of the ministerial departments aim to close this gap.

3.5.2 Strategic objectives and thematic priorities

Innovation systems differ, among other things, in the extent to which the government with its instruments influences innovation activities in terms of their orientation. The two ideal types are on the one hand a liberal, *bottom-up* approach, which rejects specifications of a content-related nature and only accepts market signals as well as scientific curiosity as a controlling authority. On the other hand an interventionist *top-down* approach is conceivable, which not only suggests topics, but also names concrete technologies as worthy of promotion. Thematic funding programmes with tightly defined content place high demands on the knowledge of decision-makers; this knowledge can primarily be acquired through a broad dialogue with society, industry and science.

The reality of innovation policy contains numerous hybrid forms of these two positions, which can also vary between fields of technology and various stages of technological development. Recently the thematic orientation of the innovation policy has become increasingly important and is discussed under the keywords "*Grand Challenges*" and "*Social Challenges*". A policy that explicitly takes up the thematic challenges addressed and deals with them using appropriate instruments is called *mission-oriented innovation policy*.[207] Ultimately this should contribute to innovation-driven economies not only expanding quantitatively, but also developing qualitatively in line with societal objectives (as expressed for instance in the *Sustainable Development Goals* and the *Europe 2020 strategy*).

The thematic orientation of RTI policy in Austria has for some years also been co-determined by the *Smart Specialisation Strategy* as part of the EU 2020 Strategy. The goal is essentially to find focussed themes and develop innovation in the regions based on the potentials of the area. To this end, the regional governments have defined regional thematic priority fields in accordance with the RTI strategy and agreed on them with the federal government.[208]

Against this background, the federal government's 2011 RTI strategy also defined five strategic objectives with regard to thematic priorities. A distinction is made between "*generic cross-cutting fields*" and "*Grand Challenges*"; the RTI strategy also mentions four cross-sectoral fields as examples, namely information and communication technologies (ICT), material sciences, *life sciences* and humanities, social sciences and cultural sciences (GSK). In the course of the work on the concept of *Smart Specialisation* the topic of bioeconomy and sustainability was defined as a further thematic priority.[209] Under "*Global Challenges*" the RTI strategy summarises the three chal-

207 See European Commission (2017).

208 See Schuch and Testa (2018)

209 See Federal Ministry of Science, Research and Economy (BMWFW) and Federal Ministry for Transport, Innovation and Technology (BMVIT) (2016).

lenges: climate change, dealing with scarce resources and securing quality of life in view of demographic change. While objectives (2), (3) and (5) concern the process of defining thematic priorities, objectives (1) and (2) are dedicated to a stronger thematic focus, taking into account economic patterns of specialisation. So the five objectives are:

1. "...*Strengthen Austria's competitiveness in a wide range of cross-cutting fields in science and technology by focussing activities on units of internationally competitive size. To do this, fields in which domestic science and business are strong should be taken into account. Special attention must be paid to the skills and potentials of Austrian firms that can help implement research results for overcoming the Grand Challenges.*
2. *Strategic objectives in research and technology development should be set on the basis of systematic selection and decision-making processes. While doing so we must make sure that governmental strategic objectives are well-justified and will prevent market or system failure.*
3. *The definition of new priorities for specific challenges should lead to a concerted coordination of activities in a comprehensive system approach by all ministerial departments in the context of the Research, Technology and Innovation Task Force.*
4. *Comprehensive system priorities must be established to address the great societal challenges (Grand Challenges) of the future.*
5. *Priorities should be defined on the basis of a preliminary analysis, their impacts should be limited in time, and they should be monitored."*[210]

The measures assigned to the objectives relate more directly to those objectives which deal with the process of developing priorities (concerns objectives (2), (3) and (5)). The overview presented in Table 3-7 assigns to the general measures listed in the strategy a selection of concrete measures taken by the relevant ministries since the strategy was established in 2011.[211]

In addition, it should be noted that the federal government's innovation policy operates a number of thematic funding programmes which address in par-

Table 3-7: RTI strategy measures for setting strategic and thematic priorities

General measures in accordance with the RTI strategy	Specific measures (selection)
(1) Development of national strategies for generic science and technology fields	• Realignment of the ICT-R&D portfolio along the lines of "ICT of the future": definition of four ICT topical areas that can offer solutions to societal challenges • ICT priorities: Efit21, Umbrella brand for a range of ICT initiatives and projects in the field of education • Creation of a strategy of the future for the life sciences and for Austria as a centre for medical technologies • Creation of a strategy for artificial intelligence
(2) Establishment of categories for "Cross-departmental ministerial research, technology and innovation priorities" and "Single-ministry priorities"; definition of mechanisms and structures for their implementation	• Single-ministry priority at the Federal Ministry for Digital and Economic Affairs (BMDW): Smart and digital services, biotechnology, Industry 4.0, digital economy / ICT, digitalisation • Single-ministry priority of the Federal Ministry for Transport, Innovation and Technology (BMVIT): Energy and environmental technology, aerospace technology, security technology, mobility, nanotechnologies
(3) Examination of the possibility to set "Cross-departmental ministerial research, technology and innovation priorities", in particular with regard to the Grand Challenges of "climate change", "resources" and "quality of life and demographic change"	• Creation of two inter-ministerial working groups for "Climate Change and Scarce Resources" and "Quality of Life and Demographic Change" • Joint programming – transnational research cooperation between EU Member States and the European Commission as a means of funding research that can help address major societal challenges (Grand Challenges).

210 See Federal Chancellery (BKA) et al. (2011, 37)
211 ibid.

ticular objectives (1) and (4). The thematic programmes of the Austrian Research Promotion Agency (FFG) are of particular importance here. These include five priorities (energy, urban and environmental; ICT; production, nano and quantum technologies; mobility; security) and a module on transnational initiatives and calls.[212] The Climate and Energy Fund (KLIEN), financed by the Federal Ministry of Sustainability and Tourism (BMNT) and the Federal Ministry of Transport, Innovation and Technology (BMVIT) plays a central role in the field of environment and sustainability.[213]

Achieving the objectives of increasing competitiveness in selected technology segments and establishing comprehensive system priorities

Objective (1) and objective (4) aim to increase competitiveness in selected technology segments and establish comprehensive system priorities. We will take a closer look at them here, with a focus on certain selected areas and quantitative indicators of relative specialisation. If the value of the indicator "*Revealed Technological Advantage" (RTA)*, calculated on the basis of patent data, is less than one, the country has no specialisation; if the value is greater than one, the country is considered to be specialised in the area concerned. Table 3-8 shows the RTA for four different technology fields (with the exception of the humanities, social sciences and cultural sciences, which are missing here), that roughly correspond to the "generic cross-cutting fields" of the RTI strategy.

According to the RTA, Austria's only specialisation is in environmental technologies. It can also be stated that an increase in specialisation could only be achieved in ICT by an increase in the RTA value from 0.47 (2002–2005) to 0.54 (2012–2015). Comparing Austria's figures for the years 2012–2015 with those of its peer countries, the picture is relatively clear: In total, Austria is much less specialised in the four technology fields mentioned in the RTI strategy. In environmental technologies, for example, only the Netherlands is behind Austria, while Austria is ranked last in nanotechnologies. Taken together, these data therefore do not provide strong evidence for a positive achievement of objective (1) and objective (5) and the measures taken to achieve them.

The finding of a relatively low degree of specialisation is also confirmed by Fig. 3-17. Accordingly, at 70%, Austria spends a relatively high proportion of government funds without direct socio-economic earmark-

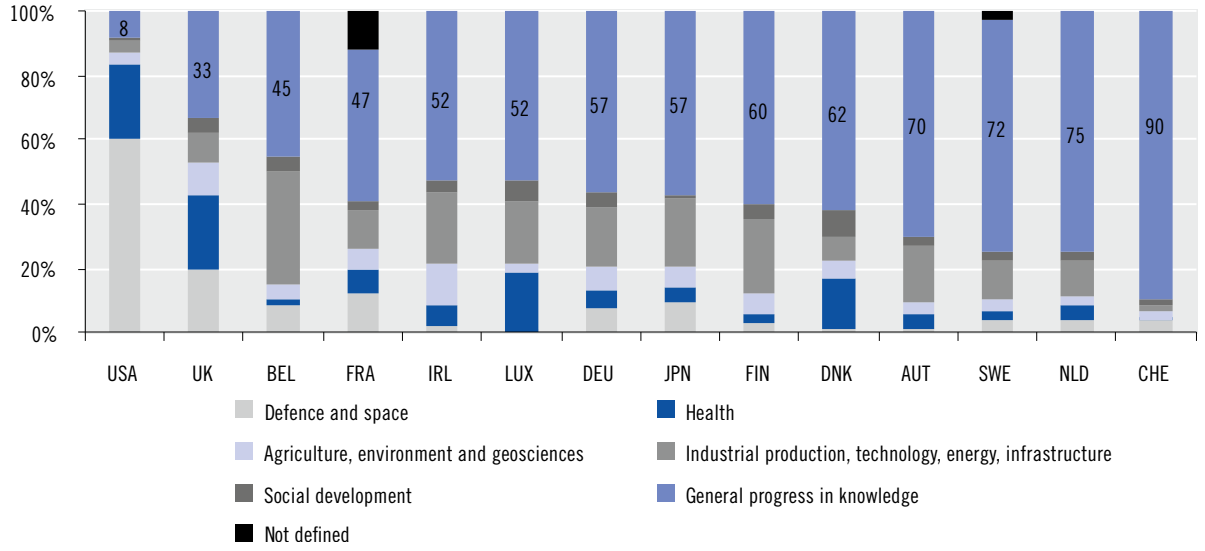
Table 3-8: Revealed technological advantage in selected technology fields, 2002–2005 and 2012–2015

	Biotechnology		ICT		Nanotechnology		Environmental technology	
	2002–05	2012–15	2002–05	2012–15	2000–03	2010–13	2002–05	2012–15
Denmark	3.53	3.04	0.45	0.52	0.64	0.27	1.45	2.24
Germany	0.72	0.74	0.49	0.42	0.56	0.39	1.27	1.23
EU-28	0.99	1.07	0.62	0.57	0.61	0.59	1.13	1.19
Finland	0.63	0.65	1.49	1.17	0.23	0.52	1.02	1.15
United Kingdom	1.54	1.58	0.82	0.86	0.79	0.85	0.97	1.15
Netherlands	1.12	1.67	1.23	0.65	0.78	1.11	0.70	0.83
Austria	0.82	0.67	0.47	0.54	0.44	0.25	1.21	1.04
Sweden	1.28	1.04	0.76	1.16	0.64	0.51	1.13	1.16

Source: OECD Science, Technology and Industry Scoreboard 2017; OECD Key Nanotech Indicators; OECD Key Biotech Indicators.

212 See https://www.ffg.at/thematische-programme
213 See https://www.klimafonds.gv.at/

Fig. 3-17: Government expenditure on R&D for specific socio-economic objectives, 2016



Source: OECD (2018b).

ing. This corresponds to the dominance of a funding system according to the *bottom-up* principle.[214]

There is no quantitative database for assessing the achievement of objectives (2) and (5), which are dedicated to the process of selecting strategic priorities. On the basis of qualitative evidence, however, the OECD points out that in Austria, in comparison to other countries (such as Germany or Great Britain), systematic processes for identifying focal points are still rarely used.[215] This indicates that objectives (2) and (5) have not yet been fully achieved.

The establishment of inter-ministerial working groups and the development of strategies are important for improving the coordination of cross-departmental activities to cope with the "Grand Challenges". Objective (3) on concerted coordination of the activities of the ministries can thus be regarded as fulfilled in any case in terms of the prerequisites.

Overall, the RTI strategy thus called (at least in part) for an increased focus on strategic topics and for the selection of thematic priorities to be made more professional. In addition to thematically oriented funding programmes, the associated measures also include the establishment of working groups to coordinate cross-departmental topics in the spirit of the "Grand Challenges". An evaluation of the achievement of the objectives shows, however, that the measures taken in this respect have not yet led to a higher degree of specialisation in the economy. This seems to be the consequence of a funding system that has so far been successful at favouring open-themed programmes over a *top-down* funding philosophy.

3.5.3 Optimisations of the funding system

Funding systems for innovation processes comprise a variety of programmes, instruments and stakeholders. In addition to direct and indirect monetary funding instruments, the regulatory conditions, such as product market regulations or patent law, are also important approaches to a comprehensively conceived innovation policy.

The organisation of the funding system is becoming more and more complex due to the fact that different stakeholders at different levels of the

214 See Ecker et al. (2018).
215 See OECD (2018b).

innovation system are involved in the planning, implementation and demand for funding. Funding systems have grown historically on the one hand and are constantly adapted to new conditions on the other. This means that national funding regimes have specific characteristics that distinguish them from other countries. At the same time, this is probably one of the reasons why no consensus has yet emerged on how an optimal funding system should be designed. Nevertheless, some *best practice* approaches have prevailed which should be taken into account in the design of instruments, programmes and their interaction within the *policy mix*.[216]

The Austrian funding system is highly differentiated so it can respond to the different needs of the funding recipients. Direct funding, which was initially more developed, was increasingly supplemented by tax-based, indirect R&D funding; in the meantime, both funding schemes are of almost similar importance in monetary terms. Open-themed programmes are contrasted with thematic programmes, with the former being predominant. Stand-alone projects as well as cooperative research projects are funded, whereby both short-term cooperation projects and structure-building institutions in the institutes' sub-sector ("Kooperativer Bereich") are funded.

In addition to a high programme density and instrument diversity, the Austrian funding system is also characterised by relatively high funding intensities. When relating the direct and indirect R&D funding for the business enterprise sector to GDP, Austria was ahead of all the *Innovation Leaders* at 0.27% in 2015; France and Belgium showed even higher values at 0.39%.

Table 3-9: RTI strategy measures for optimising the funding system

General measures in accordance with the RTI strategy	Specific measures (selection)
(1) Elimination of the Research Allowance as defined in Section 4 Subsection 4 of the Austrian Income Tax Act; increase of the research tax premium as defined in Section 108c of the Austrian Income Tax Act from 8% to 10%	• Implemented
(2) Optimisation of direct research funding	• Reduction of the variety of thematic programmes • Various deadlines for the calls for R&D programmes have been / are being merged. • Direct funding instruments have been standardised.
(3) Establishment of a modern homogeneous research funding law as the basis for all funding activities conducted by the federal government	• New guidelines of the Austrian Research Promotion Agency (FFG) and RTI guidelines came into force on 1 January 2015; all programme documents were amended in line with the new regulations. • Research Funding Act as a component of the 2017–2022 government programme (see Chapter 1).
(4) Increase in the share of basic research subject to competitive funding	• The Austrian Science Fund (FWF) budget will increase by a total of €110 million in the period 2018-2021.
(5) Greater focus on actual performance in the funding of institutes (through performance and target agreements for basic funding)	• Performance agreements of the Federal Ministry of Education, Science and Research (BMBWF) with the Austrian Academy of Sciences (ÖAW) and IST Austria • Framework/ funding agreements between the Federal Ministry for Transport, Innovation and Technology (BMVIT) and Austrian Institute of Technology (AIT), Joanneum Research (JR) and Salzburg Research (SRFG) have been concluded • Austrian Cooperative Research (ACR) Strategy+ • Research Funding Act as a component of the 2017–2022 government programme (see Chapter 1).

216 See OECD (2010).

Against the background of national and international developments, the RTI strategy defined four objectives for improving the national funding system[217]:

1. "*Establish an overall policy approach in the funding system that applies the most efficient bundle of measures in a coordinated way in each context.*
2. *Direct research funding should be further developed as regards the use of an adequate mix of instruments.*
3. *The regulatory basis for funding research should be streamlined.*
4. *The principle of competition-based allocation should be strengthened.*"

Objectives (1) and (2) refer to the interaction of the instruments and the resulting need to coordinate them. Objective (3) is devoted to the legal basis for funding and objective (4) relates primarily to the mode of awarding funding to institutions in general and universities in particular (see also measures (4) and (5) in Table 3-9).

The five general measures to optimise the funding system according to the RTI strategy are shown in the left-hand column of Table 3-9; the right-hand column shows a selection of concrete measures taken by the relevant ministries. Measures (1) and (2) refer essentially to objectives (1) and (2); measure (3) is for objective (3) and measures (4) and (5) address objective (4)[218].

To what extent were the objectives achieved and the measures to optimise the funding system implemented?

Objectives (1) and (2) via the optimisation of the instrument or programme mix can only be evaluated in terms of quality. The bundling of tax concessions for research within the framework of the research tax premium[219] was an important measure to simplify the funding system. Despite the measures taken to optimise direct research funding, some institutions still consider the current system to be in need of improvement. For example, the Council for Research and Technology Development (RFTE) points out that overlapping multiple structures, over-regulation, fragmentation and unclear responsibilities still exist.[220] On the basis of an audit of selected federal government research programmes in the years 2012–2016, the Court of Auditors concludes that the number of research programmes in the years 2012 to 2016 will be reduced by around 8% from 52 to 56, and that the fragmentation of the R&D-related agendas at the level of the federal government leads to thematic overlaps in the research programmes.[221] The OECD also sees in its country report on the Austrian innovation system further demand for coordinating the individual programmes.[222] In summary, there is no clear picture as regards the achievement of objectives (1) and (2). While indirect funding has been simplified, direct funding still seems to require coordination and consolidation.

The objective (3) of establishing a uniform research funding law was achieved to some extent by means of new guidelines (Austrian Research Promotion Agency (FFG) and RTI guidelines), which came into force in 2015. Further significant improvements in the legal basis can be expected from the planned Research Funding Act. In this sense, we can say that objective (3) will be largely achieved in the near future.

The increased allocation of funds by means of competition mechanisms is the subject of objective (4). Assessing the achievement of this objective is

217 See Federal Chancellery (BKA) et al. (2011, 39).
218 ibid.
219 Increase in the research tax premium for R&D expenditure from 10% to 12% from 1 January 2016 and from 12% to 14% from 1 January 2018.
220 See Council for Research and Technology Development (RFTE) (2018a).
221 See Court of Auditors (2018).
222 See OECD (2018a).

difficult because there is no standardised metric for recording the competitively allocated share of public R&D funds.[223] Plausible approximate values must therefore be used. Competitive funding to universities can be evaluated by looking at the development of the global budget of funds from the Austrian Science Fund (FWF), the Austrian Research Promotion Agency (FFG) and the EU over time. The Austrian Science Fund (FWF), the Austrian Research Promotion Agency (FFG) and EU funds are considered to be competitively allocated funds. An increase in the global budget of the universities from the 2010–2012 to the 2016–2018 performance agreement period by approximately 17.3% can be observed.[224] Between 2010 and 2017 there was a 29% increase in the competitive funds acquired from the Austrian Science Fund (FWF), the Austrian Research Promotion Agency (FFG) and the EU.[225] This means we can conclude that the competitive allocation of funding in the university sector became more important during the period under consideration. This would mean that objective (4) has been achieved.

In an international comparison, the entire Austrian research funding system is still relatively unaffected by the competition mechanism. A pilot study carried out by the EU Commission resulted in the development of indicators for 14 countries. These indicators are meant to enable a comparison of the funding systems. The financial resources, which are allocated on the basis of ex-ante or ex-post performance criteria, are considered as a proportion of total public R&D funding. In the country comparison for 2013, Austria with its approximately 35%, together with Denmark, France and Italy, is at the lower end of the range. Shares for Germany, Finland, the Netherlands, Sweden, Great Britain and Switzerland are up to twice as high. A comparison over time shows an increase in Austria's share of competitive funds from around 27% in 2004 to around 35% in 2013.

This general finding is also confirmed by the OECD study.[226] Here, the share of project funding in total research expenditure of the federal government is used as an indicator for the application of competitive allocation mechanisms. The most recent data point for international comparison here is 2011: Austria's value in 2011 was 25.5%, which put the country in last place among the eleven countries considered. For example, Denmark had a share of 35.3% and Germany 38.6%. In the course of time, no sustained increase in the share of project funding in Austria has taken place since 2005.

The assessment whether objective (4) can be considered as achieved is therefore ambivalent. An increase in the competitive funding can be observed for the universities, yet the entire funding system still does not show orientation towards the principle of competition.

In summary, Austria has a well-developed funding system for research and innovation activities. The objectives for optimising the funding system according to the RTI strategy have been achieved to a varying degree. An improvement in the coordination of the funding portfolio has only been achieved in part. Some of the problems mentioned in the RTI strategy (such as programme overloading or lack of focus of the funding instrument portfolio) still seem to have been only partially solved. The legal basis will be modernised in particular by the new Research Funding Act. Competitive funding has increased in the university sector; however in an international comparison, the entire funding system proves to be a system with relatively little competitive orientation in the allocation of funds for research and innovation.

223 ibid.

224 See Federal Ministry of Education, Science and Research (BMBWF) (2017), Table 2.1.2-1.

225 See Federal Ministry of Science, Research and Economy (BMWFW) (2014) and Federal Ministry of Science, Research and Economy (BMWFW) (2017) Table 7.6.

226 See OECD (2018a), Table 1.

3.5.4 Improving Austria's international positioning

It has always been a priority for Austria to make full use of its international connections to, among other things, strategically position itself internationally. The RTI strategy consequently identifies four targets for improving Austria's international positioning: An overarching target encourages a "*coordinated scientific and research foreign policy with appropriate institutional structures*". Two targets address collaboration within the EU: One addresses the "*active participation in shaping the 'European Knowledge Area' and an appropriate positioning of Austria in it*" and the other the "*increased Austrian participation in European funding programmes and additional increases in the proportion of funding that returns back to Austria*". Two additional targets relate to "*global cooperation with non-European and Central, Eastern and Southeastern European countries*"[227].

With reference to Austria's successful participation in the European Union's Research Framework Programmes FP4 through FP7, the RTI strategy 2020 notes that Austria has been very well integrated into the European Research Area from the start. Looking at this development up to the current level of participation in Horizon 2020, we see an improvement on Austria's already good performance, as measured in terms of participations and funding awards. Austria increased its share of funding awards from 2.55% in FP6 to 2.79% in Horizon 2020 and its share of participations from 2.62% to 2.76% (see Table 3-10). As such, the target related to increasing Austria's rate of return has been met.

Following the criticism at that time from the system evaluation[228] of a mentality that focused too much on programme return flows and was not adequately supported by strategic co-determination, the RTI strategy also called for a coherent package of measures for optimum use of the opportunities of the European Research Area and for the positioning of Austrian interests. It is much more difficult to assess the extent to which this target has been met, though the variety of activities and measures undertaken demonstrate the active role Austria has assumed in the design of the European Research Area. On the other hand, evaluations of the implementation of H2020, EUREKA, COSME, EEN and ERA in Austria[229] clearly indicate that achieving the comprehensively formulated strategic goals will require additional efforts related to strategic positioning, governance and support structures. The extent of these changes will depend on Austria's intended positioning with respect to European RTI policies. This positioning and the associated changes are outlined in three scenarios.

Scenario 1 assumes an incremental progression of the status quo, which currently functions well, without any substantial additional changes. In line with this scenario, Austria's positioning in EU initiatives remains essentially a matter for RTI institu-

Table 3-10: Performance in the Framework Programme FP6 up to H2020

	FP6: 2002–2006	FP7: 2007–2013	H2020: 2014–2020
Total participation	74,584	136,388	93,716
Participation by Austria	1,957	3,595	2,587
Austria in %	*2.62%*	*2.64%*	*2.76%*
Total funding in €millions	16,697	45,236	35,245
Total funding for Austria in € millions	426	1,185	984
Austria in %	*2.55%*	*2.62%*	*2.79%*

Source: Austrian Research Promotion Agency (FFG) EU PM Portal, (data as of 29 September 2018).

227 See Federal Chancellery (BKA) et al. (2011, 41).
228 See Aiginger et al. (2009).
229 See Dinges et al. (2018).

tions themselves and the individual federal ministries which, in accordance with the specific priorities set by the respective ministry, work to secure this positioning and advocate Austria's interests. In contrast, the "*smart alignment*" scenario (Scenario 2) imagines a much more proactive role in designing European RTI policies, which would allow Austria to exploit opportunities presented by EU RTI polices in a more targeted and effective manner. The central starting point in this would be the development of a European participation strategy, which would allow Austria to play a more formative role in high-priority areas. This would require fostering closer connections between national and European programmes, which could, for example, involve selective participation in strategic EU initiatives or improved complementarity/coordination between national and European calls for proposals. To succeed, this scenario would require not only an accepted political leadership role, but also support in the form of a robust Austrian Research Promotion Agency (FFG) with its varied activities at the national and European levels in addition to improved mechanisms for coordination among ministries. Finally, the "*distributed empowerment*" scenario (Scenario 3) envisages an expanded involvement in the design of and participation in European RTI policy, particularly that related to reinforcing and improving networking among RTI insitutitons themselves. Staking out a larger and more influential role for Austria requires political support to overcome subcritical resource levels (e.g. competitive co-financing), which represent a significant factor behind the minor role played by Austrian RTI institutions in larger-sized European initiatives. This scenario requires that organisations have a separate development strategy and the ability to organise themselves in effective national networks. The Austrian Research Promotion Agency (FFG) could support participation by RTI stakeholders in larger initiatives through an appropriate shift in priorities. As in the second scenario, this scenario envisions closer interconnections between the national programme and European initiatives.

The RTI strategy identifies potential for expansion in collaboration with countries outside of the EU alongside a need for a coordinated approach. The strategy specifically names the US, the BRIC countries, neighbouring Central, Eastern and Southeastern European countries and Asia. In this case, too, it is difficult to clearly define or measure the extent to which targets have been met, whereas the extent to which activities and measures have been implemented is easier to report.

Three support measures[230] were set out for this in the RTI strategy:

- Establish a permanent working group to coordinate and implement an Austrian policy for international science and technology, consisting of the functional departments
- Develop an action plan for "*Austria and European Science 2020*". It should be worked out by the Federal Ministry of Science, Research and Economy (BMWFW) and the Federal Ministry of Transport, Innovation and Technology (BMVIT), including relevant ministerial departments and stakeholders
- Develop a coherent cooperation strategy for various priority areas: Central, Eastern and Southeastern Europe, North America, Asia and the BRIC countries

Establish a permanent working group (WG) to coordinate and implement an Austrian policy for international science and technology, consisting of the functional departments

A working group on "*Internationalisation and foreign RTI policy*" within the *RTI Task Force* (WG 7a) was established; in mid-2013 it released a strategy paper titled "*Beyond Europe – The Internationalisation of*

230 See Federal Chancellery (BKA) et al. (2011, 41).

Austria in Research, Technology and Innovation in Europe and Beyond"[231]. The formulated recommendations start from the acknowledgement that there is a significant need for improvements if Austria is to catch up to the *Innovation Leaders*. The recommendations identify three groups of priorities for countries and regions and outline topics and measures (targeted *top-down* measures in bilateral and topic-specific collaborative efforts, general *bottom-up* measures in multilateral and open-topic collaborative activities, increasing the number of knowledge transfer centre agreements, support for university collaborative efforts). There are planned improvements to Austria's external representation with the expansion of the OSTA (*Offices of Science and Technology Austria*) initiative and the creation of the post of RTI attaché at Austrian embassies in selected Priority 1 or 2 countries. Based on this strategy, the following measures were implemented in subsequent years:

- The start of the "*Beyond Europe*" programme: In 2015 the first call for proposals for the "*Beyond Europe*" programme of the Federal Ministry for Digital and Economic Affairs (BMDW), which is open-topic and non-restricted by geographical region, was issued. The programme has been continued (the third call for proposals was issued in December 2018) and was positively evaluated in 2018. "*Beyond Europe*" is targeted at Austrian firms interested in conducting innovative development projects with partners in non-European countries;
- Establishment of the "*Office of Science and Technology Austria – OSTA*" at the Austrian Embassy in Beijing in 2012;
- Expansion of Knowledge Transfer Centre agreements (Scientific & Technical Cooperation) with non-European countries and with Central, Eastern and Southeasern Europe[232];
- Expansion of collaborative activities on the parts of the Austrian Science Fund (FWF) and Federal Ministry for Transport, Innovation and Technology (BMVIT) and the Austrian Research Promotion Agency (FFG) with non-European research partners and funding organisations particularly in Asia (e.g. topic-specific calls for proposals with the *Chinese Academy of Science* and the University of Shanghai), implementation of the "*Global Incubator Network (GIN)*" initiative;
- Support for Austrian researchers and firms that collaborate with third countries within the framework of Horizon 2020 through the provision of targeted information and advice by the Austrian Research Promotion Agency (FFG)[233], involvement in the strategic development of EUREKA with the associated countries South Korea, Canada, South Africa and Chile, and active participation in Globalstars and in the Eurostars programme.

Development of an action plan for "Austria and European Science 2020" by the Federal Ministry of Science, Research and Economy (BMWFW) and the Federal Ministry for Transport, Innovation and Technology (BMVIT), including relevant ministerial departments and stakeholders

A second working group within the *RTI Task Force* was set up as Working Group 7b under the title "*Action plan for Austria and the European Knowledge Space 2020*". In mid-2013 this group presented a strategic plan ("*Austrian EU Action Plan*"[234]) under the guiding principle "*Boosting Austrian stakeholders promotes successful Europeanisation*". This plan identified six priorities and a total of 72 measures, which the working group is implementing towards the goal of optimising Austria's positioning within the framework programmes and the ERA. In 2016 the

231 See Federal Ministry for Transport, Innovation and Technology (BMVIT) et al. (2013).

232 For a list of all knowledge transfer centre agreements and current funding opportunities for study or research stays abroad, see https://oead.at/de/projekte/internationale-kooperationen/wissenschaftlich-technische-zusammenarbeit/

233 See https://www.ffg.at/ausschreibungen/H2020_internationale-kooperation

234 See https://era.gv.at/directory/159

Austrian "*ERA Roadmap*"[235], which is based on the "*European Research Area Roadmap 2015–2020*", was agreed. It identified seven spheres of activity along six priorities that are considered essential for the continued expansion of the European Research Area. There was discussion in 2019 of possible adjustments following from the Council's position on the ERA agreed on 30 November 2018. Furthermore, negotiations at the EU-level regarding "*Horizon Europe*", the successor programme to "*Horizon 2020*", were continued in 2019. These also touched on the extent to which the defined thematic areas for "missions" and "partnerships" should be taken into account identifying national strategic objectives.

The Austrian Research Promotion Agency (FFG) has expanded and intensified its support and consultative activities with respect to both European and global collaboration. There was a gradual move from measures devoted purely to the provision of information to advisory services that are informed by the "*empowerment* approach". The recently performed evaluation of Austria's implementation of European programmes has confirmed the success of the chosen path and recommended additional measures towards improving the strategic orientation.[236] After the introduction of the "*EU-Performance Monitoring" (EU-PM)* mechanism, the Austrian Research Promotion Agency (FFG) processes data on the EU framework programmes and evaluates this with special consideration of the Austrian participations. The tool is user-friendly and interactive and also allows for the integration of national funding programmes.

Develop a coherent cooperation strategy for various priority areas: Central, Eastern and Southeastern Europe, North America, Asia and the BRIC countries

The internationalisation efforts of the past several years, which focused on implementing the RTI strategy and the conclusions reached in the strategy paper "*Beyond Europe*" on intensifying cooperation with the priority areas of North America, Asia and the BRIC countries, were expanded in 2018 to include collaborative efforts with Africa. These were presented publicly during the *High Level Forum Africa-Europe* on 18 December 2018, which was organised as part of Austria's EU Council presidency. This initiative is undertaken against the backdrop of Africa's significant economic dynamism of recent years, international responsibility for the *Sustainable Development Goals (SDGs)*, the related need for the consolidation of local productive, economic and social structures and increased awareness in developing and newly industrialised countries of the importance of endogenous R&D potential. Expanding cooperation with Africa is essentially based on three pillars:

- First, a *Memorandum of Understanding* on scientific and technological cooperation (knowledge transfer centres) was agreed with the Egyptian ministry of science. Another knowledge transfer centre agreement with the Ethiopian ministry of science and technology is currently in preparation. Together with the currently existing knowledge transfer centre agreement with the ministry of science in South Africa, these form the first bilateral cooperation agreements in the fields of science and research between Austria and select African countries.
- The new Federal Ministry of Education, Science and Research (BMBWF) programme for development research represents the second pillar. This succeeds the Commission for Development Research (KEF) at the Austrian Exchange Service, OeAD GmbH, which completed its work at the end of 2018. The new programme, also under the aegis of OeAD GmbH, has a budget of up to €315,000 per year. With this programme the Federal Ministry of Education, Science and Research (BMBWF) looks to boost development re-

235 See ERA Observatory Austria and the Federal Ministry of Science, Research and Economy (BMWFW)(2016).
236 See Dinges et al. (2018).

search, gradually expand research collaboration with developing countries, particularly – but not exclusively – in Africa and support Austrian higher education institutions and research institutes in their efforts towards implementing the *Sustainable Development Goals (SDGs)*, agreed by the United Nations in 2015. It covers mobility and material costs in Austria and in the partner country.

- A third pillar complements the above through the expansion of the research network among Austrian and African higher education institutions and research institutes, which will be coordinated during the start-up phase by the University of Natural Resources and Life Sciences, Vienna and administratively implemented by the Austrian Exchange Service, OeAD. The research network aims to expand research collaboration with countries in Africa by promoting and funding network activities and project-based collaboration between Austrian and African higher education institutions and research institutes. The Federal Ministry of Education, Science and Research (BMBWF) provides €250,000 of funding annually for the support services provided by the Austrian Exchange Service (OeAD) and for networking activities. Network activities include alumni activities, trainings, workshops, seminars, conferences, bilateral and multilateral research projects with at least one African institution among its members and project initiation for joint proposals for Horizon Europe, Erasmus+, and projects funded by the Austrian Research Promotion Agency (FFG) and the Austrian Science Fund (FWF). There is no restriction by topic.

This measure additionally includes already existing open-topic and geographically unrestricted programmes, such as those of the Austrian Science Fund (FWF) and the "*Beyond Europe*" programme of the Federal Ministry for Digital and Economic Affairs (BMDW).

3.5.5 Expanding the connection between research and society

The federal government has also identified concrete targets in the RTI strategy with respect to the relationship between research and society. The aim is "*a culture of appreciation for research, technology and innovation*" and to promote an understanding of "*how this field makes an essential contribution to increasing the quality of life and societal prosperity*"[237]. To achieve this, a stable environment, including infrastructures, for multiple forms of dialogue between science and society along the lines of a "scientific citizenship" needs to be established. Responsibility and integrity in science should be strengthened via institutional processes.

A large number of measures have been defined[238]:

- Establish a central administrative location for dialogue between science/research and society
- Promote dialogue activities for research, technology and innovation
- Conduct a regular national performance show to demonstrate how research makes a social contribution that shapes the future
- Expand independent impact assessments of technology
- Establish high standards for scientific integrity:
  - Strict guidelines for dealing with conflicts of interest in contract research
  - Disclosure of value systems in research
  - Make the findings of publicly financed or subsidised research projects available to the public in an appropriate manner
  - Strengthen the organisations that are intended to do this
- Create a clear statutory regulation of research ethics commissions related to audit contracts, the legal quality of auditor's opinions and procedural rules

In addition to these measures, there are other activities not directly addressed in the RTI strategy that

237 See Federal Chancellery (BKA) et al. (2011, 43).
238 ibid.

nevertheless reflect the diversity and dynamism that characterises the Austrian research landscape.

Dialogue activities for research, technology and innovation

The international discourse on science and society is reflected in the concern to promote the dialogue between RTI and society. This debate began with the assumption that a passive public, uneducated in questions of science, only needed to be informed about the achievements and benefits of research in order to gain the public's acceptance.[239] Meanwhile the picture of a dialogue between the different actors has come to the fore here, and approaches of "*public engagement*", i.e. of the involvement of the public in research processes, have gained importance beside "classical" formats of the exhibition of achievements also in Austria, as becomes apparent by the example of the activities described below about *Citizen Science* and *Responsible Science*. In addition to predominantly monodirectional information and communication about science and research, measures for bi-directional cooperation between science and society are increasingly being taken. This will improve the public's understanding of the role and importance of RTI and will also facilitate the inclusion and management of the social dimensions of scientific activity in research practice. In addition, new ways of knowledge open up for research, for instance via *Citizen Science*. The term *Citizen Science* covers different kinds of participation of citizens in scientific activities. From data collection to the initiation of research projects, innovative combinations of local, practical community knowledge with the systematic knowledge of researchers take place.

The Federal Government has developed and implemented various dialogue formats and has repeatedly renewed them in the light of experience. Until 2016, the Federal Ministry for Transport, Innovation and Technology (BMVIT) supported the networking between stakeholders from politics, research, industry and economy with events on current innovation topics in the "*forum bmvit*". With "*fti remixed*"[240] a science communication platform was established especially for young people, which informes them about RTI and associated career perspectives. The "*European Researchers' Night*"[241], financed within the framework of Horizon 2020, is also aimed primarily at a young audience. It is a Europe-wide campaign in which a large number of events take place in parallel at many locations, whereby emphasis is put on interactive formats.

The Federal Ministry of Education, Science and Research (BMBWF) also addresses the interested public with its series of events called "*Science Talks*"[242] in the form of panel discussions with researchers on current topics. These events take place in the "Aula der Wissenschaften" (Hall of Sciences), which was also established as part of the RTI strategy as a central venue for the dialogue between science/research and society. In 2015, the Federal Ministry of Education, Science and Research (BMBWF) summarises its measures for implementing the RTI strategy in the "*Action Plan for a Competitive Research Area*". The line of action "*Deepen the dialogue between science and society*" focuses especially on the concepts of *Responsible Science*, *Citizen Science* and *Crowdsourcing* as well as *Open Innovation*.

One of the biggest Austrian measures in this context is the programme "*Sparkling Science*"[243] of the Federal Ministry of Education, Science and Research (BMBWF), which contains elements of the *Citizen-Science* discourse and clearly shapes it in Austria. *Sparkling Science* is administered by the

239 See, for example, the internationally pioneering document of the Royal Society (1985).
240 See https://www.fti-remixed.at/
241 See http://sci4all.eu/de/
242 See https://bmbwf.gv.at/das-ministerium/veranstaltungen/science-talk/
243 See https://www.sparklingscience.at/

Austrian Exchange Service (OeAD). The programme aims to combine "*high-quality research with pre-university encouragement of young talent*"[244]. This is done by supporting ambitious scientific projects in which pupils actively participate in the research process. Research is to benefit from unique scientific findings, education from the fact that pupils (and teachers) come into direct contact with the latest state of knowledge as well as with scientific approaches in the course of school education.

The *Sparkling Science* programme was the subject of two evaluations (2009 and 2013)[245] and one analysis each of its scientific and institutional impacts[246]. The programme has successfully mobilised its target groups and has been very well received, in particular by schools, universities and university colleges of teacher education. The experiences with the funded projects in *Sparkling Science* are overall very positive, and both the participating researchers and the pupils report high motivation and a positive dynamic in the projects which has also been beneficial to the research contents. The contacts and activities from the *Sparkling Science* projects are often continued beyond the funded project, for example in the form of further joint research work or teaching activities. The programme has thus clearly contributed to improving the interface between schools and higher education institutes. In addition, there has been a significant impulse away from "classical", one-way paths of science communication towards actual cooperation in joint research. The partnerships and competences built up at the participating institutions as a result form a basis for future activities, which, however, still require public funding, since research is highly dependent on third-party funding.

Since 2015, elements of *Citizen Science* have been increasingly supported within the framework of *Sparkling Science*. This includes above all the "*Citizen Science Awards*", which are supposed to achieve a higher visibility for citizen science, as well as the expansion of *Sparkling Science* projects with elements of *crowdsourcing*. This means the involvement of citizens beyond the pupils directly involved in the consortium within the *Young-Citizen-Science*-pilot projects. In an accompanying analysis[247] also the optimal design of support measures for *Citizen Science* was investigated.

Structured *Citizen Science* activities were also organised at universities, research institutes and agencies of the federal government in the past years, among them the following:

- In coordination with the Federal Ministry of Education, Science and Research (BMBWF), the Austrian Science Fund (FWF) and the Austrian Exchange Service (OeAD) have financed "*Top Citizen Science (TCS)*"[248] expansion projects (up to a maximum of €50,000) on current FWF projects and *Sparkling Science* projects in three calls for proposals so far.. These extension modules finance project extensions in the sense of *Citizen Science*, i.e. citizens and persons with specialised expertise - so-called "*Knowledge-Communities*" - are to be actively involved in ongoing research work, and thus the possibilities for excellent research are to be extended. So far, 31 TCS extension projects have been funded.
- The Ludwig Boltzmann Society (LBG) has established the "*LBG Open Innovation in Science Center*" in 2016 with funds from the National Foundation[249]. The concept of the centre is based on successful pilot projects in the fields of *Crowdsourcing*

244 See Federal Ministry of Science, Research and Economy (BMWFW) and the Austrian Exchange Service (OeAD) (2016, 2).
245 See Mitterauer and Birch (2009); Birch and Fettelschoß (2013).
246 See Manahl et al. (2016); Tiefenthaler (2018).
247 See Tiefenthaler und Warta (2016).
248 See https://www.fwf.ac.at/de/forschungsfoerderung/fwf-programme/foerderinitiative-top-citizen-science/ and https://www.zentrumfuercitizenscience.at/de/top-citizen-science
249 See https://ois.lbg.ac.at/

and training for *Open Innovation* in science. *Open Innovation in Science (OIS)* means that scientific methods are applied in a targeted manner within the framework of open, collaborative and participatory processes. The aim is to create something new and to achieve added value for society. In the context of the latest *Crowdsourcing* project "*Talk to me about accident injuries!*" patients and experts have submitted more than 800 research questions via the online platform "*Tell us!*".

- *Citizen Science* was also a topic of the knowledge transfer centres existing from 2014 to 2018[250]. The Federal Ministry of Education, Science and Research (BMBWF) and the Federal Ministry for Digital and Economic Affairs (BMDW) financed the activities within the framework of the funding programme "*Knowledge Transfer Centres and Exploitation of IPR*", in order to intensify the transfer of knowledge from science to industry and society. The initiative was coordinated by Austria Wirtschaftsservice GmbH.
- In 2016 the *Citizen Science*-Platform "*Austria researches*" was founded at the University of Natural Resources and Life Sciences. By the end of 2018 there are 58 ongoing and ten completed projects of more than 30 institutions, which together gather about 100,000 *Citizen Scientists*.[251] These projects were initiated and coordinated not only by universities, but also by non-university research institutes, NGOs, museums, associations, private research institutes and foundations. In addition to the natural sciences, humanities and social sciences, projects from the arts and cultural sciences have also been represented since 2018. An inter-institutional working group has developed quality criteria for *Citizen Science* projects[252], which have also been perceived positively internationally.

Exhibition: Research that makes a social contribution that shapes the future

In June 2014, within the scope of the Eurobarometer study "*Public perception of science, research and innovation*", approximately 28,000 people in the 28 EU Member States were interviewed on the impact of science and technology on key aspects of life over the next 15 years.[253] The findings for Austria continue to show a comparatively high degree of scepticism towards science and technology. On the other hand, various measures are attracting a great deal of public interest. The central activity in this category of measures is the "*Long Night of Research*".[254] In addition, various state awards serve both to honour outstanding achievements in R&D and to present them to the public. These are in particular the *State Prizes "Mobility"* and *"Patent"*, which are awarded every two years, as well as the annually awarded State Prizes *"Innovation"* and *"Design"* and the founders' prize *"Phönix"*. In 2019, a national prize for *"Digitalisation"* is awarded for the first time.[255] The "*Diversitas Award*" is presented[256] for special achievements in diversity management at higher education and research institutes, and the *Gabriele-Posanner Prizes* are awarded every two years for achievements in gender studies[257].

The *"Long Night of Research" (LNF)* is Austria's largest research event for a wide audience. Since 2005, the LNF has taken place in Austria's major cities, biennially since 2012, and nationwide since 2014, making the achievements and challenges of Austrian

250 See Knowledge Transfer Centre (WTZ) East, Knowledge Transfer Centre (WTZ) South, Knowledge Transfer Centre (WTZ) West: http://www.wtz.ac.at/, and the thematic WTZ: www.wings4innovation.at
251 See Citizen Science Network Austria (2018, 22).
252 See Heigl et al. (2018).
253 See European Commission (2014).
254 See https://www.langenachtderforschung.at
255 See https://www.bmdw.gv.at/Ministerium/Staatspreise/Seiten/default.aspx
256 See https://bmbwf.gv.at/wissenschaft-hochschulen/gleichstellung-und-diversitaet/programme-und-initiativen/diversitas/
257 See https://bmbwf.gv.at/das-ministerium/staatspreise-und-auszeichnungen/gabriele-possanner-staats-und-foerderpreis/

science - from school projects to cutting-edge research - accessible and tangible.[258] Visiting the LNF is free of charge. Universities, non-university research institutes, universities of applied sciences, industry, infrastructures and schools are called upon to communicate their activities in a low-threshold manner in order to achieve a better understanding of research and technology and to generate enthusiasm for research and for the open dialogue between science and society. In addition, the diverse research landscape is presented as an attractive workplace for early stage researchers. In interactive presentations, hands-on stations and guided tours, interested visitors can get in touch with the researchers, set experiments in motion themselves, and discuss current challenges. The eighth and largest LNF so far took place in 2018: Over 228,000 visitors of all ages were addressed at 265 locations with 2,601 stations.[259] The nationwide measures of the LNF are financed by the Federal Ministry of Education, Science and Research (BMBWF), the Federal Ministry for Digital and Economic Affairs (BMDW) and the Federal Ministry for Transport, Innovation and Technology (BMVIT). The Austrian Research Promotion Agency (FFG) is commissioned with the legal and financial implementation. The Council for Research and Technology Development (RFTE), together with the LNF Coordination Office, coordinates the content and communication between the federal ministries and the regional governments. Representatives of the regional governments are responsible for operational management in the various regions. The next "*Long Night of Research*" will take place in 2020.

In addition, this package of measures also includes the assessment and research of the societal impact of science. The explorative study commissioned by the Council for Research and Technology Development (RFTE) entitled " The Societal Impact of Social Science Knowledge in Austria: Impact Pathways, Measurement, Potential" is dedicated to the university-based social sciences in Austria and sheds light on the possibilities of recording and measuring the social impact.[260]

Expand independent impact assessments of technology

Since 2017, the Institute of Technology Assessment (ITA) of the Austrian Academy of Sciences and the Austrian Institute of Technology (AIT) have supported Parliament for three years with advisory services in the fields of *Technology Assessment and Foresight*.[261] This includes an annual monitoring, in which current trends and the impact of technologies on our everyday lives are reported on an regular basis. Studies on priority topics are commissioned separately. The total budget of the contract put out to tender by the Austrian Parliamentary Administration amounts to €200,000 per year.

For dealing with the risks of nanotechnologies for environment, health and safety, a cross-departmental approach was chosen, based on the *Austrian Nanotechnology Action Plan*: The Federal Ministry for Transport, Innovation and Technology (BMVIT), the Federal Ministry for Sustainability and Tourism (BMNT) and the Austrian Federal Ministry of Labour, Social Affairs, Health and Consumer Protection (BMASGK) have commissioned the Institute of Technology Assessment (ITA) with the project "*Nano Trust*" until 2020.[262] The Nano Trust Team identifies and addresses the most urgent questions on the safety and dangers of nanotechnologies and provides a publicly accessible information platform. The Nano-EHS[263] (Environment, Health and Safety) programme funds projects that investigate the environ-

258 For details on the history of the LNF, see Council for Research and Technology Development (RFTE) (2015).
259 See https://www.langenachtderforschung.at/2018/index.html
260 See Felt and Fochler (2018).
261 See https://www.parlament.gv.at/PAKT/AKT/SCHLTHEM/SCHLAG/J2017/132Technikfolgen.shtml
262 See https://www.oeaw.ac.at/ita/projekte/nanotrust/ueberblick
263 See https://www.ffg.at/programme/nano-environment-health-and-safety

mental and health risks of synthetic nanomaterials. In addition to the above-mentioned ministries, the Federal Ministry for Digital and Economic Affairs (BMDW) and the Austrian Economic Chambers (WKO) are also involved in the strategic orientation of this programme, which is administered by the Austrian Research Promotion Agency (FFG). The programme runs until 2020.

Establish high standards for scientific integrity

In the RTI strategy four measures were formulated with the goal of establishing high standards of scientific integrity: the development of strict guidelines in dealing with conflicts of interest in contract research, the disclosure of value systems in research, improved access to information on publicly financed research, and the strengthening of the respective designated organisations[264]. In this context, the goal of creating clear legal regulations for research ethics commissions should also be mentioned. Positions are currently being sought on this; for example, the viewpoints of the universities were collected during the accompanying discussions on the performance agreements.

Develop strict guidelines for dealing with conflicts of interest in contract research and the disclosure of value systems in research

In April 2015 the "*Guidelines for Good Scientific Practice (GPW)*"[265] were revised by the Commission for Research Integrity and adopted by the General Assembly of the Austrian Agency for Research Integrity (ÖAWI). Their implementation is currently under discussion. By decision of the Austrian Higher Education Conference the working group *Research Integrity/ Research Ethics* was entrusted with the development of proposals for the implementation of the guidelines with regard to the *European Code of Conduct for Research Integrity*[266] published in April 2017. Findings are expected in early 2020.

In 2015, Austria anchored "*Responsible Science*" in the "*Action Plan for a Competitive Research Area*"[267]. One measure in it is the foundation of the *Alliance for Responsible Science*[268], to which numerous institutions from science, research, education and practice have already joined. In the same year the "*Platform RRI*"[269] was founded by mainly non-university research institutes. As a competence network it collects experiences and *best practices* from RRI projects in order to promote critical reflection and opening of research to societal challenges. Studies are also carried out via this platform. For instance, the Federal Ministry of Education, Science and Research (BMBWF) has commissioned a *Use Case Study*, which is to test the principles for responsible research in the research field of care and support in the context of the activities of the "Network Ageing".[270] First results will be available in mid-2019. European and Austrian *Responsible Science* debates will be tested for their practical usefulness in a concrete research and application context and problems and approaches of research on ageing will be translated into a public discourse on responsible research. The members of the "*RRI platform*" and the "Network Ageing" contribute their respective research backgrounds in order to generate and discuss new questions. In the context of the new Austrian and European data protection guidelines, data generation and use in a particularly sensitive area - elderly people - with a simultaneously high market and innovation potential are to be discussed, and proposals for the modification of existing practices are to be developed.

264 See Federal Chancellery (BKA) et al. (2011, 43).
265 See https://oeawi.at/richtlinien/
266 See All European Academies (2017).
267 See Federal Ministry of Science, Research and Economy (BMWFW) (2015a).
268 See https://www.responsiblescience.at/
269 See https://www.rri-plattform.at
270 See Federal Ministry of Science, Research and Economy (BMWFW) (2017b).

On the part of the Austrian educational and research institutions the topic *Integrity* is already increasingly implemented in practice. The *Klagenfurt Declaration of 2016*[271] establishes the informal Austrian Network of Ombudsmen in Higher Education which are active in the fields of counselling, complaints, diversity, information, conflict, crisis, quality and improvement management. Through the regular exchange of information, a culture of fairness is to be further established, services professionalised, and competencies expanded.

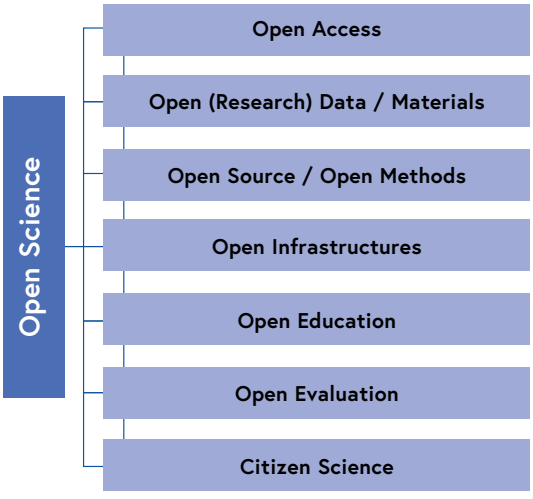
Improved access to information on publicly funded research and the strengthening of respective dedicated organisations

In addition to opening up research to societal challenges, a central concern of European research agendas is to make the findings of publicly funded research generally available if it does not disclose critical information or other information that needs to be protected. With the "*Open Innovation – Open Science – Open to the World*"[272] initiative, the European Commission set a milestone in an international comparison for the improvement of research quality and the application of scientific findings. Transparency, integrity, cooperation, usability and social innovation are at the centre of the debate (see Fig. 3-18).

The most discussed area at the moment probably is *Open Access (OA)*. This means unrestricted and free access to scientific information on the Internet. This includes primarily scientific publications, but also primary data and metadata, source texts and digital reproductions. *Open Access* includes the claim that the findings of publicly financed research should also be publicly accessible for all interested parties. Free licenses regulate the additional rights of subsequent and further use. The OA movement reacts to criticism of unnecessary public multiple funding of research: When publicly funded researchers publish, the same must be done so that the publications appear in formats that are in turn acquired by publicly funded libraries from publishers. OA also brings many benefits to the researchers themselves, including increased visibility and citation.

Austria plays a pioneering role in the field of *Open Access* and Open Data, and representatives of various institutions and initiatives are internationally recognised experts. The Austrian Science Fund (FWF) has been pursuing an *Open Access* strategy since 2004 and is a core member of the Task Force on

Fig. 3-18: Fields of open science



Source: Katja Mayer CC BY. For an explanation of the sub-fields, see www.oana.at.

271 http://www.hochschulombudsmann.at/wp-content/uploads/2016/06/Klagenfurter-Erkl%C3%A4rungfinal_bf.pdf
272 European Commission (2016).

"*Plan S*", a declaration of commitment by national research funding organisations and international charities, and the European Commission, which aim to publish all publications facilitated with their funds in *Open Access* journals or on *Open Access* platforms from 2020. "*Plan S*" describes ten principles whose implementation is currently being negotiated and to which the members of the *Coalition* commit themselves. The most important activities in Austria in the area of OA are described below.

- Since 2013 the *Austrian Science Fund (FWF) has been documenting OA costs*, since 2015 data on the *OA Compliance* has also been collected. In 2017, the Austrian Science Fund (FWF) was able to show an OA compliance rate of 90 %. Furthermore the Austrian Science Fund (FWF) operates an *Open Access-Journal Initiative* as start-up financing for highly qualified OA journals. Since 1 January 2019 the new *Open Access Policy of the Austrian Science Fund (FWF)* has been supplemented by a mandatory *Open Research Data Policy* and a mandatory research data management.[273] The mandatory *Data Policy* was developed on the basis of experience gained from the *Open Research Data Pilot Programme* (ORD)[274] and the exchange with *Science Europe*.[275]
- The *Open Science Network Austria*[276] (formerly *Open Access Network Austria - OANA*) was founded in 2012 as a *Joint Activity* under the organisational umbrella of the Austrian Science Fund (FWF) and Universities Austria (UNIKO). OANA regularly publishes reports, recommendations and checklists. The network informs about its activities in an annual public event. In 2016 the Austrian Council of Ministers adopted 16 *Open Access* recommendations. In the performance agreements of the 22 universities there is a commitment to the activities of the OANA, linked to the willingness to contribute working groups. Furthermore, a set of proposals for an *Open Science Strategy* according to the recommendations of the EU Commission and the national *ERA Roadmap* will be developed in an OANA working group.[277]
- Besides OANA there are in Austria a multitude of projects and initiatives dealing with *Open Science*. The Austrian Academic Library Consortium "*Kooperation E-Medien Österreich (KEMÖ)*" is dedicated to the coordinated acquisition of e-media and rights of use for e-media within consortia. KEMÖ is constantly negotiating *Open Access* contracts with publishers and can show significant success. Although cost neutrality has not yet been fully achieved, 80 % return of costs for large deals means a significant cost minimisation. Another important goal of KEMÖ is the preservation of the diversity of the scientific landscape and the inclusion of smaller publishing houses and scientific umbrella organisations in consortium agreements. Therefore, a multiplicity of *Open Science* infrastructures and platforms are (co)financed throughout Austria. Due to the activities of KEMÖ and the other Open Access initiatives, Austria is very well prepared for the implementation of "*Plan S*".
- During the Austrian EU Presidency the *European Open Science Cloud (EOSC)* was ceremoniously launched in October 2018.[278] With the EOSC, Europe aims to play a leading role in the scientific data infrastructure. It provides European researchers and science and technology professionals with a virtual environment with free access, and free

273 See https://www.fwf.ac.at/de/forschungsfoerderung/open-access-policy/
274 See https://zenodo.org/record/803234
275 See Science Europe (2018).
276 See https://www.oana.at/
277 See https://ec.europa.eu/info/news/new-commission-guidance-supports-eu-member-states-transition-open-science-2018-apr-25_en
278 See https://ec.europa.eu/research/openscience/index.cfm?pg=open-science-cloud

and seamless services for storing, managing, analysing and re-using research data across borders and disciplines. During the *launch* Austria presented a reference model for the establishment of administration, services and a data architecture within the *European Open Science Cloud*.

- In January 2014, the three-year partner project *e-Infrastructures Austria*, funded by the Federal Ministry of Science, Research and Economy (BMWFW) (today: Federal Ministry of Education, Science and Research (BMBWF)), was initiated. The project pursued the coordinated development of digital archiving infrastructures and the further development of research-supporting services. By networking and bundling know-how and resources, a competence network was created that provides assistance in the implementation of repositories as well as in the expansion of technical systems, services and accompanying issues. The follow-up project "*e-Infrastructures Austria Plus*" is a project of nine Austrian universities that will build infrastructure for *eScience* in Austria from 2017-2019. [279] Seven working packages deal with such different things as *RDM policies*, "*machine-actionable* data management plans", the set-up of institutional repositories for research data, standards for metadata according to the FAIR principle, the development of DOI (*Digital Object Identifier*) infrastructures, and first steps for the implementation of *Electronic Lab Notebooks*.
- The higher education area funding project "Austrian Transition to Open Access (AT2OA)", supported by the 280Federal Ministry of Education, Science and Research, aims to support the transformation from *Closed* to *Open Access* in scientific publications and to take supporting measures. Within the framework of the project duration of 2017-2020, an increase of the Austrian *Open Access* publication output is to be generated and new ways for *Open Access* publishing are to be opened by redesigning the licence agreements with the providers and by targeted publication support of the researchers.
- The disciplinary repositories "*Austrian Social Science Data Archive (AUSSDA)"* for social science research data and the "*Austrian Center for Digital Humanities (ACDH)"* with its repositories ARCHE and GAMS for humanities-related research data showcase how national research data archives mediated via European ESFRI research infrastructures contribute to the establishment of the European Open Science Cloud (EOSC). AUSSDA contributes to the EOSC via CESSDA, and the ACDH via CLARIN and DARIAH. Within the framework of the Horizon2020 project SSHOC a European consortium is currently working on the development of services for the humanities, social sciences and cultural sciences within the EOSC. In addition to archiving research data, AUSSDA also provides the social science research community with extensive services, such as the creation of Data Management Plans (DMPs).

Open access to high quality data is essential for research. The *Research Organisation Act (FOG)* in the amended version of 2018 opens up new possibilities for scientific research at the interface of politics and society. Following the adoption of the Data Protection Act Adaptation Act 2018 - Science and Research (WFDSAG 2018) by the National Council on 20 April 2018 and the associated amendment of the Research Organisation Act (FOG), a pilot project was launched at the Federal Ministry of Education, Science and Research (BMBWF) with the aim of using its own register data to demonstrate the procedural, infrastructural and legal requirements for the transparent and research-friendly implementation of register research in Austria. In this context, coordination talks were held with both the research community and Statistics Austria and the possibilities of a microdata cen-

279 See https://www.e-infrastructures.at/de/
280 See https://at2oa.at/home.html

tre for register data at Statistics Austria. An information event was also organised for all federal ministries in order to share the findings of the pilot project and to deal with questions relating to the Research Organisation Act (FOG) and register research. The Austrian research community accompanies the legislative initiative with the foundation of the *Platform for Registry Data Research)*[281] in 2018 (see Section 5.1.1).

A further contribution to the accessibility of publicly financed contracts in the context of RTI policy is the *Repository of the Austrian Platform for Research and Technology Policy Evaluation (fteval)*[282]. Following the common wish of the members of the Austrian Platform for Research and Technology Evaluation (fteval) for a transparent publication policy, the *fteval repository* collects evaluation reports and studies from the fields of science, research, technology and innovation policy in Austria and makes them accessible to an interested public.

Research information systems are the backbone of a robust research and innovation policy. In 2016, the Austrian Court of Audit proposed the creation of a single *research funding database*. Commissioned by the Federal Ministry for Transport, Innovation and Technology (BMVIT) and the Federal Ministry of Education, Science and Research (BMBWF), the Council for Research and Technology Development (RFTE) conducted a feasibility study and a cost-benefit analysis, which led to a recommendation for the establishment of a national database for the comprehensive and transparently comprehensible documentation of all federal and state research funding.[283] In agreement with the other ministerial departments represented in the RTI Strategy Task Force, the Federal Government commissioned the Federal Ministry of Finance (BMF) to set up a project team with the planning and preparatory work for the implementation of a research funding database spanning across regional authorities and to submit an implementation concept by the RTI Summit in 2019.

The first steps in this direction have already been taken: The federal database *Bundesforschungsdatenbank (BFDAT)* has been web-based and publicly accessible since 2008. It is operated by the Federal Ministry of Education, Science and Research (BMBWF) and records research projects funded with federal funds. In 2018, the Federal Ministry for Transport, Innovation and Technology (BMVIT) activated the "*Open4Innovation Portal*", on which above all research results are communicated and actors networked.

3.6 Findings of the OECD Review of Austria's Innovation Policy

The *OECD Review*[284] was commissioned by the Federal Ministry of Education, Science and Research (BMBWF) and the Federal Ministry for Transport, Innovation and Technology (BMVIT) and carried out by the OECD Directorate for Science, Technology and Innovation. The final report was presented at the Europe conference[285] in December 2018.

The purpose of the review was to achieve a comprehensive understanding of the central elements, relationships and dynamics within the Austrian innovation system and identify the options available to policymakers to optimise that system. Ultimately, the review was also meant to serve as a basis for the formulation of the new RTI Strategy 2030. The review contains a summary and the following five chapters:

- Chapter 1 ("*Overall assessment and recommendations*") provides an overview of Austria's innovation system and presents a compact description

281 See www.registerforschung.at
282 See https://repository.fteval.at/information.html
283 See Austrian Council for Research and Technology Development (RFTE) (2018b).
284 See OECD (2018a).
285 See https://era.gv.at/europatagung2018

of the key findings and recommendations of the review.

- Chapter 2 ("*The Austrian innovation system: Evolution and current challenges*") outlines the latest developments in Austria's innovation system on the basis of key indicators and within the framework of an international comparison. It also discusses the challenges associated with the described developments.
- Chapter 3 ("*Business innovation and Industry 4.0 in Austria*") analyses the main innovation stakeholders and their performance capacities, as well as the public support offered for innovation and enterprise creation, and the current portfolio of political measures designed to provide such support. Special attention is paid here to Industry 4.0 (including *cloud computing*, data generation and data availability, and 5G networks).
- Chapter 4 ("*Improving the performance and attractiveness of higher education institutions and public research institutes in Austria*") examines the performance and attractiveness of higher education institutions and public research institutes. It also describes developments in the higher education sector and assesses its performance with regard to human capital formation, research and "*third mission*" activities. The strategic coordination and funding of public universities are also discussed, as are the roles played by various public research institutes.
- Chapter 5 ("*Reconfiguration of science, technology and innovation governance in Austria: Structures for innovation leadership*") focuses on the management of the system. This chapter presents an overview of the key stakeholders (ministries, funding organisations, advisory bodies) and analyses tasks and coordination and evaluation processes, including the role played by societal challenges and international cooperation and partnerships.

Initial situation

The beginning of the review presents a key finding from which various areas where action needs to be taken ("*main policy challenges*") and possible measures ("*priority actions*") are derived:

Austria is among the group of countries with the highest degree of R&D intensity. With an R&D intensity value of 3.19% in 2018, Austria was second (only behind Sweden) in the EU. The R&D intensity (adjusted in line with industry structure) of Austria's business enterprise sector is the highest in the OECD. At nearly 1.4 percentage points, growth in R&D intensity in Austria between 1998 and 2016 was the second-highest in the OECD countries, behind only South Korea. At the same time, the sharp increase in R&D expenditure over the last few years has not (yet) led to any significant improvement to Austria's position in key innovation rankings, nor has it closed the gap between Austria and the leading countries with regard to key output indicators (including indicators relating to digitalisation and Industry 4.0). Austria's international position has thus remained more or less the same over the years. This is due, among other things, to the fact that the countries with which Austria directly compares itself are undergoing progressive development.

Despite Austria's own further development, the country has been unable to catch up to the group of *Innovation Leaders*. According to the *European Innovation Scoreboard (EIS) 2018*[286], Austria (as was the case in previous years) was ranked in the middle of the group of *Strong Innovators* (10th place). This can be explained in part by the fact that the EIS rates economies with a high proportion of high-tech sectors as being more innovative than those whose innovation activities are focused in sectors with a mid-range or low technology intensity, as is the case with Austria.[287] Austria has also received below-average ratings for research excellence, venture capital investment and intellectual property rights.

286 See European Commission (2018b).
287 See Janger et al. (2017b).

On the basis of its findings, the OECD Review formulated the notion that Austria needs to refocus its research and innovation efforts away from a concentration on inputs and towards a concentration on outputs and impacts: "*To join the leading countries in research and innovation, Austria needs a long-term perspective, continued reform efforts and sustained investment that is likely to require adaptation in the mix of policy instruments. In addition, a broader policy approach is required that goes beyond an increase of R&D intensity.*"[288]

The suggested refocus is subsequently described in greater detail in the form of recommendations for five key areas in which action needs to be taken ("*main policy challenges*"):

Main policy challenge 1: Excellence in research

Given the numerous new developments in the higher education sector (university funding NEW based on indicators, introduction and further development of the Austrian National Development Plan for Public Universities, creation of additional career opportunities for early stage researchers, etc.), it is recommended that the new system for university funding and coordination be further developed on the basis of indicators and performance agreements in a manner that creates incentives for outstanding research achievement. This includes the further development of the indicators and, in particular, the possible introduction of output indicators for research.

Another central recommendation relates to the introduction of an excellence initiative and the strengthening of the competitive component of basic research funding. This can be done by increasing the Austrian Science Fund (FWF) budget, whereby the additional funds should be used for both existing formats and for innovations in the programme portfolio.

The OECD Review also recommends that action be taken with regard to the recruitment of established researchers and the career development opportunities offered to young researchers. Here, the OECD Review offers a critical appraisal of current reforms such as the introduction of the new "*tenure track*" models and the simplified recruiting processes made possible by the amendment to the Universities Act in 2015.[289] The implementation and management of these reforms should be monitored and refined in order to increase the international attractiveness of Austrian universities even further.

Main policy challenge 2: Improving the industrial R&D base and accelerating the implementation of Industry 4.0

This main policy challenge relates to two issues. The first involves the necessity of accelerating and supporting innovative enterprise creation in research and technology-intensive sectors, which have been traditionally under-represented in Austria. The second relates to supporting the structural change in order to be able to prepare the business enterprise sector more quickly and extensively for current challenges within the context of increasing digitalisation and Industry 4.0 (i.e. date generation and use, robotics, *cloud computing*, artificial intelligence, digital infrastructures, etc.).

"Industry 4.0" is not a precisely defined technical concept. Instead, it is more of a variety of phenomena that link industrial production with modern information and communication technologies that are based on intelligent and networked systems. The significance of individual elements, such as industrial robots, artificial intelligence or fibre-optic technology, differs greatly from industry to industry. Indicators on the level of digitalisation in the business enterprise sector show that Austria is in the middle of the field in this regard as well.[290]

288 See OECD (2018a, 21).

289 See Austrian Federal Act on the Organisation of Universities and their Studies (Universities Act 2002 – UG).

290 For a detailed discussion of indicators on digitalisation and of Austria's position in an international comparison, see Section 1.3.2.

The OECD Review therefore recommends that three packages of measures be implemented. These involve:

1. Greater support for innovative firms that display growth potential, as well as support for enterprise creation, in order to expand the corporate research base and accelerate the structural change;
2. Focusing public research funding on new technological solutions, new combinations of technologies and the implementation of new scientific discoveries;
3. Expanding R&D capacities in key topics of Industry 4.0 and strategically important fields (artificial intelligence, data analytics), and accelerating the diffusion of Industry 4.0 technologies.

Main policy challenge 3: Establishing a world-class human resource base

Despite the significant increase in the number of graduates from the natural sciences and technology fields and the successful establishment and expansion of the university of applied sciences sector over the last few decades, clear and significant deficiencies are still apparent as regards the share of women among researchers and developers and the degree of permeability between tertiary education and vocational training. The same applies to doctoral education programmes, continuing education programmes and the opportunities available to earn further qualifications in the areas of innovation and entrepreneurship.

The OECD Review therefore recommends the following:

1. Continue tackling inequities and barriers to the advancement of female researchers;
2. Increase flexibility and modularity in tertiary and vocational education and training and further expand the university of applied sciences sector;
3. Expand structured PhD training and improve funding for doctorate students.

Main policy challenge 4: Increasing the contribution of science to innovation

Cooperation between industry and the scientific realm is well established in Austria and is also supported publicly in many ways through special funding programmes, relevant infrastructure and non-university research institutes. Nevertheless, the OECD Review sees the necessity of further improvement in terms of the strategic focus employed: *"A key challenge will be to develop new institutional arrangements that provide powerful incentives for path-breaking innovation that links application oriented basic research with industrial innovation across disciplinary boundaries."*[291]

The OECD Review recommends that the following measures be taken if this challenge is to be addressed successfully:

1. Establishment of a focus on globally leading innovation and radical innovation in fields of great strategic importance, with active involvement on the part of business enterprises;
2. Strengthening of the capability to utilise issues-driven programmes. Such programmes might support research and innovation in new markets, address societal challenges or support missions;
3. Further development of the existing network of non-university, technology-oriented research institutes (RTOs), achieved by expanding their capacity for outstanding research, improving the assessment of their performance through the use of a common core of comparable indicators, and developing strategic and performance-based governance and funding systems.

291 See OECD (2018a, 19).

Main policy challenge 5: Balanced mix of measures and strong polical governance

The approach used for funding corporate research in Austria has changed considerably in recent years and now focuses on the provision of tax incentives for R&D activities (the research tax premium). About three-quarters of additional public R&D funding to enterprises between 2006 and 2015 can be attributed to the research tax premium. The level of funding provided by the Austrian Research Promotion Agency (FFG) grew at a much slower rate during the same period. Another feature of the research funding system in Austria involves the dominance of thematically open programmes. For example, more than two-thirds of public research funding is allocated to thematically open formats (including funding targeted at higher education institutions and research institutes).

With all this in mind, the OECD Review makes the following recommendations:

1. Adaptation of the mix of instruments to future needs and opportunities:
   - More direct and competitive funding for outstanding research and ambitious innovations (Austrian Science Fund (FWF), Austrian Research Promotion Agency (FFG), other research funding organisations);
   - Concentration on corporate research that focuses on new technological solutions or makes use of new scientific discoveries;
   - Creation of a balanced mix of programmes and instruments that cover everything from low-threshold SMEs and young firms to complex R&D collaborative research programmes;
2. Establishment of methods for addressing societal challenges:
   - Development of capacities for addressing societal challenges and specific missions (through long-term cooperation between relevant stakeholders involved in both basic research and applied research);
   - Exploitation of compatibilities between Austrian and European priorities (by means of a comparison with the thematic areas of the Horizon Europe programme and the utilisation of the mission-focused approach);
3. Strengthening of RTI governance methods;
   - Orientation of the entire innovation system towards excellence that can be recognised internationally and innovations with a major impact; a new RTI Strategy 2020+ can play a major role here and offer a framework for such (re)orientation;
   - Strengthening of the operational autonomy of research promotion agencies (in particular the Austrian Research Promotion Agency (FFG) and the Austria Wirtschaftsservice (aws)) and simultaneous establishment of strategic steering capacities in the responsible ministries;
4. Creation of a strong Council for Science, Research and Innovation that would be anchored at the highest political level (e.g. in the Federal Chancellery) and which would either have an advisory function or manage the agenda for policy coordination and forward-looking decision-making;
5. Performance of portfolio evaluations;
   periodic evaluations of the portfolio of instruments should be conducted using a suitable mix of methods that also enable access to the underlying data.

3.7 Summary and outlook

Austria has caught up tremendously over the last few years in the areas of research, technology and innovation – and this is in large part due to the fact that RTI has increasingly become a focus of political interest. Such interest is also reflected in the RTI strategy adopted by the federal government in 2011. This strategy was and remains an unmistakable and clear symbol of the Austrian government's *commitment* to strengthening activities relating to research, technology and innovation in all relevant sectors.

Here, the RTI strategy serves as the foundation for all objectives and measures that require funding,

support, etc. In view of current developments, sub-strategies have also been formulated in order to support and promote certain selected topcs such as the establishment of new firms or *open innovation*. Looking back, it can be stated that the RTI strategy – i.e. the coordinated course of action of policymakers and all other stakeholders in the innovation system – has succeeded. Most of the objectives have been achieved and a large number of measures have been implemented. The only thing the strategy failed to achieve was the grand vision of the FTI Strategy 2020, namely to position Austria as an *Innovation Leader* (in the European *Innovation Scoreboard)*.

The RTI strategy has enabled Austria to develop in a progressive manner in the scientific realm as well as in the economic and public sector. The *RTI Task Force* – the inter-ministerial committee for coordinating the RTI strategy – also played a key role in pooling and consolidating resources. The task force was set up with the objective of improving coordination between those ministries responsible for RTI programmes and policies (Federal Ministry of Education, Science and Research (BMBWF), Federal Ministry for Digital and Economic Affairs (BMDW) and Federal Ministry for Transport, Innovation and Technology (BMVIT)), with the involvement of the Federal Chancellery (BKA) and the Federal Ministry of Finance (BMF) as well. More specifically, the *RTI Task Force* was responsible for defining, supporting and coordinating the implementation of the RTI strategy, as well as for the system-based, strategic coordination of activities at the individual ministerial departments. Its members are of the opinion that the task force performed its responsibilities exceedingly well. The fact that the *RTI Task Force* was organised at the highest level – i.e. within the Federal Chancellery, which assisted with the coordination process – is also viewed as an important factor that contributed to its success. For this reason, the *RTI Task Force* has now been commissioned by the federal government to draw up the new RTI Strategy 2030.

The most important task for the future will be to continue to pursue the efforts made to date and further develop the associated measures – all from a system-wide point of view – and also adapt all efforts and measures to changed or new circumstances. Along with the review of the RTI strategy presented above, input for this can be provided by the results of the OECD Review and the performance reviews issued by the Council for Research and Technology Development (RFTE), here with regard to the strengths and weaknesses of the Austrian innovation system as well.

In addition, it is crucial that the *policy mix* in Austria remains well coordinated in the future as well – between *bottom-up* and *top-down* and between direct and indirect research funding. As determined by the OECD and Council for Research and Technology Development (RFTE), output must be improved as well – more specifically the relation of input to output. Austria does in fact have the second-highest research intensity in Europe at the moment. However, the country remains in the middle of the field in terms of certain output indicators. In connection with the question of societal impact, discussions relating to output are taking on a new dimension once again, although this also means that debate on this issue in future must be more wide-ranging than has previously been the case. Quantitative indicators will always represent only one component of this debate.

Another important aspect of Austria's RTI policies involves the goal of continuously improving and/or adapting the *governance* system. The OECD has made several recommendations in this regard as well, and the federal government's advisory panel therefore also needs to be restructured in future. As was stated in the government programme, plans call for the merger of the Austrian Council for Research and Technology Development, the Austrian Science Board and the ERA Council Forum. The merger of these three bodies will create a new advisory panel in the federal government, one that is in line with international standards and also possesses a higher level of economic expertise. Plans also call for the *governance* methods utilised in the

Austrian research system to be restructured and optimised through provisions contained in the new *Research Funding Act*. In particular, the Research Funding Act will enable long-term financial support for central research and research funding agencies. In line with the recommendations made in the recent evaluation of the Austria Wirtschaftsservice (aws) and the Austrian Research Promotion Agency (FFG), the management of the federal funding agencies by the ministries is to become more strategic in nature, with the agencies being granted greater operational autonomy. Such an approach is necessary to ensure a rapid and effective response to new challenges and the ability to define key priorities.

These plans are also part of the *RTI action plan for the future*, which was developed jointly by the Federal Ministry of Education, Science and Research (BMBWF), the Federal Ministry for Transport, Innovation and Technology (BMVIT) and the Federal Ministry for Digital and Economic Affairs (BMDW) on the basis of the government programme as an ambitious package of measures for the future of research, technology and innovation in Austria. The RTI action plan for the future is designed primarily to increase efficiency, with the aim of establishing a highly dynamic, sustainable and suitably structured innovation system in Austria. The plan consists of the following components:

- A new *RTI Strategy 2030*, based on the principles of excellence, competition, impact and openness;
- An *excellence initiative* for strengthening and further developing the competitive component of basic research funding;
- Merger of the Austrian Council for Research and Technology Development, the Austrian Science Board and the ERA Council Forum to create a new federal government advisory panel with a higher level of economic expertise;
- Establishment of a standardised nationwide *research funding database* for Austria that will ensure comprehensive, transparent and understandable documentation of all research funding by the federal government and the states;[292]
- Creation of a *Pact for Research, Technology and Innovation (RTI Pact)*, to be based on the Research Funding Act and which in particular will define the terms associated with the funding and setting of strategic objectives for the three-year performance and financing agreements with the participating agencies and institutes.

The *new RTI Strategy 2030* will also play a crucial role over the long term. The strategy will be designed in a manner that will allow it to be used as a framework for policymakers and RTI stakeholders and also serve as a guide for structuring national funding programmes – all with the aim of advancing Austria into the group of *Innovation Leaders*.

292 It is important that trade secrets be protected here.

4. Digital transformation

Digital infrastructures, products and services are resulting in fundamental changes in our economy, science and research, society and politics. Technological change and processes of innovation are being substantially accelerated by digitalisation. Because of the profound significance of digitalisation for social and economic development, national and international policy makers are giving it their utmost attention at present. This applies both to support for the education sector and to the encouragement of the business enterprise sector and the expansion of the public infrastructure as regards increased use of digital technology and modern communications services; the latter receives comprehensive support by the Digital Roadmap Austria.

4.1 Implementation of the Digital Roadmap Austria: current position

As illustrated in Section 1.3, the European Commission continuously monitors the progressive diffusion of digital technology in business and society; the Digital Economy and Society Index (DESI) provides a quantitative comparison between the member states. In 2018 Austria's result was just average, as it was ranked 11th overall Position among the EU member states. Internet use was actually below average relative to other countries. Although there had been some slight improvements over the previous year, Austria did not manage to improve its position in the 2017 ranking of the EU Member States.[1] While Austria performs particularly well when it comes to digital public services, ranking among the top five EU countries, its use of internet services is less advanced. Similarly, in 2016 Austria had ranked as average, occupying only 10th place.[2]

It was Austria's mediocre starting position in this major policy area that gave the impetus for developing the Digital Roadmap. In December 2016 the *Digital Roadmap Austria*[3] laid the foundation for a joint digitalisation strategy for the Federal Government; it brought together, for the first time, the activities of all ministerial departments in a joint strategy paper published by the Federal Government as a whole. More than 100 experts from all ministries, regional governments and the Association of Towns and Municipalities, together with social partners and other organisations, contributed to the initial compilation of the Digital Roadmap. In the following online consultation process a large number of citizens participated. The resulting consultation paper formed the basis for the Digital Roadmap Austria. The Roadmap gives an overview of the current challenges and focuses on twelve guiding principles for the organisation and implementation of digitalisation in Austria. The Digital Roadmap identifies a total of twelve spheres of activity and approximately 150 measures. The Digital Roadmap is regarded as an important signpost to the digital future and thus forms the basis for the new digitalisation strategy currently being developed.

All spheres of business are directly or indirectly affected by the digital transition. Digital technologies enable new business models, products and services. One particularly relevant question for the industry is how existing production and business processes along the value chain can be linked into the information and communication technologies; Industry 4.0 is just one expression of this.

The government programme for 2017-2022 recognised the central significance of digitalisation. A separate coordinating ministerial department, the Federal Ministry for Digital and Economic Affairs (BMDW), was created. A Chief Digital Officer (CDO) was assigned to each ministry and made responsible for digital affairs. The inter-ministry CDO Task Force, led by the Federal Ministry for Digital and Economic

1 See European Commission (2019a).
2 See European Commission (2018d).
3 See www.digitalroadmap.gv.at

Affairs (BMDW), coordinates digitalisation activities. A Digitalisation Agency has been set up under the aegis of the Austrian Research Promotion Agency (FFG), to support the Federal Government's digitalisation initiatives.

Finally, in the course of a broad-based stakeholder survey, various concrete measures in the fields of infrastructure and applications were formulated as the basis for developing the strategy plan. Of the 34 measures to be adopted in the fields of infrastructure and applications, 24 have a practical benefit in simplifying and reducing the cost of expanding the digital infrastructure. Ten additional measures aim to unlock the technological capabilities and potential of 5G for businesses and the society through the support of the development of 5G services and applications in the very near future. The development of these applications will be encouraged by means of targeted funding programmes, co-innovations, testbeds and the Public Procurement Promoting Innovation (PPPI).

There is no doubt that the expansion of the digital infrastructure is making rapid progress in Austria. So far, the Federal Government's broadband initiative has brought fibre optic connections to 3,100 locations in more than 1,100 communities. The broadband initiative announced by the European Commission in November 2015 will be running in line with the tender cycle until the end of 2020. It is envisaged that the full implementation of all associated projects will take until the end of 2025.

Since 2015 a series of measures has been introduced in the public sector, involving the targeted promotion of consultancy services and qualification programmes. Such initiatives have included the establishment of an electronic one-stop shop for enterprise creation to simplify and shorten the foundation process, a user-friendly digital platform for the award of public sector mandates and the introduction of a programme for SMEs (called "KMU.digital"[4]) to encourage digital transformation. Meanwhile key sectors of the future in the field of digitalisation are being strengthened. Fields such as big data and data science, cloud computing, quantum technology and cybersecurity are targeted and supported with specific programmes.

To fully exploit the potential of digitalisation, there is extra emphasis on current efforts to improve the skills and qualifications of the society. Accordingly, digital skills and competences are developed and expanded by stepping up ICT specialist training and continuing professional development; in the tertiary sector this is to be achieved by expanding the STEM subjects in particular. On a broader scale encompassing all levels of the population, the Federal Government's fit4internet initiative is playing a prominent role[5]. As part of this, Austria has developed a digital competence module, *DigComp 2.2 AT*, based on the European Digital Competence Framework. The module classifies and compares digital competences. *DigComp 2.2 AT* groups digital competences under six headings (foundation and access, handling information and data, communication and collaboration, creation of digital content, security, problem solving and continuous learning). It subdivides these headings into 25 individual competences. In addition, the Federal Ministry for Digital and Economic Affairs (BMDW) has set up an interdisciplinary Austrian Task Force as an advisory body. The Task Force seeks to ensure the DigComp.at reference model as a widely accepted and coherent working basis for developing and improving the digital competences of all citizens. For this purpose the Task Force continuously updates the reference model, encourage networking between the relevant stakeholders and contribute to the quality assurance of projects and initiatives.[6]

4 See https://www.wko.at/Content.Node/kampagnen/KMU-digital/index.html
5 See https://www.fit4internet.at/
6 See BMDW (2018).

The Federal Government is also planning to monitor professional occupational profiles to keep jobs requiring vocational training up to date with the demands of the digital work environment and with current developments.

In total, the Austrian Federal Government has appreciably stepped up its efforts to improve conditions for the development of digital technologies. The creation of a ministerial department and a task force to head up digitalisation, as well as the setting up of a digitalisation agency have significantly boosted the momentum behind the measures envisaged in the Digital Roadmap.

4.2 Digital transformation, digitalisation and Industry 4.0 in Austria's business enterprises

The digital transformation of business, society and the administration plays a decisive role in the development of Austria as a business location. The following section gives a brief overview of the status quo of digital transformation in Austrian business enterprises, especially with regard to SMEs, and refers to the *Digital Innovation Hubs* (DIH) as an example of how businesses can be innovatively supported on the path to digitalisation. Equally, digitalisation of production (Industry 4.0) holds tremendous potential; what is important here is to recognise opportunities quickly and to use new technologies to strengthen innovative skills. This section will also highlight research fields that are central to the development of technology in Austria and that are regarded as significant drivers of Industry 4.0 and of digitalisation. In this context, also the process of developing an Austrian robotics and AI strategy will be discussed.

Digital transformation in Austrian business enterprises: the current position

The status of digitalisation in the Austrian economy can be demonstrated by the level of business engagement with specific technologies and processes central to the technological transition. The results of the Europe-wide survey on ICT usage in firms published in 2018[7] contain several key findings for Austria. First of all it turns out that Austrian business enterprises (with more than ten employees, excluding the financial sector) were less active in the usage of *big data* analyses than the EU-28 average. 6% of the Austrian firms carry out this type of analysis, as compared with 12% in the EU as a whole. This result is primarily attributable to the fact that Austrian SMEs range significantly below the EU average (6% in comparison with 12%). Concerning large Austrian enterprises, the gap is significantly smaller at 29% as compared with 33%. Nevertheless, the Austrian economic structure offers only a partial explanation, since the proportion of firms applying big data analyses is below the EU-28 figures in all economic sectors. An analysis of the extent to which business enterprises in Austria commit their own resources and employees to the analysis of big data helps to clarify matters: Only 4% of all Austrian firms do so, compared with an average of 8% in the EU-28. Again the same figures apply to SMEs; with a share of 25%, large enterprises range only slightly below the EU average of 29%.

In addition, the use of robotics in firms serves as an indicator of the extent to which digital technology has permeated the Austrian economy. Here it is important to distinguish between the "classic" industrial robots, which have been in use in semi-automated sectors of the economy for decades, and the "intelligent" robots that are vital to the fully automated processes of Industry 4.0. In its ICT survey, the only distinction made by the EU is between industrial ro-

7 See https://ec.europa.eu/eurostat/web/digital-economy-and-society/data/database

bots and so-called service robots. Focusing on the latter it is reasonable to assume that service robots that automate more complex tasks tend to depend on the use of artificial intelligence. This gives further insights into the status of digitalisation in Austria: In 2018 2% of all Austrian firms had deployed service robots, a figure that is consistent with the EU-28 average. However, concerning SMEs, the share is only 1%, half that of the EU as a whole. Focussing on large firms, Austria's figure of 10% is actually slightly above the European average of 9%. Unlike in the field of big data, there are economic sectors in Austria that rank above the European average (e.g. information and communication, metal production and processing, manufacture of metal products) or below (e.g. petroleum processing, manufacture of chemical and pharmaceutical products, rubber and plastic goods, glass and glassware, ceramics, manufacture of other non-metallic mineral products, transport and storage).

In 2017 and 2018, specific research was commissioned by the Austrian Economic Chambers to investigate the status-quo of the digital transformation in SMEs in Austria.[8] This study showed that firms in Austrian banking and insurance sectors had become digital pioneers and had overtaken even firms from the narrower ICT category. It is SMEs from the transport and traffic sectors and manufacturing that show the lowest scores on the Digitalisation Index. According to firms, digitalisation activities were intensified and extended to all business aspects (e.g. production, human resources, marketing), including revenues from digital channels. A significant majority of SMEs regard themselves as digital novices or as "digitally aware". (The proportion of those who describe themselves as "digitally oriented" or "digital champion" is consequently comparatively low and is close to 0% in some areas.) The key challenges facing SMEs primarily result from uncertainties with respect to data protection as well as a lack of expertise, but also from a lack of resources for digitalisation projects. Across all industries, roughly 40% of Austrian SMEs have not yet carried out any adaptation of their portfolios to the alterations in the market brought about by digitalisation.

A survey conducted by Ernst & Young and published in 2018 under the title Industry 4.0 in Austrian medium-sized businesses[9] gives similar insights into partial aspects of digitalisation. According to the survey, in 23% of the industrial enterprises questioned production is already networked using digital technology, either in whole or in part. In more than one third of the firms, at least parts of the production process are already digitally controlled. In contrast, one in four firms neither uses nor plans to use digital technology in its production processes. Also here a significant increase is expected. This should be promoted with the necessary investment; as expected, large enterprises participate in a much larger extent than small firms.

Digital Innovation Hubs (DIH)

In order to benefit from digitalisation, firms must learn to integrate digital technology into their everyday business activities. Among SMEs in particular there is need and interest in gathering information, trying things out and experimenting. Only then will they be able to make essential business decisions in favour of digital innovations which will introduce new business and working models. To do so they need access to new technologies and expertise, to build up adequate business knowledge throughout the firm and training for their employees.

In order to provide SMEs with relevant support in confronting these challenges, the Federal Ministry for Digital and Economic Affairs (BMDW) has launched the *Digital Innovation Hubs (DIH)*, a funding programme administered by the Austrian Re-

8 See Arthur D. Little (2017a); Arthur D. Little (2018).
9 See Ernst & Young (2018).

search Promotion Agency (FFG).[10] The aim is to support SMEs in the digitalisation process by creating a number of DIH in Austria from a network of existing facilities (known as Digital Centres). These centres will offer SMEs expertise and infrastructure to assist their transformation process.

The national DIH programme encompasses both new interventions and links to existing initiatives, including the European initiative, Digitizing European Industry (DEI):[11]

- mobilisation of Austrian SMEs to participate actively in the digital transition so as to leverage their potential for productivity, innovation and value creation and to increase their competitiveness through the use of digitalisation technologies;
- providing SMEs with institutional access to expertise and know-how in the field of digitalisation, together with the transfer of knowledge to firms by means of training initiatives;
- encouraging SMEs to introduce digital innovations via providing access to infrastructure, the exploration of new business models, joint R&D projects and to development of prototypes for digitalisation applications;
- Improved integration of Austrian key players in European networks and successful participation in relevant European initiatives.

A DIH consists of at least three organisations or firms with digitalisation as a research priority (e.g. traditional universities, universities of applied sciences, intermediaries, centres of excellence, research institutes, business enterprises), which will form a so-called Digital Centre. In view of the call's objective of regional coverage, consortia are invited to submit DIH hub projects with more than three Digital Centres.

The first call for proposals has an overall budget of three million euros to address the following objectives:

- Wide regional cover – A majority of Austrian SMEs should have a hub point (Digital Centre) as their primary contact in their immediate vicinity.
- The content of the bid proposal should match regional needs – A special invitation to tender addresses consortia whose bid proposal focuses on artificial intelligence (AI), security, blockchain or 3D printing.
- Preparation of the Austrian stakeholders for participation in the relevant European Innovation Hub initiatives.

Key research fields: the Technology Roadmap for Industry 4.0

R&D is an important driver in the fields of Industry 4.0 and digitalisation. For this reason over 70 representatives of politics, business, science and employees have been collaborating in the working group "Research, Development & Innovation" as part of the platform Industry 4.0 Austria[12]. The resulting Technology Roadmap identifies eight interlinked research fields that are pivotal for the future of technology development in Austria.

The working group was set up to prepare recommendations for the R&D sector and to bring together relevant stakeholders. It should provide information to politics and firms about potential directions of the development so that they can take appropriate measures timely. It is intended to increase awareness for the role of research, development and innovation, and to support research institutes and businesses so that they can work effectively under the best possible conditions. Given the far-reaching changes that are expected to result from Industry 4.0 and its impact on society, an interdisciplinary approach was taken to tackle the relevant subjects; this approach should address more than just the technical aspects.

10 See https://www.ffg.at/dih/1.Ausschreibung2018

11 See European Commission (2018a).

12 The association "Industry 4.0 Austria" was established in 2015 as an initiative by the Federal Ministry for Transport, Innovation and Technology (BMVIT), together with employer and employee organisations; see https://plattformindustrie40.at/uber-den-verein-2/ and Association Industry 4.0 Austria – The Platform for Smart Production (2018).

The Roadmap delineates areas that require intensified research efforts so that appropriate solutions for implementing Industry 4.0 can be offered. It is intended to serve as a guidance showing in which areas further development is useful and necessary to strengthen Austria's position in the global market. In practical terms it relates to the following research fields[13]:

- **Virtualisation:** Precise digital images, such as a digital twin or a digital factory, are a prerequisite for Industry 4.0 and are inconceivable without modelling and simulation. This means that production must be preceded by work with a model to forecast product features and production processes, and to control and track them.
- **Sensor systems:** Measurement systems provide important information for the production process and therefore take on increasing significance for quality control. In future sensors must become more intelligent (e.g. using self-diagnosis and predictive maintenance) and more energy-efficient.
- **Software engineering:** Software as a cross-sectional technology is one of the key technologies for the transformation process in Industry 4.0. The use of software enables the intelligent combination of algorithms, sensors (including the data they measure), physical objects and cyber-physical systems. So as to adjust to ever more rapidly changing production requirements, cross-sectional technology software must become more flexible in future.
- **Physical systems:** Cross-linking with information technology and sensor technology generates new opportunities and challenges for the physical representation of "smart" machine concepts. Smart machines and robots are pivotal for production; additive production (3D printing) makes production faster and safer. In Industry 4.0, new surface treatments to enhance functionality and new materials (ceramics, plastics, metals, composites) with improved properties are finding their way into the production process. In the future, the use of smart logistics will require the development of autonomous, cellular, self-driving transport systems.
- **Cyber-physical systems (CPS):** A key feature of CPS is that they are able to establish contact with different environments and thus also with sensor technologies. They also have the (cognitive) capability to communicate effectively with different types of end-user at different levels of qualification and competence, using human/machine interfaces. In the future, machines will be interacting and collaborating more frequently with humans. This will result in the creation of new intelligent production systems. A new theoretical basis for the research and development of large complex distributed systems is therefore required.
- **Work and assistance systems:** The widespread introduction of Industry 4.0 technologies raises the question as to the best possible organisation of the collaboration between humans and machines. Current developments are concentrating on improving the user interface between humans and machines with the aim of simplifying work in real time (e.g. through visualisation with the aid of augmented reality). This will affect the organisation of work and competences, which will require the building of awareness and acceptance. The very question as to the best use of any scope for action in the sphere of work organisation opens up a broad spectrum of as yet unanswered questions.
- **Value networks and business models:** Industry 4.0 changes value creation and business models – pure producers are increasingly evolving into service providers. Data-driven and data-based models are the key here. In order to exploit these opportunities there needs to be a new approach to many processes, which may involve creating and assessing value models and defining what data are needed.

13 See https://plattformindustrie40.at/ergebnispapier-forschung-entwicklung-innovation-in-der-industrie-4-0-praesentiert/

- **Domain knowledge and key technologies:** Domain knowledge denotes the knowledge already available in a given field of application. The successful embedding of Industry 4.0 technologies in the production process calls for a more detailed consideration of the necessary process and domain knowledge. Technological changes must therefore be organised so that the necessary knowledge is available; this should include any practical knowledge which staff have acquired from experience.

Artificial intelligence (AI) und Robotics

AI and robotics are areas of future thinking that are growing constantly in significance, and which will result in lasting changes to industry. This prompted the Federal Ministry for Transport, Innovation and Technology (BMVIT) to set up the Austrian Council on Robotics and Artificial Intelligence in 2017.[14] In November 2018 the Council presented a white paper entitled "Shaping Austria's Future Positively with Robotics and Artificial Intelligence", which sets out the current development status, opportunities, challenges and spheres of activity, together with recommendations for activities at federal level, with particular attention to all that needs to be taken into consideration when dealing with these technologies.[15]

Three cornerstones are considered relevant for Austrian robotics and AI strategy:[16]

1. *Smart Governance*: The broad involvement of all stakeholders, especially of citizens, in the strategy process is deemed necessary in order to increase acceptance of the new technologies.
2. *Smart Innovation*: Accurately targeted research, development and investment policies are needed in order to exploit the potential of robotics and AI technologies in all their fields of application, thus opening up new markets and applications.
3. *Smart Regulation*: Stable and secure conditions are required to gain the confidence of business stakeholders and for the positive development of markets. So the use of robotics and AI must guarantee people's security and maintain ethical standards which comply with fundamental rights and the European framework of values.

This translates into four spheres of activity considered to be priorities for the development of a smart strategy for robotics and AI:[17]

- technology, R&D and business
- the world of work and qualifications
- society and law
- awareness raising, communication and public relations

A recent transnational study by the Boston Consulting Group (BCG) and its subsidiary BCG GAMMA on the subject of AI in business recognises an undeniable need for action in Austria.[18] As Figure 4-1 shows, in Austria a mere 13% of all firms are currently making use of AI applications in practice, and 29% are only now beginning to develop them. The clear forerunner in an international comparison is China, where 85% of firms are engaging actively with AI and one in three businesses is already working towards using AI in production or services. In Europe the current leaders are Germany and France, where 49% of all firms are actively engaging with AI and 20% now use AI applications in practice.

A comparison between the industries shows that in Austria it is particularly the financial services and consumer goods/trade sectors that have some catching up to do. Things look better when it comes to firms with a focus on technology, media and tele-

14 See https://www.acrai.at/
15 See https://www.bmvit.gv.at/innovation/forschungspolitik/robotikrat.html
16 See Austrian Council on Robotics and Artificial Intelligence (2018).
17 ibid.
18 See BCG and BCG Gamma (2018). Note: The study questioned 2,700 managers from different industries in Germany, China, France, Japan, Austria, Switzerland and the USA about AI strategies in their firms.

communications, or indeed the energy industry. In these industries more than two-thirds of Austrian firms are already active in the field of AI.[19]

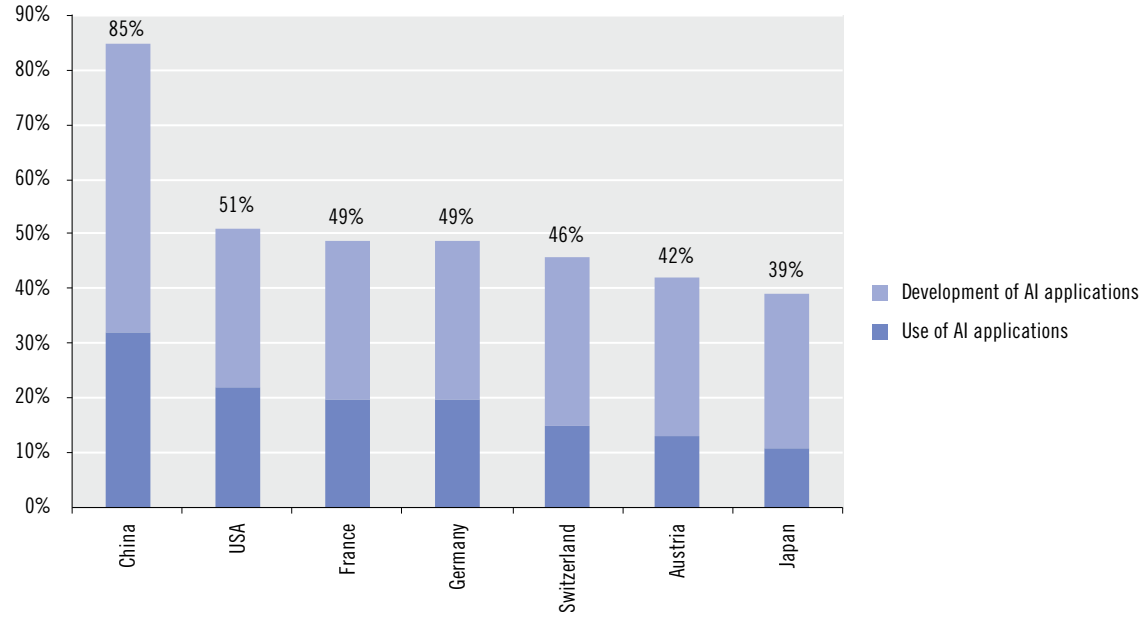
Research on AI has a long tradition in Austria. The traditional emphases include logical systems and knowledge-based approaches, neural networks, robotics and language understanding systems. New emphases have appeared in the field of production and Industry 4.0, e.g. predictive maintenance. The federal government provided support for this research from 2012 to 2017 of in total 349.9 million euros.[20]

In order to achieve a broad consensus when shaping the future of AI in Austria, civil society and as many business and research stakeholders as possible need to be involved in the strategy process, so that Austria is at the forefront of competition in AI technology and social and individual basic rights are preserved. With this in mind, the Federal Ministry for Transport, Innovation and Technology (BMVIT) and the Federal Ministry for Digital and Economic Affairs (BMDW) have drawn up a preparatory paper entitled *Artificial Intelligence Mission Austria 2030*, and will be using it as the basis for a draft strategy during 2019. Besides the *White Paper* from the Austrian Council on Robotics and Artificial Intelligence there are international studies and EU guidelines which can be used as bases. Cross-departmental working groups are being established to work out the strategy under the direction of the Federal Ministry for Transport, Innovation and Technology (BMVIT).[21]

5G as an infrastructural key to digital transformation

As a country with a high level of income, it is only by innovation and innovative technologies that Austria can maintain its competitive edge and further expand its industrial base. For this, though, a modern and efficient digital infrastructure is of major importance. Nationwide 5G coverage is also essential to

Fig. 4-1: Proportion of firms using artificial intelligence, by country, in %



Source: BCG and BCG Gamma (2018), Diagram IWI.

19 See BCG and BCG Gamma (2018).
20 See BMVIT and BMDW (2018).
21 See https://infothek.bmvit.gv.at/strategie-fuer-kuenstliche-intelligenz-auch-fuer-oesterreich/

the future economic development of the country, not least due to the large number of successful SMEs and their geographical distribution.

Provision of 5G will create the basic infrastructure for numerous downstream industries and services, particularly in rural areas. A study by Arthur D. Little calculated that, with Austria in the role of a 5G pioneer, the effects would include a GDP contribution of €32 billion by 2030, an addition of 35,000 to the workforce plus further indirect effects from an influx of specialist personnel, direct investment from outside Austria, R&D growth and the establishment of startups.[22]

With its national *5G strategy* the Austrian federal government has defined a specific programme of work for the central fields of activity, together with a schedule, to facilitate upgrading to 5G standard throughout the whole of Austria as rapidly as possible.[23] The aim is to make Austria a 5G pioneer in Europe and to take it into the top 3 digital countries within the EU and the top 10 digital nations worldwide. The proposed route by which to achieve this has three stages:

- Phase 1: The first pre-commercial 5G test positions are to be implemented by the middle of 2019.[24]
- Phase 2: It is intended that by the end of 2020 the interim goal of ultrafast broadband connection (100 Mbit/s) will have been achieved across virtually the entire country. This will lay the foundation for a nationwide rollout of 5G. Meanwhile there is to be a market launch of 5G in all Austrian provincial capitals.
- Phase 3: By the end of 2023 5G services are to be available on the main transport connections. The goal of virtually nationwide availability of 5G is to be realised by the end of 2025.

Industry 4.0, autonomous driving, nationwide use of big data and AI and Internet of Things applications all need an effective IT infrastructure which can only be rendered feasible by ubiquitous computing and the transmission of large amounts of data. In addition to the broadband infrastructure, this also requires an extremely effective mobile network. As a disruptive factor in digitalisation, 5G has the potential to speed up processes even further. Its full commercial potential, however, will only be able to unfold within the context of new and innovative business models. In tandem with the expansion of the 5G infrastructure, therefore, processes must be initiated which open up fields of application, bring stakeholders together and generate new ideas. This bundling of activities should lead to implementation projects and measures that foster the widespread use of 5G.

One stakeholder survey envisages that the greatest potential of 5G technologies for Austria as a business location will be for applications in the field of mobility and transport. Beyond that, it anticipates considerable potential with major commercial and social relevance in the fields of business and industry, environment and energy, health, care and social services, politics and administration, and education, with security, protection and trust as a cross-cutting theme. For the effective development of these various applications in the near future, the 5G Strategy focuses therefore on six steps to ensure that Austria can play a leading role in Europe:[25]

1. encouragement of active dialogue and networking by setting up a 5G platform;
2. international involvement through research and targeted commercial collaborations;
3. R&D in the field of 5G applications by means of 5G innovation and test laboratories;
4. implementation of 5G pilot projects in public administration;

22 See Arthur D. Little (2017b).

23 See Federal Ministry for Transport, Innovation and Technology (BMVIT) et al. (2018).

24 At the moment 5G test installations and pilot areas are being put in place. In 2018, for example, a 5G data connection with a drone flight was tested in Innsbruck and a 5G test operation was launched in Vienna at the Rathausplatz.

25 See Federal Ministry for Transport, Innovation and Technology (BMVIT) et al. (2018).

5. regional flagship projects for 5G applications;
6. establishment of 5G testbeds and sandboxes with experimental use at large events.

4.3 Skilled workers and an education system for the digital transition

Digitalisation as a foundation for social and economic transition is currently an ever-present topic, although changes resulting from the spread of microprocessors have been under discussion since at least the 1980s. Neither the electronic processing nor the remote transmission of ever-increasing quantities of data are new topics in their own right – the issue of work processes being taken over by machines is as old as industrialisation itself; it is not the technology that is revolutionising itself, but the way in which we handle it. Data are not only collected en masse, but also intelligently linked. This creates new demands on employees, in the sense that digitalisation requires increasingly higher levels of qualification.

The *Digital Roadmap Austria* highlights how the digital transition is influencing and changing the structure of work. It particularly emphasises the fact that, in most cases, new technologies will affect only certain tasks, rather than entire workplaces. Consequently, the demands on employees' qualification profiles are changing. This connection has long been described in academic literature via the following chain of effects.[26] The skill sets required by employees depend on the state of technology and change as a result of technological progress. Firstly, some skills are more in demand than others. In the labour market, wages for certain tasks depend on the extent to which these jobs can be carried out by employees on the basis of their skill sets. Secondly, regardless of the relative changes, technological progress tends to increase the demands on skill sets in general, i.e. it is necessary for more and more employees to have more and more skills.

Against this backdrop, the discussion also distinguishes between the *tasks* a job involves and the *skills* it requires.[27] The distinction between tasks and skills is primarily relevant when employees with a particular skill can take on more tasks. Current development is shaped by the fact that digitalisation poses challenges that demand very specific competences. This is not necessarily comparable with the previous trend towards a generally higher level of qualification. The increase in demand for skills in order to carry out multiple tasks is seen as the cause of growing polarisation in the labour market, with a rise in the number of both high-skilled, high-paid positions and low-skilled, low-paid positions.

While at the beginning of the 2000s, the fact that a part of the society did not have access to the internet was seen as a problem, a new *digital divide* is emerging in the new decade. This time the gap is between those who use the internet and ICT deliberately to obtain information and use that information systematically, and those who act as mere consumers.[28] The distinction can also be made among professionals, since those who use ICT deliberately to obtain information have skills that are increasingly in demand in the labour market. Digitalisation calls for specific cognitive and abstract abilities, which can lead to this type of polarisation. Up to now there is little evidence of such polarisation in Austria. One possible reason for this is that the Austrian education system, which distinguishes between vocational training and academic schooling in the middle years, is already extremely well adapted to the needs of the labour market.

The digitalisation of work demands that more and more employees are able to manage multiple tasks

26 The theses set out primarily trace back to Jan Tinbergen, who published influential articles on the subject in the 1970s. See Tinbergen (1974) and Tinbergen (1975).

27 This distinction can be traced back to works by David Autor and Lawrence Katz and is explained in detail by Daron Acemoglu and David Autor, among others, in *Handbook of Labor Economics* (Volume 4b).

28 See OECD (2009).

with their skill sets. It is not necessarily a high level of formal education that is required, rather employees should possess the skills needed to cope with future digital challenges. The DESI Human Capital sub-index shows that within the EU, Austria is in sixth and fifth place respectively in terms of ICT specialists as a percentage of employees and as a percentage of STEM graduates per 1,000 persons (20-29 year olds) (see also Section 1.3.2). The DESI report also points out the relevance of the objectives set out in the current government programme[29]:

- Promoting continuing professional development, particularly when it involves supporting digital learning.
- Equipping schools with suitable digital infrastructure.
- Keeping a digital record of success for students from kindergarten through to the end of their school education.
- Further developing the colleges for higher vocational education (BHS) and technical colleges (HTL), particularly in respect of STEM subjects and digitalisation.
- Creating more university places, in order to further develop digitalisation and STEM subjects at tertiary level.
- Introducing a Digitalisation Campaign for Training as an education and training strategy, with the aim of ensuring that:
  - digital competences are taught in all schools;
  - programming language (such as Scratch) is taught from primary school upwards;
  - teachers' digital skills are enhanced through mandatory training;
  - a comprehensive range of digital professional training is available.
- Introducing an Austrian digital academy, i.e. an online platform for training programmes and lifelong learning.

The Federal Ministry for Digital and Economic Affairs (BMDW) compiled a review of the status of digitalisation in Austria entitled *Digital Dossier 2018*[30]. The review also mentions the DESI, and introduces the Digital Competence Pact, an association of business, educational institutions and public administration with various sub-programmes.

Using the extensive Master Plan for Digitalisation in Education prepared by the Federal Ministry for Education, Science and Research; the aim is to incorporate the changes resulting from progressive digitalisation gradually and, above all, comprehensively into the Austrian education system.[31] The master plan stipulates three areas for action:

- Educational concepts and teaching and learning content – digital competences and digital education should be incorporated systematically into curricula as part of a fundamental revision of existing curricula. Within a modern education system, digitalisation should be taken into account in the methods and teaching of all subjects.
- Education, training and professional development of educators – digital competences and digital training should be anchored systematically in the education, training and continuing professional development of educators.
- Infrastructure – infrastructural equipment should be improved. Across the country, the necessary conditions should be created so that digital media and tools can be used in schools.

The Federal Ministry for Digital and Economic Affairs (BMDW) has also developed a digital competence framework for Austria, *DigComp 2.2 AT*, with the aim of alignment and comparability of digital skills, providing the basis for lifelong learning, social inclusion and employment in a digitalised society.[32] On the initiative of the Federal Ministry for Digital and Economic Affairs (BMDW), the association "fit4internet" was also founded in December 2018, as a platform –

29 See European Commission (2019b).
30 See https://www.bmdw.gv.at/DigitalisierungundEGovernment/Documents/DigitalDossier.pdf
31 See https://bmbwf.gv.at/presseunterlagen/masterplan-digitalisierung/
32 See BMDW (2018).

in cooperation with firms, institutions and organisations – with the aim of increasing digital skills in Austria, and ensuring that all areas of society are able to participate in the digital transformation.[33]

These measures are urgently needed to provide targeted support for digital transition in Austria, with education and training at all levels. The business community, especially the IT sector, is already highlighting the fact that the need for high-skilled IT specialists cannot be met, and there is continuing high demand for qualified human potential in computing.[34] Computing is seen as a key competence for firms, and not just studies in computing in the stricter sense. Interdisciplinary computing studies such as business computing, geo-information technology and health computing, which involve using information technology to solve specific business problems, are also relevant. As a result there is a demand, not so much for pure computer programmers, who are needed more in very specialist firms, but increasingly for those with an interdisciplinary education, who are able to develop specific computing solutions. To do so they must have appropriate knowledge of processes in the specific area of application.

With that in mind, a distinction is made between two types of computing competences, in addition to pure computer programming. The first is interdisciplinary development of IT solutions, which primarily involves computing technologists with process knowledge, such as business information technologists employed in the production sector. The second pertains to the increasing number of non-specialists who are being taught IT skills for use in their specialist areas, e.g. people working in health care who are using new methods and procedures, as opposed to people working in medical engineering, who develop and maintain those methods and procedures. Responding to this development, the Federal Ministry for Digital and Economic Affairs (BMDW) has recently issued new profiles for digital jobs requiring vocational training within the scope of professional training. These include "Application development – coding", "Information technology" (with two different study emphases – "System technology" and "Operating technology") and "eCommerce businessperson".[35]

At a tertiary level, there has already been a reaction to the changing environment of future requirements in the professional and working world. As part of the "Future of higher education" ("Zukunft Hochschule") project (implemented by the former Federal Ministry of Science, Research and Economy (BMWFW)), a computing working group concentrate in particular on identifying sector-specific educational profiles, developing new, and sometimes cooperative educational programmes, and developing proposals for teaching IT competences to all students, including specific proposals for "*job-outs*"[36]. It also focused on joint future activities in study information, as well as measures to promote interest in studying information technology, raise the proportion of women, and reinforce the dialogue between universities and the business community.[37] With regard to economic and business sciences and computing studies, the focus in the university segment is on developing personnel capacities and improving staff-student ratios, whereas in universities of applied sciences it is on expanding the number of study places and offering interdisciplinary degree programmes.[38] In addition, interest in studying computing should be increased in general, particularly among women.

As far as the range of study programmes is concerned, in the 2018 winter semester, 15 bachelor programmes and 27 master programmes in computing

33 See https://www.fit4internet.at/

34 See https://bmbwf.gv.at/fileadmin/user_upload/wissenschaft/Zukunft_Hochschulen/AF_3_Informatik.pdf

35 See https://www.bmdw.gv.at/Presse/Archiv/Archiv%202018/Seiten/Schramboeck-Lehre-wird-wieder-cool-Neue-Lehrberufe-stark-nachgefragt.aspx

36 "Job-outs" are students who have broken off their studies before completing them in order to take up a job offer.

37 See https://bmbwf.gv.at/fileadmin/user_upload/wissenschaft/Zukunft_Hochschulen/Management_Summary.pdf

38 See BMBWF (2017).

were offered by 10 public universities in Austria[39]. At universities of applied sciences, a total of 56 bachelor programmes and 68 master programmes was offered in the same academic year. Overall, in Austria 10 universities and 15 universities of applied sciences offer degrees in computing.

Table 4-1 shows the number of computing (degree) students at universities and universities of applied sciences for the 2013-2017 winter semesters. For universities it is evident that despite the demand, since 2015 there has been no upward trend. The numbers for bachelor and doctorate programmes have in fact decreased, although the number of master's students has admittedly increased. At universities of applied sciences, on the other hand, a different picture can be seen. The number of students studying computing increased in the period from 2013 to 2017. However this upwards trend applies only to bachelor programmes. Currently, no such positive trend is discernible for master's programmes. Overall, summarising the numbers of students at universities and universities of applied sciences, the number of students has increased both at bachelor level (from 12,890 in 2013 to 14,021 in 2017) and at master's level (from 5,133 in 2012/13 to 5,621 in 2016/17).

Various indicators point to the fact that graduates of universities and universities of applied sciences are in great demand.[40] Consequently, in future more computing study programmes should be offered at individual institutions, as well as a variety of information technology disciplines. In light of this, a number of measures are being put in place to extend and develop digital competences among the population even further in future. These include[41]:

- Teaching computing in all study disciplines to impart basic competences and IT skills, and provide relevant programmes.
- Offering innovative study formats that are designed to address specific target groups, such as working students and "job-outs". eLearning and remote study programmes are of particular interest here.
- Setting up new courses in areas such as big data, Industry 4.0, data engineering, data science, etc.

In order to anchor the momentum systemically, the current performance agreements with universities for the period 2019-2021 place an emphasis on digitalisation. Consequently, at the University of Innsbruck, for example, the range of optional courses in the field of digitalisation is due to be extended. At the Technical University of Graz, as well as further development of eLearning, the intention is to work on "learning analytics", where students' learning behaviour is evaluated by machine. The Vienna University of Technology has set up the specific position of Vice-Rector for Digitalisation and Infrastructure, and the Graz University of Technology is working to become a "digital university".

Various indicators suggest that Austria is experiencing more of a "*brain drain*" than a "*brain gain*". In other words it is losing, rather than gaining, high-skilled individuals.[42] As the OECD points out, it is difficult for labour migrants from outside the EU and the EFTA to gain entry, which ultimately reduces motivation for high-skilled individuals.[43] Another problem is that workers highly skilled in computing are generally not included on shortage occupation lists.[44] However, since 2019 there has been a second shortage occupation list in Austria, with eight (shortage)

39 This includes "Computing, general" (480) and "Computing" (481).
40 See https://bmbwf.gv.at/fileadmin/user_upload/wissenschaft/Zukunft_Hochschulen/AF_3_Informatik.pdf
41 See https://bmbwf.gv.at/fileadmin/user_upload/wissenschaft/Zukunft_Hochschulen/AF_3_Informatik.pdf
42 See Wisbauer and Fuchs (2014).
43 See OECD (2014).
44 In fact, despite there being evidence of a clear shortage, computing technologists and other IT occupations do not appear on the 2019 shortage occupation list.

Table 4-1: Regular students studying computing, Winter Semesters 2013–2017

		2013	2014	2015	2016	2017
Universities	Bachelor programme	9,770	10,065	10,701	10,597	10,481
	Degree programme	301	259	12	12	7
	Master programme	3,648	3,778	3,858	4,026	4,263
	Doctorate	1,220	1,234	1,181	1,129	1,070
	Total	14,939	15,336	15,752	15,764	15,821
Universities of applied sciences	Bachelor programme	3,120	3,076	3,211	3,400	3,540
	Degree programme	10	9	3	0	0
	Master programme	1,485	1,571	1,536	1,462	1,358
	Total	4,615	4,656	4,750	4,862	4,898

Note: Because of the changeover to the Bologna system hardly any diploma degree study programmes are now being offered.
Source: Federal Ministry of Education, Science and Research (BMBWF), uni:data

occupations requiring a university degree, including graduate data processing engineer. This means that workers with these qualifications can be admitted more easily as "especially high-skilled workers" and obtain a Red-White-Red card (Austrian work and residency permit valid for two years).

4.4 Digitalisation in the public sector

Digitalisation means two things for the public sector: on the one hand the transfer of analogue information, processes and services to digital formats, and on the other hand the introduction of completely new forms of interaction and access to new forms of knowledge through the use of digital technology. In view of this broad understanding of the digital transformation as a radical process of change, the public sector in Austria has been working for many years at improving services and at integrating information and joint strategies. After all, it is not until properly coordinated organisational, logistical, legal and technical procedures are established at an administrative level that society can benefit from the transformative potential of digitalisation. The focus of public sector digitalisation initiatives in Austria is currently the provision of innovative digital services, such as the Digital Office, e-Health and Open Data. Background initiatives are increasingly concentrated on interoperability and the integration of infrastructures.

4.4.1 The digitalisation strategy, Digital Austria and Chief Digital Officers

At a national level, Austria had already drawn up a digitalisation strategy, entitled the Digital Roadmap, in December 2016[45]. It gives an overview of present and future challenges surrounding digitalisation and forms the basis for the new digitalisation strategy, which is currently (May 2019) in the process of being formulated. Digital development was enshrined as a cross-cutting theme in the 2017–2022 government programme[46]. The Federal Ministries Act Amendment of 2017 (BMG amendment), Austrian Federal Law Gazette No. 164/2017[47], which came into force on 8 January 2018 made some changes to the responsibilities of the various federal ministries. In the area of digitalisation particularly, some matters which had hitherto been the responsibility of the Federal Chancellery (BKA) (such as data protection issues), or of the Federal Ministry of Finance, were combined and transferred to the Federal Ministry for Digital and Economic Affairs (BMDW).

45 See https://www.digitalroadmap.gv.at/
46 See BKA (2017).
47 See https://www.ris.bka.gv.at/eli/bgbl/I/2017/164

A *Chief Digital Officer (CDO)* was appointed in each ministerial department to coordinate the areas of innovation and digitalisation between the ministries in line with an overall federal innovation and digitalisation strategy. A concerted approach means that cross-departmental objectives, such as continuing automation of processes or the provision of improved digital services, can be coordinated and implemented more efficiently. The CDOs also send regular progress reports to the federal government. The CDO Task Force is directed by the Federal Ministry for Digital and Economic Affairs (BMDW), with the Federal Chief Digital Officer heading up a section called Digitalisation and e-Government. Essentially e-governance covers *"support for the relationships, processes and political participation within government agencies at all levels and between the government agencies and all their stakeholders through the provision of appropriate opportunities for interaction using electronic media"*[48].

The coordination of digitalisation initiatives across the entire federal government (timetable, emphases, pilot projects, etc.) is being developed in consultation with the CDO Task Force and the newly established digitalisation agency. This structural reorientation includes the consolidation of key regulations for digital administration. The e-Government Act as amended in 2016[49] and the ICT Consolidation Act[50], which together form central components of digital administration and govern the funding of joint projects, are now within the competence of the digitalisation agency. Furthermore, it has been stipulated that questions of strategy encountered by the Federal Computing Centres (BRZ GmbH) are to be resolved by mutual agreement with the Federal Ministry for Digital and Economic Affairs (BMDW).

Digitalisation agency

One key element of the structural reorientation is the digitalisation agency, Digital Austria (DIA)[51], established under the aegis of the Austrian Research Promotion Agency as a department in its own right. Digital Austria has been created as an umbrella brand bringing together all the relevant strategies and flagship projects. Essentially, it enables the administration to focus not only on the expansion of broadband and 5G coverage, but above all on user-friendly, digital applications for citizens and the business community.

Digitalisation is regarded as a task which requires collaboration between the key providers of impetus and funding for research, development and business enterprise. The agency has duties with regard to the digital state. These include advising the federal government, supporting the CDOs, ongoing implementation of the digitalisation strategy and international coordination. The main focus of responsible digital development must always be people and their needs. Alongside its role as the central port of call and coordination platform, the new digitalisation agency (DIA) will be responsible for monitoring all digitalisation initiatives.

It is anticipated that this structural reorientation of digital agendas will enable the promotion of the public sector at an international level into the league of the world's leading digital nations. At present the 2018 European Commission e-Government Benchmark places Austria sixth out of 34 countries examined.[52] Austria's e-Government solutions such as FinanzOnline or Justiz 3.0 are cited as *Best Practices* for the whole of Europe. The European Commission *Digital Economy and Society Index (DESI)* shows Austria as eighth in terms of its digital public services.[53] Up to now, Austria has been among the top 5

48 See Gisler et al. (2011).
49 See https://www.digitales.oesterreich.gv.at/e-government-gesetz
50 See https://www.parlament.gv.at/PAKT/VHG/XXVI/I/I_00381/index.shtml
51 See https://www.digitalaustria.gv.at/
52 See https://ec.europa.eu/digital-single-market/en/news/egovernment-benchmark-2018-digital-efforts-european-countries-are-visibly-paying
53 See https://ec.europa.eu/digital-single-market/desi

when compared with the rest of the EU, but only for Online Government Services (pre-populated forms and online services), whereas for other areas it is only average (for a detailed discussion of the *Digital Economy and Society Index* see also Section 1.3.2).

The Digital Office makes a cross-departmental approach integrating all the relevant stakeholders, whether at federal, state or municipality level, a reality. This broad approach ensures that the necessary regulations are introduced so that Austrian digital public administration can meet the new demands.

4.4.2 The Digital Office

The Federal Ministry for Digital and Economic Affairs (BMDW) is drawing up the legal parameters for ongoing digitalisation of the administration in its project for reform at federal, state and municipal level, launched on 31 January 2019 and entitled "Digital Office".[54] This project is giving Austria a reliable framework for developing, testing and implementing cross-departmental electronic procedures. According to the 2018 e-Government Monitor, 74% of Austrians are already using e-Government services.[55] What is more, the satisfaction level with what is being provided is 72%, higher than in Germany or Switzerland, although in recent years there has been a downward trend. Users tend to compare public sector services with those of the private sector and social media in terms of user-friendliness. This calls for the improvement and simplification of the administrative provision. So the aim of the Digital Office is to make access to government authorities as comprehensively digital as possible for both private individuals and firms. The intention is to gear the overall design towards citizens' day-to-day lives, with the structure and organisation of the administration taking place behind the scenes.

The oesterreich.gv.at platform and app

The new, central online platform https://www.oesterreich.gv.at/ will bring together all digital services provided by government authorities. Existing platforms, such as the administrative portal, HELP.gv.at, and the Legal Information System, RIS.gv.at, are being integrated into oesterreich.gv.at. This gives direct access to the business services portal, usp.gv.at and to numerous other e-Government applications (electronic enterprise establishment, social security, etc.), as well as business-related information. Applicants' data items already available to the administration do not need to be requested several times over, but are exchanged directly between administrative bodies (data once only). Besides easier access methods (single sign-on) and improved user-friendliness, there is a special focus on compatibility with different mobile devices. E-Government is being extended to Mobile Government.

The upgrade to the platforms and the mobile app will take place in several stages up to the end of 2019. From the middle of March 2019, registrations and re-registrations can be dealt with electronically, as can the official procedures following the birth of a child, the passport service, access to a pension account or a tax statement, or an application for the commuter tax allowance or a voting card. Access to criminal record extracts and the system for reporting lost documents will be added in July. From December onwards there will be digital access to driving licences, vehicle registration certificates, identity cards and e-Cards.

Electronic delivery

E-Delivery is a secure central postbox for electronic documents. Once someone is registered with an electronic delivery service a mobile signature can be used to receive correspondence from government authorities (criminal record extracts, residence registra-

54 See https://www.bmdw.gv.at/DigitalisierungundEGovernment/DigitalisierungInDerVerwaltung/Seiten/Das-digitale-Amt.aspx
55 See https://www.egovernment-monitor.de/die-studie/2018.html

tion certificates, etc) and firms (purchase contracts, policies, etc) securely via a free electronic mailbox.

SourcePIN Register Authority

The SourcePIN Register Authority is responsible for allocating sourcePIN numbers and sector-specific personal identifiers, managing the Supplementary Register, issuing sourcePIN numbers using another EU member state's electronic means of identification, establishing and publishing a mathematical method for generating the sourcePIN numbers and sector-specific personal identifiers and entering powers of authorisation on representatives' Citizen's Cards.[56]

Establishing a new enterprise electronically (eGründung)

The ease of establishing a new venture electronically via the business services portal (USP) is an Austrian success story. In 2018 there were already 750 sole proprietorships that had completed the electronic founding of their firm, and almost 1,000 had made partial use of the service.[57] In the same year, the establishment of a One-Person GmbH, in which the shareholder is simultaneously the manager of the firm, was implemented electronically by 504 entrepreneurs. This equates to a penetration rate of practically one third of the potential population.

Electronic proof of identity

Since 2017 Austrian citizens and firms have the right to communicate with government authorities electronically. Ever since, the e-ID (on a chip card or by mobile phone) has been fully valid as electronic proof of identity. In May 2018 the millionth registration of an electronic signature marked a milestone and today around 200 applications can be managed with it, in both the public and private sectors.[58]

4.4.3 Digitalisation in the administration

The CDOs will work together to continue developing areas for a future-focused digital administration – such as the question of a unified data strategy in the federal government. A unified strategy will mean that the federal government will be able to store its citizens' data securely, use their data in accordance with the "once-only" principle and have high-quality data available for Big Data Evaluations, Predictive Analytics and Artificial Intelligence applications.

The consolidation of federal IT is a further important cornerstone of digital administration and a programmatic objective that has already resulted in initial projects. The central issue is the extent to which it makes sense to bundle further operational services under the Federal Computing Centre (BRZ). The primary aim of the BRZ project, in which the Federal Chancellery (BKA), the Federal Ministry for Digital and Economic Affairs (BMDW) and the Federal Ministry of Finance (BMF) are collaborating, is the identification of individual ministries' potential, their IT procedures and costs. Capacities, resources and conditions also need to be made available so that the BRZ is in a position to fulfil its new remit in the best possible way.

A further aim is to increase the range of federal Shared Services and to future-proof these services. Key services here are the federal human resources services. For many areas, such as the electronic human resources file, human resources business processes and training management, individual ministerial departments have different solutions. Centralisation of these solutions will be an important but relatively simple process of consolidation.

Another central project is the renovation and progressive standardisation of the electronic file (ELAK). Centralised management and modernisation of the

56 Under the terms of the Federal Ministries Act Amendment of 2017 (BMG amendment), Austrian Federal Law Gazette No. 164/2017, the duty of managing the SourcePIN Register Authority falls within the scope of the Federal Ministry for Digital and Economic Affairs (BMDW), along with other "matters relevant to e-Government". This change of responsibility was embodied in the e-Government Act in accordance with the amendment published in the Austrian Federal Law Gazette I No. 104/2018.

57 See https://www.usp.gv.at/

58 See https://www.ots.at/presseaussendung/OTS_20180508_OTS0021/schramboeck-elektronische-unterschrift-schreibt-erfolgsgeschichte

administrative code will go hand in hand with technological renovation and the introduction of innovative solutions (key terms: AI and robotics) so as to reduce administrative costs.

Smaller projects leading to standardisation are the development of a federal *Content Management System (CMS)* for home pages and intranet websites and the introduction of a uniform email address for all the ministries' central offices – the first step towards a uniform email system for the federal government.

The BRZ *Innovation Lab* operates at the interface between the public sector and innovative start-ups. In February 2019, for instance, the BRZ hosted the *European Youth Award Social Hackathon*, supporting talented young IT enthusiasts by providing a secure sandbox environment in which rigorous tests were carried out under simulated real-life conditions.[59]

One of the categories for the Austrian Administration Prize 2019, awarded by the Federal Ministry for the Civil Service and Sport (BMÖDS), was Innovative Service Design and Digital Services, and the Federal Ministry for Transport, Innovation and Technology (BMVIT) and the Federal Ministry for Digital and Economic Affairs (BMDW) jointly awarded a special prize for "Public procurement promoting innovation".[60]

4.4.4 Digital developments in public procurement

Public procurement awards are a significant business factor in Austria. The value of public contracts awarded annually by over 7,000 clients stands at €60 billion (2015 figure).[61] This equates to approximately 18% of the gross domestic product. The newly enacted Austrian Public Procurement Act 2018 stipulates that all public sector calls for proposal must be processed electronically.[62] Up to now, businesses have only been able to find these tenders by making use of various publishing platforms, some of which required payment of a fee for use. Now, however, the Business Services Portal, USP, has developed a new tender search tool so that in future all calls for tender published in Austria will be available to potential participants free of charge and without restriction.[63] For Austria's many small and medium-sized businesses in particular, this significant improvement in transparency has made it simpler, faster and less complicated to take part in a call for proposal appropriate to them, and to save time and money as well. This service has made it possible, from 1 March 2019 onwards, to search for and view all calls for porposal published under the terms of the Austrian Public Procurement Act in one place without going through a separate registration process. The service has numerous features, including a full text search and various filter and sort options. Public tender data records are also published on the *Open Data Portal*.

4.4.5 Open Data

The Austrian public sector is in possession of large volumes of data – from educational, economic and social data through to cultural heritage, geographic and weather data. Some of this data is already accessible to the public without restriction. The reuse of this kind of information can be of crucial significance for the development of new technology such as AI applications, which call for the processing of large volumes of high-quality data.

In https://www.data.gv.at/ Austria has for some years had a central "Austria catalogue", which incor-

59 See https://www.brz.gv.at/wie-wir-arbeiten/veranstaltungen/social-hackathon-european-youth-award-eya.html

60 See https://www.oeffentlicherdienst.gv.at/verwaltungsinnovation/wettbewerbe/oesterreichischer_verwaltungspreis/index.html

61 See Bröthaler and Plank (2017).

62 See https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20010295

63 In relation to this, see this example of an approach to public procurement that promotes innovation: https://www.ffg.at/sites/default/files/images/Beschaffung/leitkonzept_ioeb-1.pdf
and: https://www.usp.gv.at/Portal.Node/usp/public/content/news/ueber_das_usp/407001.html

porates the metadata from the decentralised data catalogue of the Austrian administration and makes it available for downloading. The data records made available at data.gv.at include both *Open Government Data (OGD)* and information in accordance with the Public Sector Information Directive on the Reuse of Public Sector Information (IWG).[64] This open and structured access is intended to foster the further development of the knowledge-based society; this data could be used to produce software solutions (such as apps) which will serve the general public, or to create informative and economic value added by linking different data items.

Since the launch of data.gv.at in 2012, the Federal Computing Centre (BRZ) has been responsible for running the platform and for its continuing technical development on behalf of the Cooperation OGD Austria[65]. This process mainly uses open source components. In 2014 data.gv.at was selected as winner of the category Improving the Delivery of Public Services and awarded the *UN Public Service Award*. Every day it has an average of 1,200 website visitors who have access to over 20,700 data records and 450 applications. The next expansion stage will be reached in spring 2019, when the platform will be expanded by the addition of public sector tender data records. The aim is to increase transparency in public sector procurement processes significantly.

4.4.6 Digitalisation of research data held in archives, collections, museums and historical libraries

Academic institutions, archives and cultural heritage organisations generate analogue research data, although more recently there has been a trend towards digitalisation. In recent years numerous digitalisation initiatives have been prompted, encouraged and financed, so that this data may be more widely used. National and international research infrastructures and umbrella organisations for research data management have played a key role in this. Accordingly, the *European Strategy Forum on Research Infrastructures (ESFRI)*[66] has developed a long-term process to establish European research infrastructures. These take the form of *European Research Infrastructure Consortia (ERICs)* which apply to the European Commission to become permanent institutions. In 2019 Austria is currently participating in a total of 13 ESFRI infrastructures (see also Section 3.3.5).

In addition, the Vienna Wiesenthal Institute for Holocaust Studies is involved in the Horizon 2020 project *European Holocaust Research Infrastructure* EHRI.[67] EHRI provides access to fragmented, sometimes widely scattered holocaust resources (often difficult to access) particularly from archives.

In general the research infrastructures facilitate international cooperation and represent an important basis for empirical, often interdisciplinary, research in the spheres of natural sciences, engineering sciences, the life sciences, social sciences and humanities, as well as the arts and *Design Studies*.

Digital humanities and digital cultural heritage

Austria has a rich cultural heritage, and in recent years digitalisation has helped it to gain international recognition in this sphere. For instance, the Austrian Academy of Sciences (ÖAW) holds a comprehensive set of recordings of local dialects – many of which are no longer in existence – as part of its Phonogram Archive and UNESCO has declared this to be a World Document Heritage collection.[68] Together with many other research institutes in the

64 See https://www.digitales.oesterreich.gv.at/public-sector-information-richtlinie

65 On 13 July 2011 the Federal Chancellery (BKA) and the cities of Vienna, Linz, Salzburg and Graz joined forces to found the Cooperation Open Government Data Austria (Cooperation OGD Austria). https://www.data.gv.at/infos/cooperation-ogd-oesterreich/

66 See http://ec.europa.eu/research/infrastructures/index_en.cfm?pg=esfri

67 See https://www.ehri-project.eu/ and https://www.vwi.ac.at

68 See https://www.oeaw.ac.at/phonogrammarchiv/unesco/

sphere of digital humanities, the Phonogram Archive is an integral part of the digital-humanities.at[69] network. One of the divisions of the Austrian Academy of Sciences (ÖAW), the *Austrian Center for Digital Humanities* (ACDH), also coordinates the Austrian CLARIAH Consortium involvement in the European research infrastructures CLARIN and DARIAH. Another aspect of the ACDH covers the digital editions and digital archiving platforms ARCHE[70] and GAMS[71].

In March 2019, in a highly competitive process, an Austrian project was chosen for the first time by the European Commission as a contender for the FET research flagship in the category of Social Sciences and Humanities: *Time Machine*[72]. The consortium is headed up in Austria by ICARUS[73] and also involves the Austrian National Library, the Vienna University of Technology, and the Lower Austria State Archive together with numerous international universities, business enterprises, archives, libraries and research institutes. ICARUS is a non-profit-making association headquartered in Vienna; it comprises more than 160 archival and related institutions from more than 30 European countries, Canada and the USA. In the context of the *Time Machine* new forms of digitalisation and artificial intelligence are being developed and tested in order to enhance Europe's outstanding cultural heritage and to make information accessible to all, free of charge. First, however, complex historical datasets, widely scattered until now, need to be brought together. Their content extends from mediaeval manuscripts to historic objects and includes smartphone and satellite photos. The aim is to compile an extensive digital infrastructure reflecting the whole social, cultural and geographical evolution of Europe. Given the sheer quantity and complexity of the data, the artificial intelligence technologies developed for the *Time Machine* have the potential to give Europe an enormous competitive advantage in the global race to develop this type of technology.[74]

New possibilities for synergies between cultural heritage and business can also be illustrated with reference to the *Europeana* project, which has been running since 2008. Austria is actively involved in Europeana, since digitalisation of our cultural heritage means access for research, free ongoing use for the general public and opportunities for commercial use by tourism and the creative industries. In 2018 Europeana provided access to over 51 million items from the collections of more than 3,700 libraries, archives, museums, galleries and audio-visual collections across Europe through its main portal, Europeana Collections (https://www.europeana.eu/), and through the platform's application programming interfaces. These interfaces allow the reuse of data and provide services for contributing cultural institutions, research, education and the creative industries, as well as interested private citizens.[75] It is intended that Europeana will be further expanded as a cultural and digital innovation project in the future. Specific sources of Austrian content include the collections of the Austrian National Library, the Museum of Art History, the Museum of Folk Life and Folk Art, the Theatre Museum, the Austrian Media Library under the auspices

69 See http://www.digital-humanities.at/. Other members of the network are: the University of Innsbruck, the Vienna University of Technology, the Austrian National Library, the University of Vienna, the Graz University of Technology, the University of Graz, the OFAI (Austrian Institute for Artificial Intelligence) and the University of the Applied Arts.

70 See https://www.oeaw.ac.at/acdh/tools/arche/

71 See http://gams.uni-graz.at/ The acronym GAMS stands for *Geisteswissenschaftliches (Humanities) Asset Management System*. It is a system which manages almost all types of digital resources (from text to video) and allows researchers to save, manage and publish digital resources, along with their metadata, in a quotable web-based format.

72 See http://timemachine.eu/

73 See https://icar-us.eu/

74 See https://icar-us.eu/en/pressebereich/pressetexte/

75 See https://publications.europa.eu/en/publication-detail/-/publication/58538a59-b4aa-11e8-99ee-01aa75ed71a1/language-en

of the Technical Museum, the Austrian Film Archive, the Association for Historical Sound Media, the Austrian Broadcasting Corporation (ORF) and many more. It is all available from Europeana.[76]

However, in Austria public access to our digital cultural heritage is not yet as firmly guaranteed as it should be. In a study that appeared in 2017[77], 193 Austrian organisations indicated that they were digitalising their collections, although only 50 of them have made their object databases accessible to the public. The average digitalisation level of Austrian museums is 43%. This level has risen slightly in comparison with the 2014 museum statistics, with social media being used increasingly. A number of museums (10%), especially cultural, historical and archaeological museums, offer their content in the form of an app.

Digitalisation strategies vary according to the type of organisation and its data: archive records, museum collections, museum objects and historical books call for different approaches and differ widely in their suitability as research data. They also require different methods of storage and computer processing. The question as to the long-term storage and curation of our digital cultural heritage is therefore being asked afresh time and again.

4.4.7 Summary

The public sector in Austria already leads the way in some areas of digitalisation. Overall, however, it is around average in comparison with the rest of Europe. Austria's efforts to achieve digitalisation, thereby giving access to public data such as our cultural heritage, remain inadequate as yet. Flagship projects such as *Europeana* or the *Time Machine*, which sit at the interface between the humanities and social sciences and society or business can act as role models in this regard. Robust and scalable infrastructures are key to any digitalisation initiatives in the public sector and to digital services within the newly created *e-governance* structures.

The concept of e-Government stands for a modern and efficient administration. In order to become one of the leading digital nations it will be necessary, over the next few years, to pursue our current path, improving and expanding services for private citizens and firms, together with e-democracy and public participation in particular. Besides extending and upgrading *Open Government Data* and thus reinforcing transparency in politics and administration – each of which is a fundamental prerequisite for participation – we can now work towards strengthening private citizens' integration in political decision-making processes, and the provision of new communication channels such as electronic consultation and petition processes.

76 See https://www.kunstkultur.bka.gv.at/europeana-und-die-digitalisierung-des-kulturellen-erbes

77 Source: Statistics Austria, impact analysis/SMEs; note: 296 units (= 372 museums) answered the question about their digitalisation level. See http://www.museen-in-oesterreich.at/_docs/_statistiken/de/Museumsbund_Oesterreich_Zur_Lage_der_oesterreichischen_Museen.pdf

5. The culture and practice of RTI evaluation

Evaluations are an indispensable part of an intelligent, strategically oriented RTI policy, providing opportunities to reflect, assess and further develop measures, instruments and practices in RTI policy. The Austrian Research and Technology Report 2017[1] provided a comprehensive assessment of the state of evaluative practices in Austrian RTI that was confirmed by the current OECD review of Austria's RTI policy.[2] In summary, it can be stated that the last 15 years have seen a significant increase in RTI evaluation activities. There has also been a professionalisation of RTI evaluation practices, accompanied by the development of competences and capacities. All in all, the evaluation culture in the RTI field has developed and become more aware of its responsibilities. One indication of this shared responsibility is the further development of the Austrian Platform for Research and Technology Policy Evaluation (fteval), whose members include ministries, agencies, research institutes and consulting firms. The platform offers discussion forums, develops publications, and leads training sessions and workshops. In 2017, the platform established a publicly accessible repository of RTI policy studies and evaluations.

5.1 Current trends

In order to make it easier to access data for research, the Platform for Registry Data Research was founded in Austria in 2018 (Section 5.1.1). Another structural development was the creation of new standards for evaluating research, technology and innovation policy. Section 5.1.2 provides a report on this aspect. Section 5.1.3 presents a summary of the Austrian Presidency of the Council of the European Union, "Impact of R&I Policy at the Crossroads of Policy Design, Implementation and Evaluation." As usual, Section 5.2 reports on important RTI evaluations that were conducted or completed in 2018.

5.1.1 The Austrian Platform for Registry Data Research

The OECD review explicitly refers to a structural weakness of the Austrian evaluation system caused by the limited availability, accessibility and interconnectivity of statistical data at public offices such as ministries, funding institutions and Statistics Austria. The current practice limits, among other things, access to firm-specific raw and micro-data, and restricts options for comparing individual data sources. This causes methodological limitations related to robust control group sets, which makes statements about the impacts of RTI policy interventions significantly more difficult.

It was in this context that the Platform for Registry Data Research was established in Austria in 2018, which focuses on offering scholarly researchers access to data from public registers and on working to shape the necessary legal, organisational and ethical framework conditions for this to happen.[3] The legal framework for researching with registers is defined in the Research Organisation Act (FOG) in the amended version of 2018.[4] The law does not yet actually approve of any registers; instead, it creates the framework for access to public-sector registry data to facilitate answering research questions. This is, however, associated with a series of challenges: the amendment of the Federal Statistics Act; the opening of registry data for scientific purposes, which must be regulated in detail; and a directive from each of the responsible ministries is required for each individual database. There continues to be a lack of appropriate tools, such as a secure online service that would enable remote access to anonymised business firm data.

1 See Federal Ministry of Education, Science and Research (BMBWF) et al. (2017).
2 See OECD (2018a).
3 See https://www.registerforschung.at/mission
4 See https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=10009514

5.1.2 New evaluation standards in research, technology and innovation policy

The standards of the Platform for Research and Technology Policy Evaluation (fteval) were first published in 2003, and they represent essential key points and process milestones for the evaluation of RTI policy and serve their members as a binding set of guidelines ("Code of Conduct"). They offer commissioning institutions, evaluators and those affected by evaluations a framework for behaviour and instructions on how to plan, manage, implement and use "good" evaluations. These standards contribute to an improved evaluation culture, which is both a prerequisite and a consequence of relevant, effective, efficient and transparent policy.

In 2017, six years after the last update of the standards for research and technology policy evaluation by fteval, it was decided to revise the standards to take into account new developments in the field of RTI policy evaluation. These include:

- Changed circumstances, such as the introduction of impact-oriented budgeting[5] (performance and gender budgeting[6]) as well as the regulatory anchoring of evaluations in the field of RTI[7];
- The transformation, completed in Austrian RTI practice, from a pioneering, experimental evaluation culture to a mature culture with a high number of evaluations[8];
- An increasing tendency towards ex-post impact assessments and ex-ante design evaluations that are gradually supplementing the process evaluations that dominated the 2000s;
- An expansion of evaluation targets away from the evaluation of individual programmes toward larger portfolio evaluations (e.g., evaluation of all international programmes at the Austrian Science Fund (FWF)) and other RTI policy interventions such as institutions (e.g., evaluation of the Austria Wirtschaftsservice (aws) and the Austrian Research Promotion Agency (FFG)), instruments (such as the research tax premium) and regulations (e.g., public procurement promoting innovation);
- Higher requirements for ethical standards in terms of transparency, independence, impartiality, credibility, participation, protection of personal data, and research integrity.

One expression of these changes was that fteval's mission statement was modified in the course of the joint creation of new evaluation standards. While the mission statement formerly appealed to the necessity of founding an evaluation culture and the performance of more evaluations that are improved and more transparent in the narrow R&D sector, the new mission statement acknowledges the self-evident fact that evaluation is an important component of a developed and inclusive RTI policy:

"The mission of the Austrian Platform for Research and Technology Policy Evaluation is to achieve quality, transparency and an adequate degree of evaluation coverage for better strategic planning in RTI policy in Austria. Therefore, together with policy-makers from the field of research, technology, and innovation the existing evaluation culture is constantly further developed."[9]

fteval invited external support and expertise for the revision of the standards, which, in the course of a two-stage process, first developed the basic principles of the new standards. An fteval supervision group then reflected upon and modified these principles, including commenting and editing in an online group discussion procedure. The two-stage process lasted about six months. Then came a final quality assurance round, and the standards were accepted

5 See Federal Ministry of Finance (BMF) (2011).
6 See Steger (2012).
7 For example the revised RTI guidelines from 2015 or the institutional standards of the Austrian Science Fund (FWF): https://www.fwf.ac.at/de/forschungsfoerderung/entscheidung-evaluation/evaluationsstandards/evaluation-im-fwf/die-evaluierung-des-fwf/
8 See Tsipouri and Sidiropolous (2013).
9 See https://www.fteval.at/content/home/plattform/about/

and adopted by the general assembly of fteval in autumn 2018. The new fteval standards adopted the evaluation definition from the revision of the DeGEval standards, which were finalised in 2016[10].The definition summarises an evaluation as *"The systematic investigation of the benefits and/or merit of the evaluation object on the basis of empirically obtained data. [This - added by the author] implies an assessment based on clearly stated criteria for a specific purpose.."* [11]

In addition to taking into account the aforementioned developments, the new standards were also meant to provide more acting instructions in order to make evaluation processes less susceptible to faults. One particular priority focused on aspects of the professional formulation of *Terms of References (ToRs),* clear conceptual and terminological foundations (including a glossary), improved division of labour between monitoring and external evaluation, and the formulation of principles that offer, as a sort of abridged version of standards, orientation for action throughout the development, performance and use of evaluations.

For the first time, the fteval standards also explained and expounded upon the particular importance of evaluation in research, technology and innovation policy. In addition to aspects of market, system and political failure, also the needs of a goal-oriented, transformative shift in innovation systems in order to legitimate RTI policy actions in the context of major global and societal challenges were considered.[12]

New features pertain, among other things, to an increasingly horizontal emphasis on gender dimensions in RTI policy evaluation processes, the obligatory publishing of RTI policy evaluation reports in the publicly accessible fteval repository[13] after acceptance by the client, suggesting the introduction of a management response system, as well as numerous ethical and procedural tips on implementing an evaluation process that is as efficient, transparent and effective as possible.

The new fteval standards are available free of charge, in German and English, for *download*[14] at the fteval homepage.

5.1.3 The Austrian Presidency of the Council of the European Union, "Impact of R&I Policy at the Crossroads of Policy Design, Implementation and Evaluation"

A closer look at impact evaluation in RTI policy

Most impact evaluations of RTI policy interventions focus either on scientific-technical impacts or economic effects. Suitable indicators, data foundations and methods were created and consistently further developed for this purpose over recent decades. Transparency and the appraisal of societal or civic impacts of RTI policy interventions, however, have only recently received attention. This was caused by RTI policy's engagement with major social challenges (called the new, mission-oriented RTI policy)[15], which focuses on using suitable research, technology and innovation policy measures to make a contribution to the solution of these challenges. The mission approach by the European Commission for "Horizon Europe," the Ninth European Framework Programme for Research and Innovation, proposed within the second pillar of the next framework programme, explicitly specifies verifiable target attainment for the specific R&D missions that remain to be determined. Dealing with global challenges postulated for these missions and for Horizon Europe, as for Horizon

10 fteval is an institutional member of DeGEval.
11 See https://www.degeval.org/glossar-der-standards-fuer-evaluation/
12 See Boon and Edler (2018); Forray et al. (2012); Kuhlmann and Rip (2014); Mazzucato (2011); Weber and Rohracher (2012).
13 See https://repository.fteval.at/
14 See https://www.fteval.at/content/home/plattform/standards/
15 See Gassler et al. (2006).

2020, assigns extreme relevance to societal dimension effects, because these are explicitly related to the objectives set by society (for example, the sustainable development goals set out in the United Nations SDGs[16]).

In order to facilitate better tracking and measurement of the impact dimensions of Horizon Europe, an expert report[17] was submitted immediately after the publication of the proposal of the European Commission for Horizon Europe in July 2018. This report distinguishes between the following three impact dimensions: (1) scientific impacts, (2) societal impacts and (3) economic impacts. In the previous year, an ERAC ad hoc working group had submitted a report that also argued for the consideration of different impact dimensions[18], yet focused on the measurement of effects of European framework programmes at the national level.

An international conference was commissioned and held in Vienna

Anticipating events at the European level, there was a proposal in 2017 to conduct an event under the Austrian Presidency of the EU Council to measure mission-oriented RTI interventions, sponsored by the Federal Ministry for Transport, Innovation and Technology (BMVIT) and with support from the Federal Ministry of Education, Science and Research (BMBWF) and the Federal Ministry for Digital and Economic Affairs (BMDW). The Austrian Platform for Research and Technology Policy Evaluation (fteval) was commissioned to organise the event in November 2018 together with the *Manchester Institute of Innovation Research* and the *Institut Francilien Recherche, Innovation et Société* from Paris. The starting point for planning the event's content was two-fold: firstly, both European and national RTI policy had to be called upon now more than ever to make societal contributions and to document corresponding effects; and secondly, the new impact agenda had to have an effect on the entire policy cycle, meaning policy formulation and policy making, implementation and evaluation. The conference received registration requests from 296 experts from 39 countries; 255 of them actually attended the conference.

Thematic background

Both the Presidency event and the European Commission expert report chose the concept of impact pathways for further discussion of the measurement of the three different impact dimensions in order to emphasise the design and process character of creating and developing impact. The impact pathways for measuring societal effects are particularly challenging, as they are confronted with fundamental problems of definition. While "social impact" is understood in the EU context as an umbrella term (for example, in the case of the "*Better Regulation Toolbox*" from the European Commission), which implies impacts on society, politics, the environment, the economy and other dimensions, "societal effect" is understood as a more specific concept. The approaches and models used in the scientific literature for assessing societal effects of RTI policy measures also refer to a variety of topics, including effects on politics, but they lack clear focus.[19] Existing assessments of the societal impact of RTI policy interventions have therefore often been merely of a contextual and specific, and qualitative and anecdotal nature.

In addition to the theoretical problems of definitions, there are grave deficits with regard to the set of indicators for evaluating societal impacts, as well as a lack of systematically collected, quality-assured

16 See https://sustainabledevelopment.un.org/?menu=1300
17 See Van den Besselaar et al. (2018).
18 See ERAC (2017).
19 See Brewer (2011) and (2013); Flecha (2018); Raua et al. (2018); Reale et al. (2017).

data. Moreover, there is often a false equivalence proposed between societal impact and diffusion or transfer that focuses primarily on what are called alternative metrics ("altmetrics"). Among the special challenges facing the development of appropriate indicators for measuring societal impacts are the following:

1. it takes more time to achieve actual effects in society than it does to attain specific results;
2. it is more difficult to classify social changes than scientific references or economic attributes;
3. the availability and comparability of data for tracking effects in society and politics are very limited.

According to the literature review from the expert report by the European Commission[20], specific and frequently used indicators for measuring societal impact are almost non-existent, or if they do exist, then they are often given as proposals without any systematic application.[21] It is therefore not surprising that most agencies and evaluation projects do not incorporate the societal impacts of RTI in their work. In a few cases, societal impact is included in ex-ante evaluations as a criterion to be included, yet without being able to give any specific indicators for its measurement.

The orientation of the conference

The Austrian Council Presidency Conference, *"Impact of R&I Policy at the Crossroads of Policy Design, Implementation and Evaluation"*, was therefore dedicated to the question of how impacts along the three aforementioned impact dimensions can be better designed, conceived and measured by a supportive RTI policy. The conference structured the topic of impact evaluation into four blocks:

1. The nature of impact-oriented RTI policy;
2. Design, implementation and support measures for impact-oriented RTI policy;
3. New concepts, tools and methods for assessing societal impact of RTI policy measures; and
4. Effects of impact evaluations on policy learning.

These thematic blocks were addressed in five *keynote* presentations, four panel discussions, seven specific expert sessions in which 40 *ex-ante* selected articles were presented, three workshops, one case study regarding impact measurement at the French National Institute for Agricultural Research, and a poster session in which eleven posters were presented.

Findings

The feedback regarding the conference was entirely positive. 93 per cent of participants reported that the organisation was very good or good; 97 per cent would recommend the conference to others.

Overall, the conference achieved the following immediate results:

- The understanding about impact evaluations in the RTI sector was broadly consolidated.
- Current experiments on the promotion of impact-oriented policies and measures were put up for discussion.
- Methodological experiences regarding improved assessment of societal impacts of a mission-oriented RTI policy were exchanged in a comprehensive manner.
- Indicators to measure the progress towards the most important impact pathways or the actual attainment of effects over the short, medium and long term were introduced and analysed.
- Intensified use of more comprehensive impact evaluation approaches in RTI policy was encouraged.
- The necessity of using clear indicators and the creation of better data foundations was discussed.
- Participants were made aware of the use and ef-

20 See Van den Besselaar et al. (2018).
21 See Barré (2010); Reale et al. (2017).

fects of big data approaches and artificial intelligence for text mining, automated data collection, and automated data analysis.
- The necessity for clear expectation management was recognised.
- Several participants acknowledged that, when it comes to impact measurement, both research organisations and agencies should establish procedural arrangements to support and document societal impacts.

5.2 Selected evaluations

Evaluations of funding programmes, initiatives and instruments are assuming a role of central importance in Austrian RTI policy and in the community as well. The standard is that evaluations be performed by independent experts with several years of experience in evaluations and relevant, specific skills and knowledge. The following provides a glimpse of the latest evaluations by briefly summarising the findings of the most recent evaluations.

5.2.1 Beyond Europe

The "Beyond Europe" programme from the Federal Ministry for Digital and Economic Affairs (BMDW), which is being implemented by the Austrian Research Promotion Agency (FFG), supports research and innovation cooperation between Austrian firms and partners outside of Europe. The "Beyond Europe" programme is based on the recommendations of the Working Group 7a to the Austrian Federal Government's RTI Task Force, stipulated in the strategy paper "Beyond Europe – The Internationalisation of Austria in Research, Technology and Innovation, beyond Europe"[22], which was developed in the context of RTI strategy implementation in July 2013. The programme is open both in terms of topics and geography, although references are made to the target countries and priority lists in the recommendations found in the "Beyond Europe" strategy. This specific orientation (open-topic, close to industry and business-driven research cooperation with regions outside of Europe) makes the "Beyond Europe" programme unique within the Austrian funding landscape.

Up to now, there have been three calls in the years 2015, 2017 and 2018/19[23], in which the two instruments of "exploratory studies" and "R&D cooperation – experimental development" were offered.

Main results of the evaluation

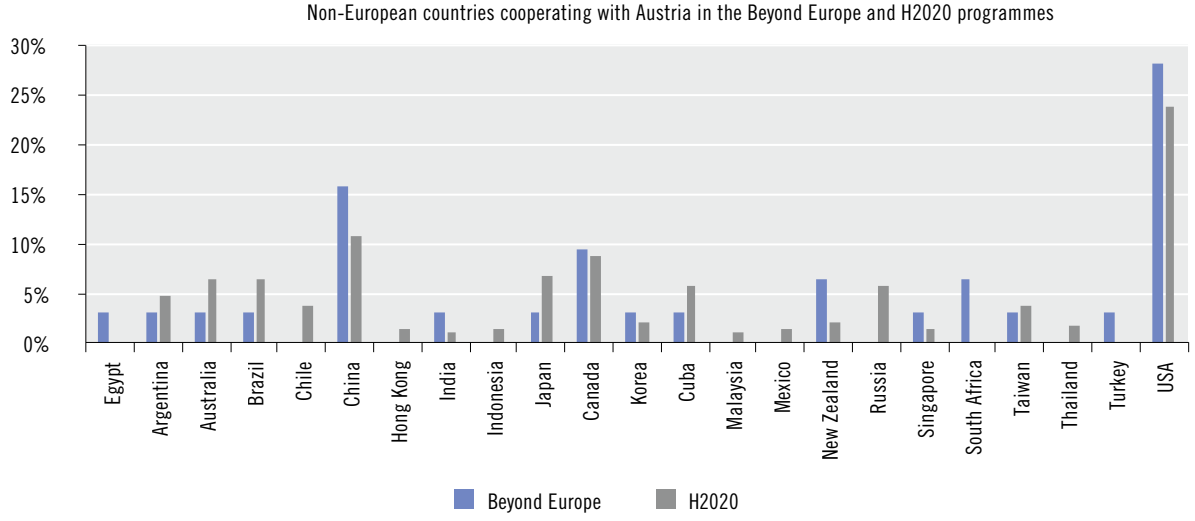
In July 2018, the Centre for Social Innovation (ZSI) was assigned the task of performing an interim evaluation [24] after the second call. Various content and work steps, as well as a mixture of qualitative and quantitative methods, were used to answer the evaluation questions.

In conclusion, the evaluation steps and methods (programme statistics, survey of participants, focus group, interviews, and comparison with programmes in other European countries) carried out thus far show a coherent programme that reaches its target audience and is well on its way to achieving its stated goals. Fig. 5-1 depicts the countries outside of Europe with which Austria cooperates in the "Beyond Europe" programme in comparison with cooperative efforts in Horizon 2020 (presented as a percentage of all collaborative projects).

Overall, a series of particularly positive findings must be emphasised:
- the success rates, just like the mixture of small and large, experienced and new applicants, are adequate.
- The calls, which are open in terms of geographical location, primarily address the priority countries in the recommendations for the "Beyond Europe" strategy (Russia and Israel are exceptions).

22 See Federal Ministry for Transport, Innovation and Technology (BMVIT) et al. (2013).
23 The third call was open until 13 March 2019.
24 See Sturn et al. (2018).

Fig. 5-1: Cooperating countries in the Beyond Europe programme



Source: Austrian Research Promotion Agency (FFG) programme statistics, FFG EU PM Portal (data as of 29 Sept. 2018).

- In most cases the initiative for the application came from the Austrian side, and mostly from a firm.
- Participants reported high satisfaction with regard to the particular expertise of partners outside of Europe (the excellence objective), the opportunity to enter new markets (the market objective), and the quality of cooperation in general. There were a few positive mentions of the access to special infrastructures and the chance to address societal challenges.
- The projects are very market-oriented, and there are already results in most cases.
- Collaboration with employees at the Austrian Research Promotion Agency (FFG) is highly valued.
- Additionality is very high and an overwhelming majority of those surveyed (both those who did and did not receive funding) would submit again.

The following points, however, were viewed critically:

- objectives, measures, expected outcomes and impacts, as well as assumptions about causal relationships and interdependencies, are not represented consistently in the various documents (programme document, the homepage of the Austrian Research Promotion Agency (FFG), various communication formats).
- The likelihood that small firms will succeed is low, although not lower than in comparable projects at the Austrian Research Promotion Agency (FFG), as is the participation by women.
- There was also criticism of the amount of work necessary to prepare applications, bureaucracy, procedures and management (this applies to the German language in the funding contract, long delays, complicated procedures, a lack of feedback on applications, etc.). This applies above all for small firms and exploratory studies.

The Austrian Research Promotion Agency (FFG) has already implemented improvements on the feedback. During the preparations for the third call, requirements were also simplified for partners outside of Europe (for exploratory studies, letters of intent now suffice). These are important conveniences for consortia that submit applications. Furthermore, consideration could also be given to whether English-language funding contracts are possible, or at least a standard template to reduce the translation efforts required for every single project. In any case, "Beyond Europe" should be prevented from becoming unattractive to small firms due to administrative barriers. Otherwise the programme would run the danger of losing its distinguishing feature of being

a low-threshold alternative to European programmes.

Overall, the evaluation of the programme's central characteristics suggests only a few items requiring urgent changes; instead, evidence was found for the following overall evaluation of the "Beyond Europe" programme:

- all sides value the open-topic format, and a majority view the geographically open opportunities for cooperation as positive in the face of increasingly scarce alternatives.
- Targeted calls in selected countries or regions could present an additional offer, with a corresponding expansion of the programme budget. Funding through "matching funds" could also be intensified in the context of bilateral cooperative agreements.
- The admission of research institutes as project leads, as well as the facilitation of other kinds of RTI cooperation beyond experimental development, would be welcomed by a majority of programme participants, yet does not rank among the top change requests. It should also be noted that modifications in this regard to the programme design may water down the consistent focus on market-oriented, business-driven cooperation.
- An expansion of the instruments currently on offer (for example, industry-oriented theses) could present another attractive way to submit, but could also increase the programme's complexity at the same time. The same applies to suggestions regarding a two-stage process.
- Programme communication should strive for closer cooperation with the Austrian Economic Chambers (WKO) and the Federation of Austrian Industries (IV) following the role model of international examples (Business France, Team Sweden, Innovation Norway), and such close communication should also take place with both OSTA offices (Office of Science and Technology Austria) in the USA and China.
- EUREKA could also be used more often as a flexible financing tool for supplemental multilateral cooperation (also through the "Global Stars Initiative"). International examples show that other countries are proceeding in a very deliberate way here and bringing existing bilateral cooperative agreements into EUREKA. More intensive collaboration between "Beyond Europe" and EUREKA should go hand in hand with more vigorous interdepartmental coordination within the Austrian Research Promotion Agency (FFG).

The programme is too small to make great leaps. With the programme's current budget, no changes should be undertaken that would further increase the degree of complexity or change the programme's focus. The objective should be to increase planning security by means of regular calls and to reduce the effort required for submission (above all for exploratory studies). Or, as one of our interview partners put it: *"Keep it going. Continuity is important. "Beyond Europe" should become established as a permanent element in the funding landscape."*

This path has been embarked upon in the third call: the budget remained the same as for previous calls so the rules remained unchanged, yet there were important simplifications for exploratory studies.

5.2.2 Global Incubator Network (GIN)

The Global Incubator Network (GIN) is an initiative funded by the National Foundation for Research, Technology and Development, and jointly implemented by the Austria Wirtschaftsservice (aws) and the Austrian Research Promotion Agency (FFG). It was started in 2015 in order to support the positioning of Austria as an internationally attractive location for founding start-ups. GIN includes both measures with financial support for start-ups (goAustria, goAsia) as well as events and networking activities, and is therefore oriented towards start-ups from Austria who want to internationalise their business activities, as well as start-ups from other countries (especially from target markets in Asia) who want to locate and establish themselves in Austria. It is also aimed at investors such as venture capital providers

and incubators. GIN offers investors for example the internationalisation of existing investments, access to new investment opportunities, and linking up private and public co-investors. In 2018, GIN concentrated on the selected target countries Israel, South Korea, Japan, Hong Kong, and Singapore.

Main results of the evaluation

In the spring of 2018, the "Global Incubator Network" programme was subject to an interim evaluation[25] by Convelop Cooperative Knowledge Design GmbH, with a focus on analysing the target system and the intervention logic, the GIN measures, and their contribution to the target system, as well as an assessment of effects and impacts. The evaluation was based on the analysis of documents and data, as well as interviews.

The programme's intervention logic assumes that most start-up firms have neither the requisite experience, contacts, access, nor the required financial funds or opportunities to acquire them, in order to carry out internationalisation activities (especially with distant markets) under their own power. Austria does not have a strong private equity market for this. Finally, Austria is still barely visible as a start-up hub in the eyes of start-ups and investors. Upon closer inspection, GIN's system of objectives is very diverse, with objectives ranging from linking up the stakeholders, increasing Austria's visibility as an innovation/start-up hotspot, internationalisation of start-ups, to strengthening the entrepreneurial ecosystem and supporting knowledge and technology transfer. The variety of objectives strikes a balance with a clear orientation towards sustainable impacts; the initiative could profit from simplifying and hierarchically organising the current target system.

Because GIN had only been active for 2.5 years at the time of its evaluation (including its development and start-up period), the evaluation assessed whether the first targeted effects were pointing in the desired direction, whether strategy and process could be expected to produce such effects, how GIN stakeholders view opportunities, and how the initiative is distinguishing itself in international comparison. The evaluation shows that, without GIN, internationalisation in the sense of increased participation in and the utilisation of venture capital, as well as "intellectual capital", from the target countries would not take place. Successes up to this point have raised GIN's visibility and generated initial long-term effects:

- 90 funded firms (62 goAustria and 28 goAsia);
- More visibility due to multiplication (+149%) of deal flows across the first five calls;
- Successful investment by an international venture capital firm on the context of a co-investment pitch, as well as further ongoing negotiations about such investments;
- Business collaborations between goAustria and goAsia start-ups and an Austrian corporation;
- A goAsia start-up is working on its Hong Kong branch office.

In addition to goAustria, goAsia and GIN co-investment pitches, supplemental measures (such as GIN Corporate Day, GIN Ambassador Concept, Corporation Innovation, GIN Conference) have been developed gradually, existing GIN networks have been expanded and GIN network partners linked to one another in order to intensify the exchange of knowledge and information and to generate "sure-fire success effects" (for example, with VC investments or cooperation between start-ups and large firms).

The initiative's weak points, as seen by GIN stakeholders, are that target firms are not mature enough and that the support and supervision phase doesn't last long enough. In the interest of its further development, GIN should therefore intensify its relationships with incubators and accelerators and initiate joint *follow-on* measures with them to lengthen and strengthen the support and supervision phase for start-ups. This stronger collaboration with incubators and accelerators, and a renewed

25 See Handler et al. (2019).

focus on investors, was taken on in early 2019. Furthermore, the evaluation suggests that GIN's system of objectives be revised, the roles for its stakeholders better conceived, and the data situation and documentation of GIN measures improved, in order to make monitoring and follow-on evaluations easier. These steps are seen as necessary because the expansion of the GIN programme is set out explicitly in the government's programme.

5.2.3 Frontrunner Initiative

The Frontrunner Initiative was developed on the basis of the Austrian federal government's RTI strategy 2011 with the overarching goal of establishing Austria as an "Innovation Leader." This addresses a very special group of firms, namely "frontrunner firms" or those that have shown potential to develop into leading businesses. "Frontrunner firms" are internationally active, particularly export-intensive firms that operate in a highly competitive market environment and influence the competition as leaders in technology and/or innovation. Against this backdrop, the Frontrunner Initiative offers two independent tracks, one of which is administered by the Austrian Research Promotion Agency (FFG) and the other by the Austria Wirtschaftsservice (aws).

The Austrian Research Promotion Agency (FFG) supports comprehensive R&D projects (up to €3 million for a period of at least 24 and at most 36 months) that enable firms to attain (or secure) a frontrunner position and whose role is clearly anchored in a relevant business strategy. The funding takes place in the form of a non-repayable grant in the amount of up to 25% for large enterprises, 35% for mid-sized firms, and 45% for small enterprises.

The Frontrunner track of the Austria Wirtschaftsservice (aws) provides funding through a subsidy (up to €0.5 million) in addition to a low-interest aws erp loan. The programme supports investments in prototypes, demonstration facilities, and the development and expansion of production capacities for the implementation of product and process innovations.

Main results of the evaluation

The objective of the evaluation performed under the leadership of Technopolis with the participation of the Centre for Social Innovation (ZSI) and the Centre for European Economic Research (ZEW) in Mannheim during 2018–2019[26] was to trace the programme's development (it started in the second half of 2013) up to 2017. The evaluation was tasked with an assessment of the relevance of the original goals in the current environment, in addition to an impact analysis of the projects supported by the programme. It should be noted that funded projects are of a longer duration (up to three years) and that many projects approved in 2016 and later are therefore still ongoing. A summative impact analysis that would include above all further impacts on the affected firms (as well as their environment, for example their suppliers, cooperation partners, etc.) was therefore not possible at this time.

Table 5-1 presents the key information on the Frontrunner Initiative. Overall, leading up to and including 2017, 95 projects with a total present value of €93.3 million were funded by the Austrian Research Promotion Agency (FFG) and 60 projects with a present value of €24.3 million by the Austria Wirtschaftsservice (aws). About €20 million were disbursed each year.

The empirical basis for the evaluation came from the analysis of monitoring data, a comprehensive online survey among the firms that received funding (whereby the project leaders were surveyed), and an econometric control group analysis. These quantitative methods were supplemented by qualitative approaches in the form of "case vignettes" that took a closer look at five very different funding cases.

The findings show first and foremost that the target group of the existing frontrunner firms was reached particularly well. In the beginning, the target

26 See Warta et al. (2019).

group of firms striving to attain frontrunner status was not yet well represented. Only in recent years have such firms become more prominent in the programme. Overall we have seen that the funded projects have a high strategic value for these firms, and that the amount of funding and the longer duration enables them to take greater technological risks in these projects. The projects are often used to broaden (in the sense of diversifying) their frontrunner position.

The econometric control group approach analyses the extent to which the impact of funding among Austrian firms can be estimated in comparison to a control group. The control group was comprised of German firms with a similar frontrunner position, and the data basis was provided by the Mannheim Innovation Panel (MIP) of the Centre for European Economic Research (ZEW). It showed that funding has a high impact on revenue and staffing (including on R&D employment) in comparison to the firms in the control group.

Overall it appears that the objectives of the Frontrunner Initiative have gained further relevance, and that in addition to the two original aims we can add a third highly relevant objective, namely the establishment of new frontrunner positions with frontrunner firms. Such an expansion at the target level would increase the emphasis upon a central aim of the RTI strategy, namely the ongoing modernisation of Austria's economic structure.

5.2.4 Implementation of H2020, EUREKA, COSME, EEN and ERA in Austria

The European and International Programmes (EIPs) at the Austrian Research Promotion Agency (FFG) were commissioned by the federal government (represented by multiple ministries) and the Austrian Economic Chambers (WKO) for the period from 2014 to 2020 to provide information, consultancy and networking services in order to attain optimal participation from RTI stakeholders in H2020 and in multilateral RTI initiatives. Furthermore, the EIP of the Austrian Research Promotion Agency (FFG) serves as the National Contact Point (NCP) of the European Commission for the Framework Programme and all initiatives and programmes connected to H2020. The core target groups are stakeholders from science and industry. The commissioning of the European and International Programmes at the Austrian Research Promotion Agency (FFG) pursued four overarching objectives that are part of Austria's national RTI strategy: (1) Hold the previous level of participation by Austrian research organisations and researchers in H2020 and in the European Research and Innovation Area: the disbursed return flows should continue to exceed the value of Austria's resources payments to the EU budget; (2) Strengthen Austrian R&D by means of internationalisation; (3) Coordination of information and advising on national programmes of the Austrian Research Promotion Agency (FFG), and

Table 5-1: Key performance indicators on the Frontrunner initiative

Year	Austrian Research Promotion Agency (FFG)			Austria Wirtschaftsservice (aws)		
	Projects	Total costs (in €1,000)	Present value (in €1,000)	Projects	Basis for assessment (in €1,000)	Grant (in €1,000)
Total	**95**	**350,189**	**93,283**	**60**	**483,869**	**24,257**
2013	26	65,589	17,485	14	176,888	7,041
2014	19	66,288	16,976	10	76,406	4,141
2015	18	63,280	16,864	14	84,971	4,946
2016	13	59,800	16,823	12	77,904	4,668
2017	9	57,675	15,528	10	67,701	3,461
2017 (National Foundation)	10	37,558	9,607	-	-	-

Source: Austrian Research Promotion Agency (FFG).

European and multilateral funding programmes; and (4) Strengthen the exchange of interest throughout Austria in the field of research and innovation in a European context.

Special attention is paid to system-oriented support and the self-empowerment of stakeholders. The EIP of the Austrian Research Promotion Agency (FFG) has developed a toolbox with specific services to implement support and supervision objectives, and they are addressed to all researchers at firms, universities, universities of applied sciences, and non-university research organisations in Austria. The instruments being used can be classified in three functional areas:[27]

1. Awareness raising and information communication to promote the recognition and reputation of European and multilateral programmes;
2. Programme and project advising throughout all project phases; and
3. Strategic consulting and orientation knowledge about the European Research Area (ERA) to support the optimal utilisation of existing funding programmes.

The ERA Observatory serves the integration of the specific tasks in the field of governance in Austria's EU RTI policy.[28] The overarching objective of the instruments used by the ERA Observatory is to support independent decision-making, especially among policy-relevant RTI stakeholders in the EU context. The specific objectives of the ERA Observatory are (1) to provide information and exchange opportunities regarding relevant EU policies (ERA Portal Austria, Europa Forum on Research), (2) need-based consultancy and support for the various ministerial departments for H2020, (3) strategic advice on policy (ERA Council Forum Austria) and intelligent processes for structural change in the policy field (ERA Policy Forum, ERA *Roundtable*, working groups on EIT, JPI etc.), and (4) the performance of impact-oriented monitoring of Austrian participation in H2020 and ERA (EU Performance Monitoring, ERA Reporting Board).

Main results of the evaluation

The objective of the evaluation of the implementation of Horizon 2020 in Austria[29] was a systematic overall assessment of the implementation of H2020 and ERA in Austria as well as of EUREKA, COSME and EEN. The evaluation was performed in 2017 and 2018 under the lead of the Austrian Institute of Technology together with Joanneum Research, KMU Forschung Austria and the Centre for Social Innovation (ZSI). The priorities here were commissioning the Austrian Research Promotion Agency (FFG) to primarily provide advice and support about H2020 and ERA (EIP service order), implement the EU Performance Monitoring (EU PM service order) and the ERA Observatory Austria. In addition, the commissioned services related to EUREKA, COSME and the EEN were also analysed. The focus of the evaluation was on the orientation and implementation of the existing formats and support services with a view to the intended impacts and required improvements or options for action.

The evaluation concludes that the relevance of the services of the FFG-EIP for its customers in the three areas of awareness-raising and information, programme and project consulting, as well as strategic consulting and ERA orientation knowledge is in general high. This applies in particular to the personalised advisory services and the offers for further training within the framework of the Austrian Research Promotion Agency's FFG-Academy. The individual range of services offered by the Austrian Research Promotion Agency through its EIP unit (FFG-EIP) is also considered to be effective overall. In particular, it contributes to increasing the application competence of researchers and the probabil-

27 See https://www.ffg.at/en/europa/service
28 See https://era.gv.at/directory/166
29 See Biegelbauer et al. (2018).

ity of success in the application process. However, the evaluation also identifies potential for improving the effectiveness that can be achieved by making target group-specific adjustments to the service portfolio. According to the evaluation, significant progress has been made with regard to the central target group of science and the self-empowerment of the stakeholders, which is particularly desired in this area, but the capacities provided by the universities at the respective research service centres are very heterogeneous. At the same time, the importance of European RTI networks and strategic partnerships in the European Framework Programmes is increasing, and there is a need for both the non-university and the university sectors to act more strategically at international level. The evaluation concludes that the EIP services of the Austrian Research Promotion Agency (FFG) should be adapted accordingly with regard to the dissemination of all information on relevant developments (e.g. call contents). In addition to the direct support services, the further development of the empowerment of the research organisations plays a key role. The central anchor points for this are the research service offices and vice-rectorships of the universities. According to the evaluation, the Austrian Research Promotion Agency (FFG) has a good basis of advisory services to address research service offices and vice-rectorships (ERA dialogue), but there is a need to further professionalise the service offices and to advance strategic empowerment.

With regard to the central target group of industry, the evaluation shows a general increase in the level of information for the "ecosystem" through H2020 support as well as the fulfilment of specific consulting requirements. Potential for optimisation can be found in the area of "expectation management", i.e. clearer communication about the possibilities and limits of the services offered. The C3 concept (Core Customer Concept) is a special element of the Austrian Research Promotion Agency (FFG)-EIP's consulting and support services for the target group of industry. It is specifically tailored to the needs of outstanding firms, with a view to their potential to participate in EU projects. In this respect, the evaluation raises the question of the extent to which the experience of this group of firms could also be made available to others.

The evaluation is also in favour of continuing EU-Performance Monitoring. It fulfils a central position as an "information broker" for national policy stakeholders in relation to the ERA.

With regard to the ERA Observatory Austria, the evaluation comes to the conclusion that the majority of the activities are well-perceived and considered meaningful. An important instrument, the Europa Forum Forschung, should in future include more dialogue elements in addition to its existing function of providing information, and reach out to an extended group of stakeholders. With regard to the function of advising and supporting ministerial departments, the evaluation also refers to the currently discussed liaison office in Brussels, which could provide relevant assistance. To this effect, the evaluation advocates clarifying the objectives of such a liaison office with the RTI community. With regard to a reorganisation of the council landscape in Austria in the field of RTI policy, the evaluation recommends ensuring a strong European dimension in the tasks and in the composition of the future body as well as regular updates on the activities of this body. In addition, the cross-cutting character of RTI policy should be taken into account. The ERA formats should be bundled and strengthened through more active coordination between the federal ministries.

In terms of an outlook, the evaluation concludes by formulating three possible scenarios for Austria's positioning in Horizon Europe and the corresponding support structures:

1. The "Enhancement in Continuity" scenario (incremental further development): The central idea of this scenario is that the well-established and largely well-functioning status quo should be further developed and that, in the course this, RTI policy should be adapted to the requirements of new instruments and initiatives at the European

level without significant changes being made in Austria, e.g. in the area of governance.

2. The "Smart and Proactive Alignment" scenario (RTI policy as an impulse-giver in the European multi-level system): In this scenario, Austrian policy aims at expanding its role towards becoming a (pro)active co-designer of European RTI policy in order to make more targeted and effective use of the resulting opportunities for EU RTI policy for Austria. The definition of such a concept as a guideline for a coherent Austrian position on EU RTI policy would be a central component of the new Austrian RTI strategy.
3. The "Distributed Empowerment" scenario (strengthening and networking of the RTI community): In this scenario, the expansion of shaping and participating in European RTI policy takes place primarily through the strengthening and better networking of the RTI stakeholders themselves, who are supported in this process of empowerment by Austrian policymakers.

5.2.5 FIT-IT and ICT of the future

The promotion of information and communication technologies is amongst the core thematic areas of research funding at the Federal Ministry for Transport, Innovation and Technology (BMVIT). The redesign of the "ICT of the Future" thematic initiative (ICT of the Future, ECSEL, benefit and Active and Assisted Living (AAL)), which followed the FIT-IT programme (2002-2012), commenced in 2011. Under the new programme umbrella, national ICT funding was geared more strongly to specific application areas and combined with funding for Austrian participation in the ARTEMIS and ENIAC Joint Technology Initiatives and, since 2014, also with the national and transnational programmes for coping with demographic change (benefit and Active and Assisted Living (AAL)).

Main results of the evaluation

In August 2018, a comprehensive evaluation[30] was presented by inspire research, including both the ex-post evaluation of the FIT-IT programme (2002-2012) and the interim evaluation of the subsequent thematic initiative "ICT of the Future" (ICT of the Future, ECSEL, benefit and Active and Assisted Living (AAL)). The evaluation is based on a comprehensive secondary data analysis (Austrian Research Promotion Agency (FFG) funding data, SCOPUS publication data, official R&D statistics, patent database, PREDICT - Prospective Insights in ICT R&D Research), an online survey of all funding recipients, case studies on the long-term effects of funding, an overview of previous evaluations, and examples of ICT research programmes in other countries.

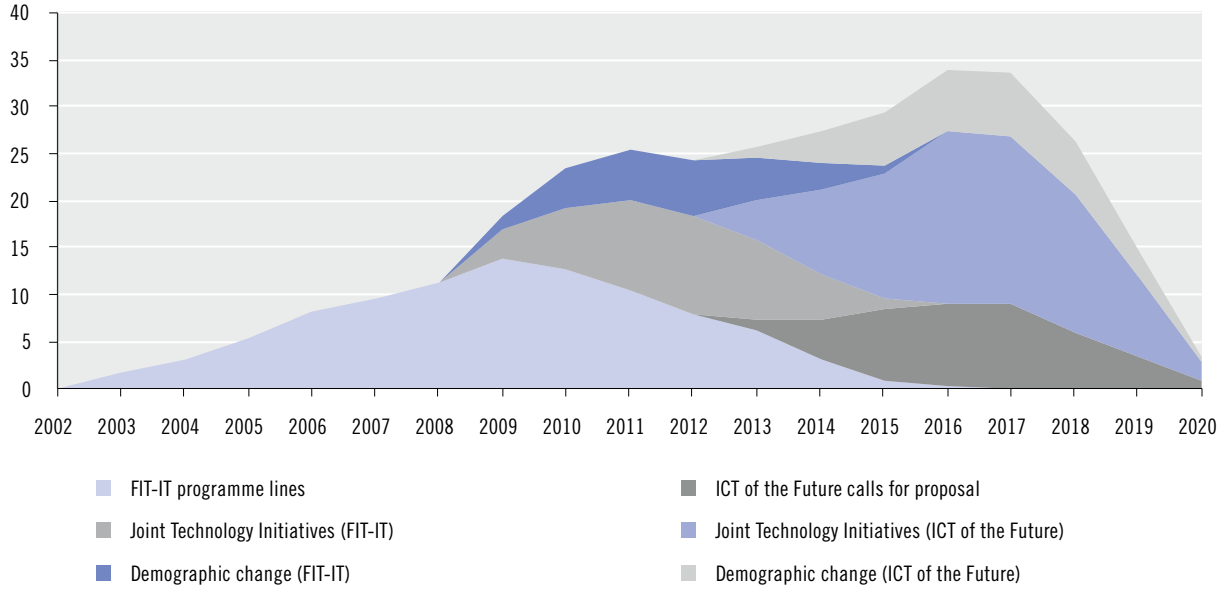
Over the duration of the FIT-IT programme, more than 1,000 project proposals were submitted in the individual programmes and programme lines with a total volume applied for of €663 million. Of the applications submitted, 67% were for the various programme lines of the FIT-IT programme, 9% for Austrian investments in the ARTEMIS and ENIAC Joint Technology Initiatives, and 24% for projects on Demographic Change. More than 470 applications were approved; the present value of the funding amounted to €165 million, of which €25 million went to projects on Demographic Change and around €45 million to ARTEMIS and ENIAC projects.

Since the reorganisation of the programme, the national funding priority "ICT of the Future" has accounted for only a quarter of the total funds approved for proposals in the period 2012-2016. More than half of the funds were used to support Austrian partners in projects of the Joint Technology Initiative ECSEL (or its predecessor initiatives ARTEMIS and ENIAC) (see Fig. 5-2).

The results of the evaluation show that, on the whole, the FIT-IT programme has been very successful in achieving the targets set. A very high propor-

30 See Geyer and Good (2018).

Fig. 5-2: Programme FIT-IT and thematic initiative "ICT of the Future": Sum of the approved amounts distributed over the project durations according to programmes/funding themes, in € millions



Source: Austrian Research Promotion Agency (FFG); evaluation and presentation: Geyer and Good (2018).

tion of 81% of the former participating scientific partners and 67% of the former participating firms are still seeing positive after-effects of the funded projects in their institutions. Above all, the qualification of employees and the internal accrual of know-how that took place with the projects, as well as the resulting networks and cooperative efforts for R&D collaboration in the field of ICT, were mentioned as long-term benefits of FIT-IT funding. In the opinion of the programme participants, FIT-IT has made a significant contribution to strengthening the performance and competitiveness of Austrian ICT research and to promoting cooperation between industry and science. The programme design, programme implementation and programme management of FIT-IT are still consistently rated as excellent by the former programme participants.

The bibliometric assessments show intensive publication activity on the part of the research partners and of the participating firms during and after the FIT-IT projects. The evaluation of the PATSTAT database about patent applications of the firms involved in the FIT-IT projects shows a very significant increase in patenting activities throughout the duration of the FIT-IT programme, which was associated with a significantly increasing share of patents in fields of ICT technology and an internationalisation of patent applications.

However, the extremely positive assessment and evaluation of the findings and impacts of the FIT-IT programme by the former funding recipients stands in contrast with the results of a special evaluation carried out in the course of the evaluation of Statistics Austria's R&D survey on the development of internal R&D expenditure and R&D employment in funded and non-funded firms. According to this evaluation, the data from the R&D survey show a stronger development of internal R&D expenditure and an increasing number of R&D employees for the SMEs in the group of funded firms only for the first programme years of FIT-IT. The general expansion of offers for the direct and indirect promotion (i.e. tax concessions) of research for firms since the mid-2000s probably influenced the results of the evaluations.

The thematic reorientation of the national funding priority "ICT of the Future" with the definition of spe-

cific ICT topic areas, fields of application and cross-sectional objectives has significantly changed the technical and content-related character of the funding in comparison to the FIT-IT programme. While the new ICT topic areas have met with a high level of acceptance among the programme participants overall, the orientation of the projects towards specific fields of application that is now obligatory does not meet with universal approval. Due to the fields of application, more generically oriented ICT projects could no longer be submitted under the programme. In addition, the unique selling points of the ICT programme decreased compared to other thematic funding programmes of the Federal Ministry for Transport, Innovation and Technology (BMVIT). The ICT funding programme of the Federal Ministry for Transport, Innovation and Technology (BMVIT) had thus lost its independent profile, as application-oriented ICT research would also be addressed in other thematic programmes.

The programme participants continue to rate the quality of implementation of the "ICT of the Future" programme as excellent. The funding recipients are extremely satisfied with the way the programme has been managed. They place particular emphasis on the information events that go with the programme along with the new calls for proposal, the submission modalities as well as the competence and support provided by the Austrian Research Promotion Agency (FFG) staff in administrative and content-related matters.

A new funding instrument was also introduced in the national funding priority "ICT of the Future": the concept of lead projects brings together existing national know-how and, by developing model solutions for major societal challenges, strengthens specific sectors or industries. Experience to date has shown that the lead project instrument is quite successful in effectively fulfilling the desired platform function and in mobilising new partners to develop innovative solutions with, beyond bounds of the funded project consortium.

With regard to the funding of Austrian partners in the projects of the Joint Technology Initiative ECSEL (or its predecessor initiatives ARTEMIS and ENIAC), Austria is ranked sixth among the participating EU states with €29.5 million of approved EU contributions for these projects. Only the Netherlands and Belgium received higher EU contributions than Austria in terms of their economic performance. The evaluation results suggest, however, that despite the already lower funding intensity substantial deadweight effects are still occurring in corporate funding.

The target group of the FIT-IT programme or now that of the thematic initiative "ICT of the Future" not only comprises the ICT sector in the narrower sense, but also addresses an increasingly broad mix of different economic sectors, not least due to digitalisation. Of the applicants in the FIT-IT programme, only around 20% of the submitting manufacturing enterprises are in the ICT sector in the stricter sense, but around 60% of the submitting firms are service providers. This distribution is also reflected in the assessments of the R&D data available for the ICT sector of the JRC (PREDICT). These show that, between 2006 and 2015, government R&D funding for ICT as a whole increased by an average of 6.6% per year, with a particularly high increase for industrial research (+182% over ten years). In absolute terms, government R&D funding benefiting firms in the ICT sector increased from €27.4 million in 2006 to €81.1 million in 2015. This is only partly accompanied by a corresponding increase in R&D expenditure by the firms themselves. The ICT services sector recorded very strong growth in business research expenditure between 2002 and 2016, from €138 million to €457 million (or an annual increase of 8.9%), while according to PREDICT, R&D expenditure at firms in the production sector fell from €648 million to €459 million over the same period (an average of 2.4% per year).

The funding priority Demographic Change is still the most ambitious of the three funding priorities of the "ICT of the Future" initiative in terms of structure and organisation. By involving non-classical stakeholders and focusing on solutions for (end) users,

these projects are very different from classical R&D projects. The combination of national proposals (e.g. benefit) and transnational proposals (e.g. Active and Assisted Living (AAL)) has proven its worth, but the commercialisation of solutions for the participating firms continues to pose a major challenge. The non-classical partner structures also make it more difficult to maintain cooperation after the end of the project than in the classical collaborative R&D projects. At the same time, however, one of the main objectives of the funding is achieved, namely to increase firms' understanding of the needs and requirements of users and end users.

What recommendations were made? In order to strengthen the demarcation of the national funding priority ICT of the Future from other thematic programmes, this initiative should preferably support especially ambitious projects of industrial research that also require a correspondingly high amount of scientific research, above all from higher education institutions. This will enable even better support for the objectives "Further developing leading-edge technology" and "Providing and winning over top talent". In contrast, collaborative experimental development projects as well as projects that are predominantly supported by internal research activities of the firms should preferably be funded by other (thematic) programmes.

When implementing the programme, the evaluation recommends opting for a mix of funding instruments; in addition to calling for collaborative R&D projects more and more lead projects should be called for. A prerequisite, however, is that the topics of the lead projects can be adequately specified in terms of content and that competition is possible between potential submitters. Exploratory studies should continue to be used to support specific programme objectives or as affirming measures for lead projects. Only projects exclusively implemented by firms or projects in which research institutes are represented only in a subordinate role (e.g. as subcontractors) should be referred to the general programmes of the Austrian Research Promotion Agency (FFG).

In any event, the content requirements and the size of collaborative R&D projects supported by the "ICT of the Future" thematic initiative should make it possible to employ doctoral students, whereby a corresponding concept could already be required at the time of the application. The focus of "ICT of the Future" on particularly ambitious scientific research could therefore also be very nicely combined with structurally effective measures such as endowed professorships. Finally, it is recommended that the programme monitoring structures be further improved. To support the management and on-going further development of the programme, impact and target indicators should be defined that can be collected as easily as possible, and regularly and promptly compared. A suitable central data source for this purpose would be the survey addressing project partners of completed projects that is done each year by the Austrian Research Promotion Agency (FFG) as part of its Impact Monitoring. The evaluation recommends making it possible to use this data from the Austrian Research Promotion Agency (FFG) impact survey on a programme-related basis and over the course of the programmes.

5.2.6 Production of the future

In 2011, the Federal Ministry for Transport, Innovation and Technology (BMVIT) launched the RTI initiative "Production of the Future" in order to sustainably secure and expand the success story of production research in Austria as a location for business. The initiative is aimed at promoting the cooperation between science and industry, building up human resources and the development of research infrastructure. The focus here is on manufacturing competitive products and increasing competitiveness in order to secure economic growth in Austria.[31]

31 See https://www.ffg.at/produktion-der-zukunft-das-foerderprogramm

The RTI initiative "Production of the Future" mainly pursues four strategic objectives:

1. Boosting the competitiveness and sustainability of Austrian industry;
2. Increasing innovation in manufacturing through:
   a. improved use of the cooperation option;
   b. widening the innovation base to mobilise firms with a weaker record of innovation;
   c. improved access to the research competence of research institutes and firms;
3. targeted development of research competence in research institutes on selected issues;
4. boosting European and international cooperation and networks.

Main results of the evaluation

The goal of the interim evaluation carried out jointly by Convelop and inspire research in 2018–2019[32] was to analyse the programme design, the progress to date as well as the impacts achieved by the RTI initiative for the funding recipients in order to estimate its degree of goal attainment and effectiveness and to be able to provide indications for any adjustments to and further development of the initiative. In order to answer the evaluation questions, funding data of the Austrian Research Promotion Agency (FFG) and publicly available data were used and the national and international context of the RTI initiative was analysed. Moreover, interviews were conducted with funding recipients, representatives of rejected funding applications, programme managers and other stakeholder. A questionnaire-based survey (online survey of funding recipients and rejected funding projects) was also carried out.

Eight Austrian Research Promotion Agency (FFG) funding instruments were used to pursue these objectives in a total of 24 calls for proposals for the 2011–2017 RTI initiative, which were the subject of the evaluation. Table 5-2 shows how the participants and the received and funded projects are distributed amongst these instruments. Table 5-3 describes the project costs and funding volumes.

Overall, the RTI initiative "Production of the Future" presents itself as a successful programme which, according to the evaluation, pursues its objectives in an exemplary manner. It addresses the target group precisely and has been constantly tapped the full available target group potential since 2011. The analysis shows that practically all top-publishing Austrian institutes in the topic area of "Engineering" in 2011–2017 were participating in the RTI initiative as research partners. Amongst the business partners, the initiative reaches approximately 12% of the target group. The available potential mainly covers SMEs with a lesser focus on technology and has been continuously utilised since 2011, so that each approved project includes around one "newcomer". The available data suggest that there is currently no sign of a slowdown in the usage rate. The programme selects the funding recipients in such a way that the received projects are largely funded in a balanced manner and without any significant distortion in the selection process.

The overwhelming number of industry (75%) and research partners (85%) can achieve the R&D targets they have set themselves. The impacts of the funding of collaborative projects, which are responsible for almost 70% of the total funding volume of the RTI initiative, can mainly be seen in three areas:

1. The funding recipients achieve not only their own R&D goals but also their strategic goals, such as improving product and service quality, improving access to research institutes and firms, and publishing the findings in scientific journals.
2. Cooperative efforts and networks resulting from the implementation of funding projects play an important role in the pursuit of objectives.
3. Not only are collaborations and networks important for the performance of R&D activities but they also open up new business cooperation possibilities, customer relationships and market access.

32 See Jud et al. (2019).

Table 5-2: Programme participation by instruments: Projects received and participating organisations

Instrument	Projects received (number)	Success rate	Participating organisations (number)	of which in approved projects
Exploratory studies	120	*30%*	209	*33%*
Industrial research stand-alone projects	20	*0%*	20	*0%*
Collaborative R&D projects	628	*30%*	2,459	*31%*
Transnational collaborative R&D projects	81	*36%*	171	*46%*
Lead projects	7	*29%*	138	*38%*
R&D services	43	*26%*	92	*28%*
Endowed professorships	11	*36%*	11	*36%*
R&D infrastructure	2	*50%*	24	*96%*
Innovation laboratories	2	*100%*	30	*100%*
Total	**914**	***30%***	**3,154**	***33%***

Source: Austrian Research Promotion Agency (FFG); calculation: convelop.

Table 5-3: Programme participation by instruments: Project costs and funding volume

Instrument	Project costs acc. to application (in €)	Approved project costs (in €)	Funding volume (in €)	Funding ratio	Distribution of funds
Exploratory studies	6,361,780	6,339,981	4,711,660	*74%*	*3%*
Industrial research stand-alone projects	0	0	0	-	*0%*
Collaborative R&D projects	177,894,102	171,650,244	114,480,274	*67%*	*77%*
Transnational collaborative R&D projects	12,507,730	12,829,684	9,836,236	*77%*	*7%*
Lead projects	13,451,431	11,952,332	7,645,568	*64%*	*5%*
R&D services	1,101,183	1,101,183	1,101,183	*100%*	*1%*
Endowed professorships	12,110,000	12,110,000	5,298,700	*44%*	*4%*
R&D infrastructure	3,537,556	2,992,106	1,496,000	*50%*	*1%*
Innovation laboratories	8,047,513	8,047,513	4,000,000	*50%*	*3%*
Total	**235,011,295**	**227,023,043**	**148,569,621**	***65%***	***100%***

Source: Austrian Research Promotion Agency (FFG); calculation: convelop.

Lead projects achieve additional added value because they bring together a particularly large number of different cooperation partners on specific key topics and in doing so increase the opportunities for access to complementary know-how both in qualitative and quantitative terms. International project cooperation is entered into in order to gain access to markets and to find suitable partners with complementary know-how who are well networked internationally.

Overall, the RTI initiative achieves funding effects with which it pursues all of its strategic objectives. The competitiveness of the business partners participating in the programme is increased and sustainable effects are achieved. Cooperation is not limited to the funded projects alone but in many cases lead to follow-up cooperation and long-term network relationships with the partners. Research competence is systematically built up in research institutes, its international visibility increased, and follow-up projects facilitated. The funding of endowed professorships leads to the targeted strategic further development of the university profile and to the development of highly qualified human capital. Pilot factories further strengthen these effects with their

specific topic-based orientation. Both European and international cooperation is promoted. With the help of M-ERA.NET and the bilateral agreements with the *Chinese Academy of Science (CAS)* and *Shanghai University (SHA)*, projects could be carried out that would not have been possible on the basis of simple collaborative R&D projects. This has boosted international cooperation. In addition, the projects have helped to fill gaps in know-how, identify partners with specific skills and capture new markets, giving them additional and sustainable added value in the process.

Not only is the content of the RTI initiative (selection of the funding content and funding instruments, development of thematic guidelines) a success but its implementation is also functioning well. The majority of funding recipients are satisfied with the administration of applications and programmes by the Austrian Research Promotion Agency (FFG). The same is true to an even greater degree for the provision of information for the proposals and the advice and support provided by the Austrian Research Promotion Agency (FFG). Criticism of the implementation is sporadic and only affects a few points. For example, some interview partners describe the topic discovery process as insufficiently accessible and the learning effects between proposals as insufficient, or make this criticism about details off the *E-Call system* of the Austrian Research Promotion Agency (FFG) or the dissemination of information on the calls for proposals and thereunder funded projects.

Finally, the evaluation also identified a few impact potentials that have not been leveraged yet, as well as a need for adjustments and additions to the range of services. Building on these findings, proposals and suggestions for adjusting, supplementing and further developing the RTI initiatives were elaborated, which can be summarised under the following key terms:

- Using the "soft" location factors of regional agencies and advancing nationwide cooperative projects;
- Creating a comprehensive overview of possibilities for cooperation;
- Sounding out possibilities for international cooperation (suitable partner countries).

Beyond that, the Austrian Research Promotion Agency (FFG) contract templates should be examined for where further improvements can be made, the instrument of endowed professorships further strengthened and realistic operating prospects highlighted for pilot factories once funding has taken place.

5.2.7 Mobility for the Future

"Mobilität der Zukunft" (Mobility for the Future, MdZ) is running from 2012 to 2020. It is the national research, technology and innovation funding programme for mobility and transport technology. The programme is based on the premise that new technologies and innovations embedded in a socio-economic, systemic context can make an important contribution to shaping mobility for the future. Mobility for the Future (MdZ) falls within the remit of the Federal Ministry for Transport, Innovation and Technology (BMVIT) and is administrated by the Austrian Research Promotion Agency (FFG). A funding budget of €15-20 million is available annually until 2020; in total, 28 individual calls for proposal were performed in 2012-2016 and almost €108 million were placed for the activities.

Main results of the evaluation

The interim evaluation[33], carried out in 2018 by KMU Forschung Austria in cooperation with Germany's Wuppertal Institute, focuses in part on the assessment of the design and processes of the RTI programme "Mobilität der Zukunft" (Mobility for the Future). This evaluation was not intended to provide a detailed impact analysis of the programme; nevertheless, interim results as well as the impacts to date and the programme objectives achieved so far are being analysed. The impact indicators in the pro-

33 See Fischl et al. (2018).

gramme and in the outcome-oriented impact assessment (WFA) are also the subject of the evaluation. The evaluation covers the programme period 2012–2017.

The evaluation views Mobility for the Future (MdZ) as a programme structured and organised in accordance with the key principles of new mission-oriented policy (i.e. it takes into consideration the link between social and technological innovation, user focus, involvement of social and societal objectives, etc.). In overall terms, the system of the programme's three strategic target clusters (social, environmental and industrial) is evaluated as being consistent and appropriate for a mission-oriented programme. With regard to the target system as a whole, the evaluation highlights a few areas for improvement. In principle, the integration of systemic and technological topic areas in the Mobility for the Future (MdZ) programme is assessed as legitimate and meaningful, above all because of the necessary firming up and focusing within the broad field of "Mobility", limited resources, the best-possible addressing and mobilisation of the community as well as easier linkage to higher-level strategies. The evaluation also considers the current topic areas to be comprehensive and comprehensible; the topic areas are also explicitly linked to operational objectives. The introduction of roadmaps for the further specification of research agendas in the topic areas and as a key controlling instrument in the programme is highlighted in the evaluation as a central improvement in the programme's design over that of the previous programme "IV2Splus".

The evaluation also addresses references in the programme to topics that are too narrowly defined on a case-by-case basis, which results in the potential danger of prematurely excluding innovations or solutions that could, for example, make a contribution to the objective through alternative approaches. According to the evaluation, Mobility for the Future (MdZ) has a relatively high need for preparation, support and dissemination of the results of funded projects and in this respect identifies a range of relevancies and procedures as well as a certain lack of clarity in the distribution of roles and tasks within the programme regarding the implementation of supporting measures (such as networking events, community workshops, etc.). The presentation or the exchange and diffusion of findings for the purposes of improved possibilities for follow-on projects as well as the utilisation of the results by user is also given high priority in the evaluation from the point of view of all surveyed groups; at the same time, there is still not enough activity regarding the dissemination of results. The evaluation also determines that Mobility for the Future (MdZ) fundamentally fulfils the self-imposed claim to be a "learning programme". However, some learning and adaptation stimuli failed due to strategic and operational circumstances and it has therefore not been possible to implement them so far. Actually implemented learning or adaptation stimuli have so far mainly come from outside or through singular stimuli. A systematically organised, regular learning process within the programme has been less established to date.

The evaluation sees the optimisation of activities across the topics as a central challenge of Mobility for the Future (MdZ). Most of the structures and practices in the programme, many of which have evolved over time, are set up or take place at topic area level. Although they work rather well, further development of the approach, which has so far been more topic-specific, would ultimately help to leverage potential that has not yet been fully tapped into. The evaluation also formulates a number of possibilities and starting points for strengthening the overall programme level. At the same time, however, these do not exclude taking into account the specific characteristics of the individual topic area communities. For example, the option of a strategic advisory council at programme level is discussed in order to improve the overall coordination of the roadmaps; a more systematic approach is recommended for the supporting measures, as illustrated by a few examples. Following the evaluation, internal coordination processes should also be strengthened in the future.

The analysis of the achievement of objectives carried out as part of the evaluation at programme level shows that most of the programme objectives and the outcome-oriented impact assessment (WFA) have already been achieved in full or – with one exception – within the envisaged timescale. With regard to the programme indicators, it is recommended that target values be reviewed for feasibility and that target indicators be revised or supplemented to reflect social target dimensions.

5.2.8 ERP loan programme

The European Recovery Programme Fund (ERP Fund) contributes to structural improvements of the Austrian economy through specific measures of direct industry funding. It was founded in 1962 with funds from the US Marshall Plan and is staffed by the same personnel as the Austria Wirtschaftsservice (aws). This enables Austria Wirtschaftsservice (aws) to bundle all of the federal government's business development activities related to firms and, as a *one-stop shop*, be in a position to provide targeted and efficient support to firms in all phases of development – from preparation for a new enterprise to internationalisation.[34]

The annual amount awarded to the ERP Fund is approximately €600 million. According to Section 1 (2) ERP Fund Act, the task of the ERP Fund is to promote the development, rationalisation and productivity of the Austrian economy, in particular by supporting and stimulating productive activity and promoting the trade in goods. Supporting technologically ambitious projects stimulates innovation, sustainable growth and employment. In recent years, "consistently promoting growth and innovation" has crystallised as an overarching goal. More concrete objectives and aims of the ERP Fund are defined in the individual annual programmes or subsequently within the individual programme guidelines.

ERP loans are primarily a financing tool for growth and innovation projects that achieve high volumes in relation to the size and funding power of the firms. EU state aid law presents the possibilities for the use of funds: The focus is on tangible investments, but intangible investments and expenditure on research, technological development and innovation are also permitted.

In recent years, it has been the stated aim of management to simplify the programmes and make them more transparent. A distinction can now be made between the Growth Loan for Start-ups and Small Firms, the Growth and Innovation Programme, the Tourism Programme, the Agriculture and Forestry Programme and the Transport Industry Programme. Loans from these programme initiatives can also be combined with other instruments, e.g. with the ERDF programme, the Frontrunner programme, the Austria Wirtschaftsservice (aws) Industry 4.0 programme or coverage provided by aws guarantees.

Main results of the evaluation

The evaluation carried out in 2018 by the Austrian Economics Center and the Industrial Science Institute focused on the significance of the ERP loan programme of Austria Wirtschaftsservice Gesellschaft mbH both at the level of the firms and at a macroeconomic level.[35] The objective of the evaluation was to provide a sound information basis for monitoring activities and strategy plan development. In addition to analysing the programme management and the efficiency of programme administration, the first part of the evaluation included a survey addressed to firms to find out about the industry-specific, micro-level impact of the ERP loan programme.

The survey of firms (online questionnaire) was performed with the support of Austria Wirtschaftsservice (aws) in summer 2018. A total of 3,013 firms were invited to participate, of which 497 returned a valid questionnaire. The regional and size-specific

34 See https://www.aws.at/historie/

35 See Kolm et al. (2018a); Kolm et al. (2018b).

distribution of the random sample reflected the structure of the population. Focal topics were the information channels of the applicants, the reasons and motivation behind the application for an ERP loan as well as a satisfaction analysis. The findings of the questionnaire were supplemented and reflected on by in-depth interviews in firms.

In the second part of the evaluation, the findings from the level of the firms were used to perform an impact analysis covering all areas of the economy. Using an input-output analysis, the economic effects of investments supported by ERP loans were determined on the one hand, and those economic effects which are recurrently generated by the ongoing operations of the firms making the investments were identified on the other.

The basis of the survey of firms and the economic calculations were all firms that had completed an ERP-funded investment project in 2015, 2016 and 2017 or in the first half of 2018. The findings show that the Austria Wirtschaftsservice (aws) achieves high levels of satisfaction with the ERP loan programme among funding recipients. The effectiveness of the programme management is high and the programme design is well tailored to the target group(s).

The respondents were very satisfied with the key conditions of the ERP loan such as the funding volume, duration, options for combination with other products from the Austria Wirtschaftsservice (aws). The funding provider is very willing to continuously improve the instrument, e.g. by taking customer feedback into account. Further improvements in the instrument's design can partly be achieved through fine-tuning (e.g. greater flexibility in terms of maturities and repayment periods).

Austria Wirtschaftsservice (aws) and its house and fiduciary banks also achieves a high level of customer satisfaction through programme management. House and fiduciary banks play a central role both in access to funding (as an information channel) and in application and processing. In this regard, the Austria Wirtschaftsservice (aws) continues to attach great importance to quality assurance. An ongoing closer examination between the Austria Wirtschaftsservice (aws) and the house/fiduciary bank is necessary within the framework of support and management processes. This poses a major organisational challenge but is of fundamental importance for the quality of programme administration and customer satisfaction. Starting points for improvements in this (interface) area can (from an industry-specific perspective) be found in a partly faster processing time for applications in the tourism sector.

In recent years, significant turnover and jobs have been created. If the impact of the investments in firms implemented to date with the help of an ERP loan is considered, the respondents observe high positive effects. Of the participating firms, 67% see increasing growth in sales, another 25% a stabilisation of sales due to the investments implemented with the ERP loan. Furthermore, 48% see an increase in the number of employees, and a further 31% a stabilisation. Further effects of the investments at the firm level can be seen above all in a strengthening of the market position and competitiveness of the firms as well as in the acquisition of new customers. From a regional policy perspective, too, investments with ERP loans lead to positive structural effects – linkage and network effects can be observed.

Roughly two thirds of the firms cite modernisation or expansion of the firm as the reason for their ERP loan application; this is particularly relevant for small enterprises (almost 90%). Other frequently mentioned motives are the establishment and expansion of new services and business fields as well as start-ups and business relocations. Even in times of economic boom or low interest rates, an instrument such as the ERP loan is an attractive option. Around 90% of respondents believe that it is and remains an important instrument of SME funding, also in times of low interest rates. The security provided by a fixed interest rate is just as important a factor as constancy and predictability or long repayment-free periods.

The evaluation shows that the resources of the ERP Fund available to firms for investments are also significant from an economic perspective. The invest-

ments made possible by the ERP Fund in Austria in 2015-2017/18 triggered a direct and indirect production value of €4.83 billion affecting the economy as a whole. In the observation period, all investments in Austria generated total economic added value of €2.40 billion. In total, more than 32,300 jobs were secured in Austria through investment activities during the three and a half year period, corresponding to approximately 27,400 full-time equivalents. A sector-specific analysis and numerous value creation studies carried out by the Industriewissenschaftliches Institut (Institute of Industrial Science) show that industrial firms in particular achieve above-average economic effects as a result of investment activities. The resources of the ERP Fund have a particularly high macroeconomic impact in this area.

In addition to the investment effects, ERP loans also have a positive and stabilising effect on the ongoing operations of firms. A comparison of the production growth of the sample firms with the overall economy shows above-average production growth for the industry sector but also for services and trade. In the course of ongoing operations, it is above all domestic industry that triggers considerable multiplier effects on the entire domestic economy through its high-quality demand in extensive added value processes.

6. List of Figures and Tables

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7. Literature

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8. Annex I

8.1 Country codes

Country	Codes	Country	Codes	Country	Codes
Albania	AL	France	FR	Nigeria	NG
Argentina	AR	Hong Kong	HK	Netherlands	NL
Austria	AT	Croatia	HR	Norway	NO
Australia	AU	Hungary	HU	New Zealand	NZ
Belgium	BE	Ireland	IE	Poland	PL
Bulgaria	BG	India	IN	Portugal	PT
Brazil	BR	Israel	IL	Romania	RO
Canada	CA	Iceland	IS	Serbia	RS
Switzerland	CH	Italy	IT	Russia	RU
Chile	CL	Japan	JP	Sweden	SE
China	CN	South Korea	KR	Singapore	SG
Cyprus	CY	Liechtenstein	LI	Slovenia	SI
Czechia	CZ	Lithuania	LT	Slovakia	SK
Germany	DE	Luxembourg	LU	Turkey	TR
Denmark	DK	Latvia	LV	Taiwan	TW
Estonia	EE	Montenegro	ME	Ukraine	UA
Greece	EL	Macedonia	MK	United Kingdom	UK
Spain	ES	Malta	MT	United States of America	US
Finland	FI	Mexico	MX	South Africa	ZA

8.2 List of Abbreviations

ABA	Austrian Business Agency
ACR	Austrian Cooperative Research
AGES	Austrian Agency for Health and Food Safety
AIT	Austrian Institute of Technology GmbH
ALR	Aeronautics and Space Agency
ASCINA	Austrian Scientists and Scholars in North America
ASO	Austrian Science and Research Liaison Offices
AUSSDA	Austrian Social Science Data Archive
aws	Austria Wirtschaftsservice Gesellschaft mbH
BASG	Austrian Federal Office for Safety in Health Care
BDI	Federation of German Industries
BIMM	Federal Centre for Interculturality, Migration and Multilingualism
BKA	Federal Chancellery
BMBWF	Federal Ministry of Education, Science and Research
BMDW	Federal Ministry for Digital and Economic Affairs
BMF	Federal Ministry of Finance
BMNT	Federal Ministry for Sustainability and Tourism
BMÖDS	Federal Ministry for the Civil Service and Sport
BMVIT	Federal Ministry for Transport, Innovation and Technology
BMWFW	Federal Ministry of Science, Research and Economy
BRZ	Federal Computing Centre
BWB	Federal Competition Authority
CCCA	Climate Change Center Austria
CDO	Chief Digital Officer
CEEPUS	Central European Exchange Program for University Studies
CEUS	Central European Science Partnership
CIS	Community Innovation Survey
CPS	Cyber-Physical-Systems
DEI	Digitizing European Industry
DESI	Digital Economy and Society Index
DIA	Digitalisation Agency
DIH	Digital Innovation Hub
DOI	Digital Object Identifier
EEK	Advancement and Appreciation of the Arts
EFF	Europa Forum on Research (Europa Forum Forschung)
EFRE	European Regional Development Fund
EHI	European University Institute
EIC	European Innovation Council
EIF	European Investment Fund
EIS	European Innovation Scoreboard
EIT	European Institute of Innovation and Technology
ELAK	Electronic Act
ELGA	Electronic health records
EOSC	European Open Science Cloud
EP	Development plan
EPA	European Patent Office
ERA	European Research Area
ERAC	European Research Area and Innovation Committee
ERC	European Research Council
ESFRI	European Strategy Forum on Research Infrastructures
EU-PM	EU-Performance Monitoring
FFG	Austrian Research Promotion Agency
FFG-EIP	European and international programmes offered by the Austrian Research Promotion Agency
fteval	Austrian Platform for Research and Technology Policy Evaluation
FWF	Austrian Science Fund
GBA	Geological Survey of Austria
GCI	Global Competitiveness Index
GCR	Global Competitiveness Report
GII	Global Innovation Index
GIN	Global Incubator Network
GSK	Humanities, social sciences and cultural studies
GUEP	Austrian National Development Plan for Public Universities
H2020	Horizon 2020
HoP	Austrian Development Plan for Higher Education
ICT	Information and Communication Technologies
PPPI	Public procurement promoting innovation
IP	Intellectual Property
ISI	Fraunhofer Institute for System and Innovation Research
IST Austria	Institute of Science and Technology Austria
ITA	Institute of Technology Assessment
JPI	Joint Programming Initiatives
JRC	Joint Research Centre

KEF	Commission for Development Research
AI	Artificial intelligence
KLIEN	Climate and Energy Fund
LBG	Ludwig Boltzmann Society – Austrian Association for the Promotion of Scientific Research
LISA	Life Science Austria GmbH
LNF	Long Night of Research
LV	Performance agreement
MdZ	Mobility for the Future
MSCA	Marie Skłodowska-Curie Actions
NARIC	National Academic Recognition Information Centre
NCP	National Contact Point
NCP-IP	National Contact Point for Knowledge Transfer and Intellectual Property
NFTE	National Foundation for Research, Technology and Development
OA	Open Access
OANA	Open Access Network Austria
ÖAW	Austrian Academy of Sciences
ÖAWI	Austrian Agency for Research Integrity
OeAD	Austrian Exchange Service
OECD	Organisation for Economic Co-operation and Development
ÖGMBT	Austrian Society for Molecular Biosciences and Biotechnology
OI strategy	Open Innovation strategy
ÖPA	Austrian Patent Office
ÖPPM	Austrian Platform for Personalised Medicine
OSTA	Offices of Science and Technology Austria
PGA	Partial General Approach
QIBB	Quality Initiative for Vocational Education and Training
RFTE	Council for Research and Technology Development
RINA	Research and Innovation Network Austria
SAL	Silicon Austria Labs GmbH
SDG	Sustainable Development Goal
SIC	CORDIS Subject Index Classification Codes
SQA	School Quality in General Education
TRC	Translational Research Center
UNIKO	Universities Austria
USP	Business Services Portal
VBCF	Vienna Biocenter Core Facilities GmbH
VCI	Venture Capital Initiative
WEF	World Economic Forum
WFA	Outcome-oriented impact assessment
w-fFORTE	Economic stimuli for women in research and technology
WIPO	World International Property Organization
WTZ	Knowledge Transfer Centre
ZAMG	Central Institute for Meteorology and Geodynamics
ZEW	Leibniz Centre for European Economic Research in Mannheim
ZH	Future of Higher Education
ZSI	Centre for Social Innovation

8.3 Activities in the context of the Presidency of the Council of the European Union

Table 8-1: Ministerial meetings

Date	Event
10 Jul. 2018	Hearing of Minister Faßmann in the European Parliament's Committee on Industry, Research and Energy (ITRE)
16–17 Jul. 2018	Informal meeting of research ministers in Vienna. Start of negotiations on the content of "Horizon Europe"
27–28 Sept. 2018	Competitiveness Council (COMPET) meeting in Brussels and negotiations on the Horizon Europe proposal
30 Nov. 2018	Competitiveness Council (COMPET) meeting in Brussels and negotiations on the Horizon Europe proposal leading to the adoption of the "partial general approach" and the council's conclusions on the European Research Area

Table 8-2: Events of the Austria's Presidency of the Council of the European Union with a focus on "Horizon Europe"

Date	Event	Outcome
17 Jul. 2018	Informal Meeting of Research Ministers	Outcome of Informal COMPET Research
13 Sept. 2018	Austrian Research Promotion Agency (FFG) Forum 2018	Outcome of the Austrian Research Promotion Agency (FFG) Forum 2018
17–18 Sept. 2018	ERAC Plenary/Working Party on Research Meeting	Outcome of ERAC Plenary/Working Party on Research Meeting
1–2 Oct. 2018	Marie Skłodowska-Curie Actions (MSCA) beyond 2020	Outcome of MSCA Conference
29 Oct. 2018	Quantum Flagship Kick-Off Conference	Quantum Flagship Conference – Outcome
30–31 Oct. 2018	Industrial Technologies 2018 – innovative industries for smart growth	IND-TECH Conference – Outcome
6–8 Nov. 2018	COST CSO-Meeting & Awareness Day	COST event – Outcome
21–22 Nov. 2018	Innovative Enterprise Vienna 2018	Innovative Enterprise 2018 – Outcome
28–29 Nov. 2018	Impact of Social Sciences and Humanities for a European Research Agenda	Impact of SSH conference – Outcome
4–6 Dec. 2018	Imagine Digital – Connect Europe (ICT 2018)	

Table 8-3: Events of the Austrian Presidency of the Council of the European Union with a focus on ERA governance

Date	Event	Outcome
10 Sept. 2018	ESFRI Meeting	
11 Sept. 2018	ESFRI Roadmap Meeting	Outcome of ESFRI Roadmap Meeting
10–14 Sept. 2018	ICRI 2018 (International Conference on Research Infrastructures)	Outcome of ICRI 2018
17–18 Sept. 2018	ERAC Plenary/RWP Meeting	Outcome of ERAC Plenary/RWP Meeting
19–20 Sept. 2018	10 Years Joint Programming – Achievements and the Way Forward	Outcome of 10 Years Joint Programming event
22 Oct. 2018	The Role of Competitive Research Funding in Science	Outcome of Competitive Research Funding Conference
30 Oct. 2018	The European Open Science Cloud (EOSC): Austria takes the initiative	EOSC Conference Outcome – Presentations
5–6 Nov. 2018	Impact of R&I Policy at the Crossroads of Policy Design, Implementation and Evaluation	Impact of R&I Policy Conference –- Outcome
23 Nov. 2018	Launch of the European Open Science Cloud (EOSC) Governance Structure	EOSC Launch event - Outcome
Higher education		
20–21 Sept. 2018	The New Student: Flexible learning paths and future learning environments	Outcome of the conference
27–28 Sept. 2018	Meeting of the Bologna Follow-Up Group	Outcome of BFUG meeting
15–17 Oct. 2018	Asia-Europe Meeting/Senior Officials´ Meeting	ASEM Meeting – Outcome
18–19 Oct. 2018	Meeting of DGs for Higher Education	Meeting of DGs for Higher Education – Outcome
15–17 Nov. 2018	13th European Quality Assurance Forum 2018	European Quality Assurance Forum – Outcome

Tables 8-4: RTI Events of the Austria's Presidency of the Council of the European Union with a focus on sectoral policy areas

Date	Event	Outcome
11–12 Jul. 2018	High Level Group Meeting on Education and Training	Outcome of HLG Meeting
4–6 Jul. 2018	WIRE 2018 – 9th Week of Innovative Regions in Europe	Outcome WIRE 2018
5–7 Sept. 2018	IIASA-JRC Evidence for Policy Summer School 2018	Outcome of IIASA-JRC Summer School
8–12 Sept. 2018	BE OPEN – Science & Society Festival	Outcome of BE OPEN
28 Sept. 2018	Human Biomonitoring in Europe – science and policy for healthy citizens	Outcome of Human Biomonitoring in Europe conference
2 Oct. 2018	High Level EU Conference: "The European Defence Fund – Driving Factor for Defence Research and Innovation"	Outcome of EDF Conference
3–5 Oct. 2018	International Sustainable Energy Conference 2018	Outcome of ISEC 2018
4 Oct. 2018	European Creative Industries Summit 2018: BEYOND I Cross-Innovation as Driver for Growth in the European Digital Single Market	"Vienna Declaration on Cross-Innovation for an Inclusive and Creative Society"
11–12 Oct. 2018	Risk Data Hub & Austrian Disaster Network Days	Outcome of Austrian Disaster Network Days
23–25 Oct. 2018	Enterprise Europe Network Annual Conference	Outcome of EEN Conference
5–6 Nov. 2018	Space Conference	
12–14 Nov. 2018	European Big Data Value Forum	Outcome of European Big Data Value Forum
13 Nov. 2018	Smart specialisation (RIS3): European workshop on universities as regional lead institutions	Outcome of RIS3 Workshop on Universities
14–15 Nov. 2018	Europe's Transformation: Where People Matter	Outcome of „Europe's Transformation" event
20–21 Nov. 2018	SET Plan Conference	SET Plan Conference – Outcome
26–27 Nov. 2018	ECOVATION 2018	ECOVATION 2018 – Outcome
26–27 Nov. 2018	The Future of Mobility in European Cities (Urban Mobility)	Future of Mobility – Outcome
5–6 Dec. 2018	Security Research Event (SRE) 2018	SRE – Outcome
6–7 Dec. 2018	Informal Meeting of the Education Committee	

8.4 Overview of Open Innovation measures and examples of their implementation initiatives

		Measure 1	Measure 2	Measure 3	Measure 4	Measure 5	Measure 6
		Building Open Innovation and experimental spaces	Embed Open Innovation elements at kindergartens and schools as well as in teacher training	Further develop public administration by means of Open Innovation and greater public involvement	Set up and operate an Open Innovation platform for social/societal innovation and as a contribution to overcoming global challenges	Set up and operate an innovation map including a matchmaking platform for innovation actors	Build up research competence for the application of Open Innovation in science
Action area 1	Creation of a culture of Open Innovation and teaching of Open Innovation skills to children and adults		BMVIT – Massive Open Online Courses "Smart Cities" FFG, BMVIT – Regional Talents BMBWF – STEM-3D printing	BMVIT – open consultations as part of the efforts to develop the energy research strategy			LBG – Open Innovation in Science Research and Competence Center (OIS)
Action area 2	Formation of heterogeneous open innovation networks and partnerships across all disciplines, industries and organisations	BMVIT – test environments for automated driving FFG – Laura Bassi 4.0		PPPI, BMDW, BMVIT – Matchmaking platform & crowdsourcing challenges ZAMG – Crowdsourcing of weather and impact observations	BMVIT and KLIEN – Future of energy 2050 dialogue process BMVIT – innovation platform AAL Austria	Austrian Patent Office – Open Data Initiative BMBWF research infrastructure database	Ludwig Boltzmann Society (LBG) – Crowdsourcing project "Reden Sie mit!" (Tell us!)
Action area 3	Mobilisation of resources and creation of the framework conditions for open innovation	ÖBB – Open Innovation Lab & Service Design Center FFG, BMVIT – innovation workshops and innovation laboratories FFG – Education LABs	FFG – Education LABs	BBG – EcoInnovation project		BMVIT – Open4Innovation platform	

Measure 7	Measure 8	Measure 9	Measure 10	Measure 11	Measure 12	Measure 13	Measure 14
Establish incentive mechanisms for research partnerships with non-traditional players in research funding to strengthen Open Innovation	Increase involvement of users and members of the public in RTI funding programmes	Develop fair sharing and compensation models for crowdwork	Further develop and provide Open Innovation methods and Open Innovation instruments specifically for small and medium-sized enterprises (SMEs)	Develop and implement co-creation and Open Innovation training programmes	Embed principles of Open Data and Open Access in research	Gear the IP and exploitation strategies of companies, universities, research institutions and intermediaries to Open Innovation in order to optimise innovation potential	Implement a comprehensive communication initiative about Open Innovation to raise awareness and create networks
	OeAD, BMBWF – Citizen Science Award		Salzburg – Competence Centre for Open Innovation (KOI)	Austrian Patent Office - Training and events	Austrian Patent Office – Open Data Initiative FWF – Plan S – Making Open Access a reality by 2020	Austrian Patent Office – Raising awareness of exploitation strategies	BMBWF and BMVIT – Information & communication work via the official Open Innovation website (www.openinnovation.gv.at) BMBWF and BMVIT – Focus on networking with OI in workshops IHS – RiConfigure – Social Lab for Quadruple Helix Innovation with the ÖBB Open Innovation Lab
ZAMG – Hackathon with a focus on innovative solutions for Big Data problems	BMVIT – AAL test regions		FFG – Focus on open innovation in the COIN networks		BMVIT – "e-genius" open content platform BMVIT – Exchange of open RTI data pioneers		BMVIT – Information & communication work within the scope of the Open4Innovation platform
FFG – Ideas Lab 4.0 CDG – Partnership in Research	FFG – Impact Innovation	aws (ncp-ip) – Working group on compensation mechanisms in open innovation	Salzburg – Competence Centre for Open Innovation (KOI) Austrian Patent Office – SME research service offering FFG – Impact Innovation		Austrian Patent Office – Patent Scan FWF – Plan S – Making Open Access a reality by 2020 Universities, BMBWF – Implementation of the OANA recommendations on Open Access BMVIT – Provision of research results of funded projects (Open4Innovation – platform)		

9. Annex II

Federal research funding and research contracts according to the federal research database

The database for research funding and contracts (B_f.dat)[1] of the federal government has been in place since 1975, and was set up as a "documentation of facts by the federal government". Today, the database is maintained by the Federal Ministry of Education, Science and Research. The mandatory reporting of the ministerial departments to the relevant Science Minister is written in the Research Organisation Act (FOG), Federal Law Gazette No. 341/1981, last amended by the Federal Law Gazette I No. 31/2018. In 2008, change to a database took place to which all ministries have access and in which they all enter their research-related funding and contracts independently. Each ministerial department is responsible for the validity and completeness of the data in its respective fields of activity. The federal research database has been accessible to the public since 1 June 2016, providing the latest overview of the projects funded by the federal ministries. As a documentation database, B_f.dat also serves to collect brief information on the content of R&D projects. With regard to the relevant reporting year, the database contains ongoing, newly approved and already completed R&D projects, their overall funding volume and funds paid in the reporting year. All in all, this gives an up-to-date picture of approved R&D projects and their funding by the federal government.

Fig. 9-1 to 9-4 provide an overview of R&D projects and their funding recorded in the federal research data base B_f.dat by the ministerial departments in 2018. The data in the B_f.dat reveals that the total funding for the 493 R&D projects amounted to around 438.43 million in 2018. Approximately 84% of the funds for 2018 were paid out as global funding to research institutions[2]. This figure also includes global funding for institutions; funding amounting to €71.39 million remains once this global funding for institutions is excluded from the partial volumes paid. This is €3.75 million or 5.5% more than in 2017. It is remarkable that the volume of funding for each reporting year generally relates to partial volumes for an ongoing or a completed project which may be subject to annual fluctuations depending on the respective progress of the project.

With regard to the main location of the applicants, Vienna still continues to be the federal Austrian state with by far the largest share in both ongoing and completed projects (70.4%) as well as R&D funds paid out (82.7%) (see Fig 9-1). Lower Austria follows with 4.5% of the projects and a share of 8% of the funding volume. For Vorarlberg, however, as in previous years, no project is documented in B_f.dat in 2018. The 7.7% of the funding volumes that were paid abroad are predominantly membership fees.

The number of ongoing and completed R&D projects with universities as contractors increased – following a decline in 2017 – from 97 to 107 projects in 2018 (an increase of 10%). In the period under review, the funding also increased by approximately 9% to €5.95 million. This means the number of projects at universities corresponds with 21.7% of the total ongoing and completed projects and 1.4% of the paid funds. Among the universities, the University of Natural Resources and Life Sciences Vienna is ranked at the top with 32 ongoing and completed projects and, with €1.97 million in 2018, obtained the highest funding volume (see Figure 9-2). In general, the number of projects and the partial volumes per university differ considerably from the previous year. Accordingly, the same universities do not always have the same projects of the same size or the same number of projects.

In contrast, the proportions by fields of science remained quite constant compared to previous years.

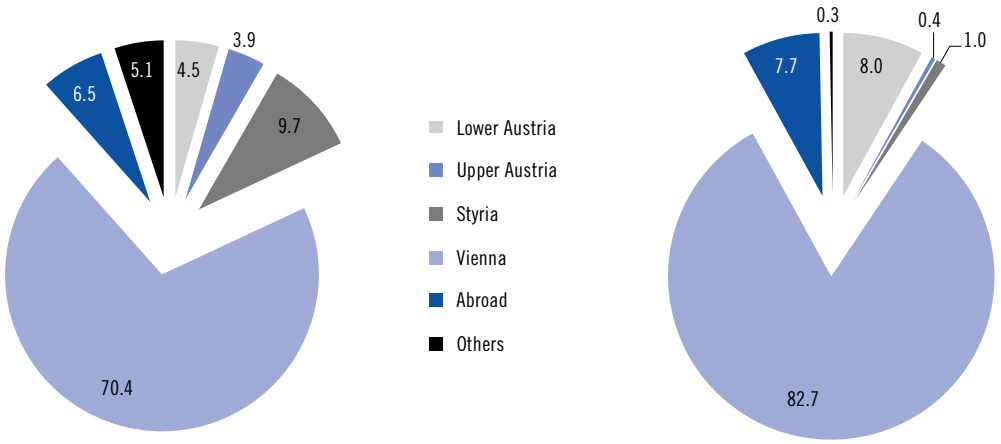
1 See www.bmbwf.gv.at/bfdat-public

2 The figure includes institutional funding of more than € 500,000 each.

As shown in Fig. 9-3, social sciences at 30.3% account for the majority of projects compared with 35.1% in 2017. The largest share of R&D funds, on the other hand, was invested in the field of natural sciences with 21.2%; in 2017 this amounted to 19.8%.

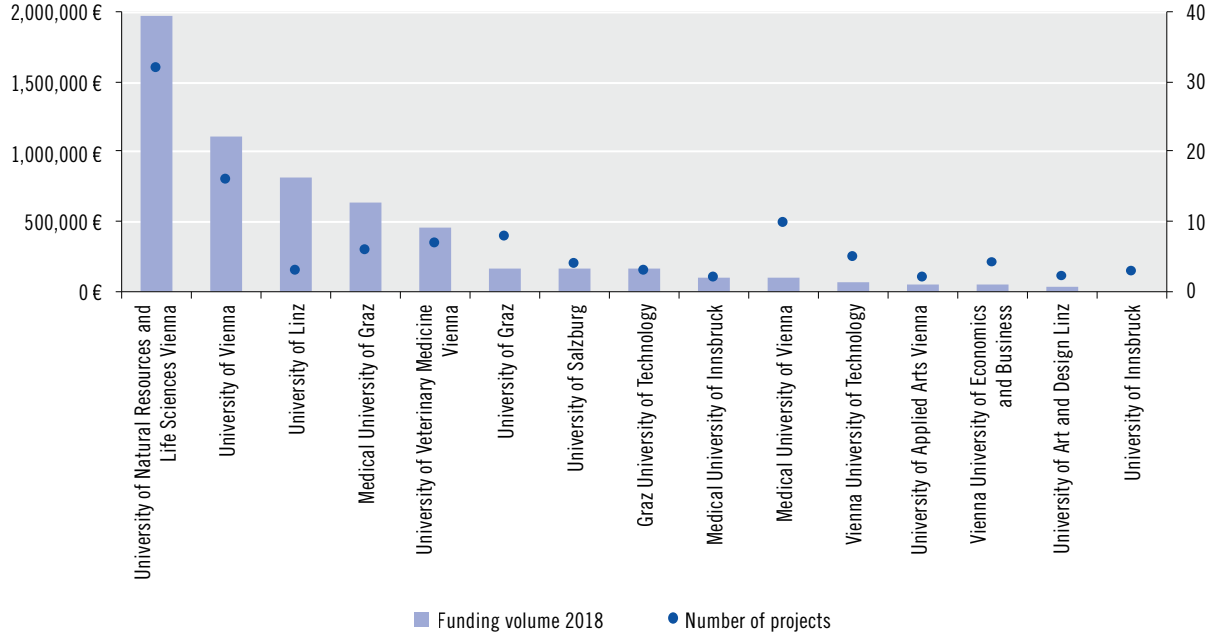
The federal research database also reveals that the Federal Ministry of Education, Science and Research (BMBWF) had the largest share of projects and funding volumes among the ministerial departments (see Fig. 9-4). Therefore the Federal Ministry

Fig. 9-1: Share of ongoing and completed R&D projects and funding volumes in 2018 by contractor's main location



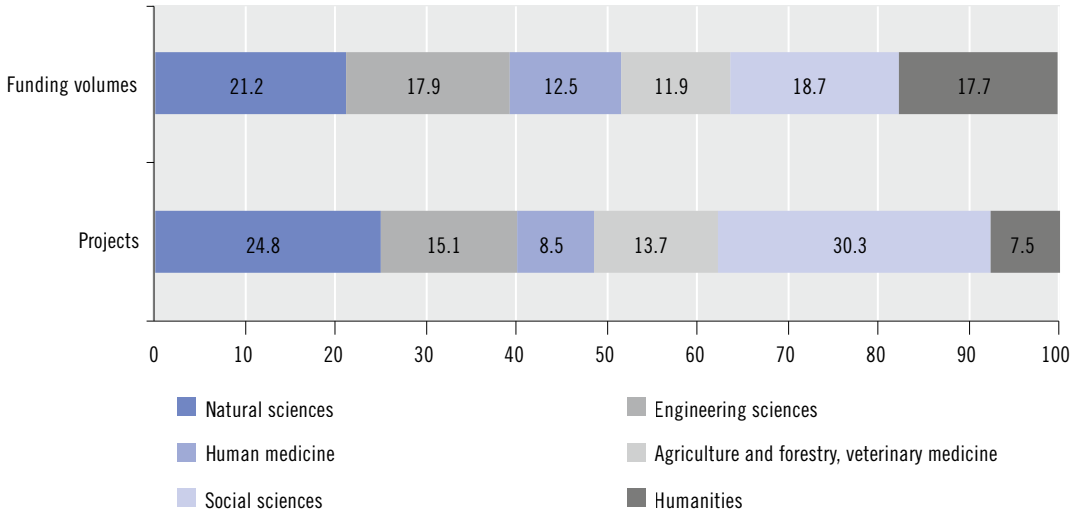
Source: Federal Ministry of Education, Science and Research (BMBWF), Federal research database B_f.dat (including "major" global financing for research institutions and the Austrian Science Fund – FWF), Vorarlberg 2018, without ongoing or completed project.
Note: The category "Other" includes all federal states with a share of less than 2.5% in ongoing and completed R&D projects (Burgenland, Carinthia, Salzburg, Tyrol).

Fig. 9-2: Ongoing and completed R&D projects and funding volumes by university, 2018



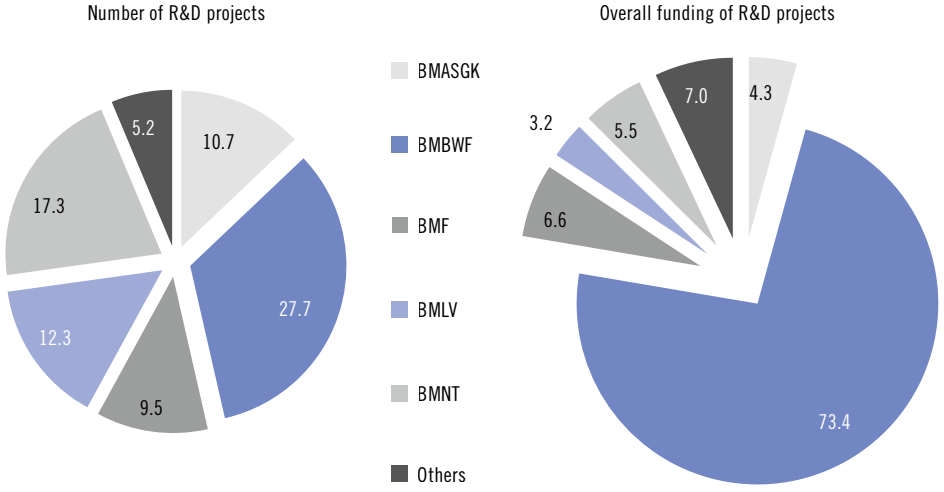
Source: Federal Ministry of Education, Science and Research (BMBWF), federal research database B_f.dat, graphic: WPZ Research.

Fig. 9-3: Ongoing and completed R&D projects and funding volumes by fields of science (in %), 2018



Source: Federal Ministry of Education, Science and Research (BMBWF), Federal research database B_f.dat, graphic: WPZ Research.

Fig. 9-4: Ongoing and completed R&D projects and funding volumes by ministerial department (in %), 2018



Source: Federal Ministry of Education, Science and Research (BMBWF), Federal research database B_f.dat (excl. "major" global financing with funding volumes higher than €500,000). Note: The category "Other" includes all ministerial departments with a share of less than 5% in ongoing and completed R&D projects (Federal Chancellery – BKA, Federal Ministry of Labour, Social Affairs and Consumer Protection – BMASK, Federal Ministry for Europe, Integration and Foreign Affairs – BMEIA, Federal Ministry for Health and Women's Affairs – BMGF, Federal Ministry of the Interior – BMI, Federal Ministry of Defence and Sports – BMLVS, Federal Ministry for Transport, Innovation and Technology – BMVIT, Federal Ministry for Digital and Economic Affairs – BMDW, Federal Ministry of Constitutional Affairs, Reforms, Deregulation and Justice – BMVRDJ, Federal Ministry of Science, Research and Economy – BMWFW).

of Education, Science and Research (BMBWF)[3] accounts for 27.7% of all R&D projects or 73.4% of the total funding volume (excluding global financing). Measured in terms of the number of projects, this is followed by the Federal Ministry for Sustainability and Tourism (BMNT), measured in terms of the funding volumes by the Federal Ministry of Finance (BMF).

The reason why the Federal Ministry for Transport, Innovation and Technology (BMVIT) had a comparatively small share (1.7%) is that most of the R&D funds here are outsourced to the Austrian Research Promotion Agency (FFG) and the Austria Wirtschaftsservice (aws).

3 Some projects may be counted twice in this presentation as a result of combined projects between ministries.

10. Statistics

10.1 Financing of gross domestic expenditure on R&D (Tables 1 and 2)[1]

According to an estimate by Statistics Austria, more than € 12.8 billion are expected to be spent in Austria in 2019 on research and experimental development (R&D). This means that the research intensity – i.e. the share of R&D expenditure in nominal gross domestic product (GDP) – will rise from 3.17% in 2018 to 3.19%. The nominal increase of the total Austrian R&D expenditures from 2018 to 2019 is estimated at 4.5% and is thus higher than the forecast increase of the gross domestic product of 3.8%. The research intensity in Austria has been above the 3% level targeted by the EU by 2020 since 2014, but below the Austrian target value of 3.76%. Over the past two decades, domestic expenditure on research and development has risen sharply: In 2009, the research intensity was still 2.60%; 20 years ago it lay at 1.85%.

In 2019, domestic firms are expected to spend around €6.3 billion on research and thus finance almost half of R&D expenditure (49.0%). The public sector will account for around € 4.5 billion, or 34.9%, of total R&D expenditure, with the federal government accounting for almost €3.8 billion (29.6%), making it by far the most important source of finance. The R&D funding of the federal government also includes the research tax premium, which is estimated by the Federal Ministry of Finance (BMF) at €670 million for 2019. With an increase of 3.6% compared to 2018, the rise in the public R&D funding is slightly over the expected nominal increase in gross domestic product. Around €547 million will be financed by the regional governments. Other public institutions – such as municipalities, chambers or social insurance institutions – will contribute around €132 million. As in the past, foreign countries will continue to be an important source of financing for domestic R&D expenditure: Approximately €2 billion are expected to be invested in Austria for research; mainly from multinational firms whose subsidiaries conduct research in Austria. R&D funding from the private non-profit sector will amount to around €77 million.

In the EU comparison for 2017 (the most recent year for which comparative data are available), Austria has the second highest research intensity among the EU-28. Only Sweden boasts a significantly higher research intensity of 3.40%. Denmark (3.05%) and Germany (3.02%) already meet the EU's 3% target. In addition, Finland (2.76%), Belgium (2.58%) and France (2.19%) are the only other countries whose R&D intensity was above the EU average of 2.06% in 2017.

Comparable countries that are important for Europe sometimes show significantly higher R&D expenditures than the EU. Within the European non-EU countries, Switzerland reaches a very high value of 3.37% (2015), while the research intensity of Iceland and Norway were also above the EU average at 2.10% and 2.09% respectively.

Among the major non-European economies, R&D expenditure in South Korea, at 4.55% of GDP, is more than twice as high as in the European Union. Japan (3.20%) and the USA (2.79%) also achieve significantly higher research intensity than Europe. Since 2015, the research intensity in China has also been higher than that of the EU-28: in 2017 it reached 2.13% (EU: 2.06%).

The estimates and year-end closing data of the federal and the regional governments, current economic forecasts and the preliminary results of the last R&D survey for the reporting year 2017 in the business enterprise sector were all taken into account in estimating the Austrian gross domestic expenditure on R&D in 2019.

1 Each year, Statistics Austria creates a "Global estimate of the gross domestic expenditure for R&D in Austria" based on the results of the R&D statistical surveys and other currently available documents and information, in particular the R&D-related budget appropriations and outlays of the federal and regional governments. As they compile this annual global estimate, any necessary retroactive revisions or updates are made, reflecting the latest data. They present, using the definitions of the Frascati Manual which are globally valid (OECD, EU) and thus guarantee international comparability, the financing of the expenditures for research and experimental development that was carried out in Austria. According to these definitions and guidelines, foreign financing of R&D done in Austria is included, but Austrian payments for R&D performed abroad are not (domestic concept).

10.2 Federal R&D expenditure in 2019

The federal expenditure shown in Table 10-1 for R&D carried out in Austria in 2019 is composed as described below. According to the methodology used for the R&D global estimate, the core is the total amount of R&D financed domestically by the federal government on the basis of the "Detailed overview of research-related appropriation of federal government funds" in the R&D Annex to the Federal Finances Act (BFG) 2019, Part b. The estimate also includes, according to the information currently available, the funds that should be paid out in 2019 by the National Foundation for Research, Technology, and Development, as well as the estimates of the 2019 payout for research tax premiums (Source: Federal Ministry of Finance (BMF) in each case).

In addition to its expenditures for R&D in Austria, in 2019 the federal government will pay **contributions to international organisations** aimed at research and the promotion of research amounting to €103.3 million. They are shown in the "Detailed overview of research-related appropriation of federal funds" in the R&D Annex to the Federal Finances Act (BFG) 2019 (Part a), but according to the domestic concept they are not included in the Austrian gross domestic expenditure on R&D.

In the tables **"Federal expenditure on research and research promotion",** the total research-related expenditure of the federal government, which include the research-related shares of the contribution payments to international organisations (see Pt. 2.2 above), were evaluated on the basis of the "Detailed overview of research-related appropriation of federal funds" in the R&D Annex to the Federal Finances Act (BFG) 2019 (Parts a and b). These correspond to the "GBARD" concept[2] used by the OECD and the EU, which refers primarily to the budgets of the central and federal states, in contrast to the domestic concept, which includes research-relevant contributions to international organisations and forms the basis for the classification of R&D budget data according to socio-economic objectives for reporting to the EU and OECD.

In 2019 the following socio-economic objectives receive the largest portions of federal expenditure on research and research promotion:

- Promotion of general knowledge advancement: 30.9%
- Promotion of trade, commerce, and industry: 24.5%
- Promotion of the health care system: 22.1%
- Promotion of social and socio-economic development: 4.9%
- Promotion of research covering the earth, the seas, the atmosphere and space: 4.3%
- Promotion of energy production, storage and distribution: 3.5%

10.3 R&D expenditure of the regional governments

The research funding by the regional governments shown as a subtotal in Table 10-1 is listed from the state budget-based estimates of R&D expenditure reported by the offices of the regional governments. The R&D expenditure of the regional hospitals is estimated annually by Statistics Austria using a methodology agreed on with the regional governments.

10.4 An international comparison of 2016 R&D expenditure

The overview shows Austria's position compared to the other European Union Member States and the OECD in terms of the most important R&D-related indices (Source: OECD, MSTI 2018-2).

2 GBARD: Government Budget Allocations for Research and Development.

List of Tables in the Statistical Annex

Table 10-1: Global estimate for 2019: Gross domestic expenditure on R&D financing of research and experimental development carried out in Austria in 2005–2019

Funding	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1. Gross domestic expenditure on R&D (in € millions)	**6,029.81**	**6,318.59**	**6,867.82**	**7,548.06**	**7,479.75**	**8,066.44**	**8,276.34**	**9,287.84**	**9,571.28**	**10,275.18**	**10,499.15**	**11,135.56**	**11,518.52**	**12,246.01**	**12,799.70**
of which financed by:															
Federal government [1]	1,764.86	1,772.06	1,916.96	2,356.78	2,297.46	2,586.43	2,614.29	2,984.27	2,852.68	3,086.03	3,036.19	3,353.01	3,418.40	3,663.04	3,786.46
Regional governments [2]	330.17	219.98	263.18	354.35	273.37	405.17	298.71	416.31	307.45	461.59	344.97	445.78	471.49	522.33	547.27
Business enterprise sector [3]	2,750.95	3,057.00	3,344.40	3,480.57	3,520.02	3,639.35	3,820.90	4,243.33	4,665.75	4,901.28	5,222.22	5,385.03	5,608.08	5,951.97	6,266.11
Abroad [4]	1,087.51	1,163.35	1,230.24	1,240.53	1,255.93	1,297.63	1,401.67	1,495.94	1,590.21	1,663.95	1,737.69	1,782.17	1,838.62	1,913.45	1,990.33
Other [5]	96.32	106.20	113.04	115.83	132.97	137.86	140.77	147.99	155.19	162.33	158.08	169.57	181.93	195.22	209.53
2. Nominal GDP [6])(in € billions)	**254.08**	**267.82**	**283.98**	**293.76**	**288.04**	**295.90**	**310.13**	**318.65**	**323.91**	**333.15**	**344.26**	**356.24**	**369.90**	**386.09**	**400.66**
3. Gross domestic expenditure on R&D as a % of GDP	***2.37***	***2.36***	***2.42***	***2.57***	***2.60***	***2.73***	***2.67***	***2.91***	***2.95***	***3.08***	***3.05***	***3.13***	***3.11***	***3.17***	***3.19***

As at: 11 April 2019.

Source: Statistics Austria (Bundesanstalt Statistik Österreich). On the basis of R&D funding of research and experimental development carried out in Austria.

1) 2006, 2007, 2009, 2011, 2013, 2015: Survey results (federal government including the Austrian Science Fund – FWF, Austrian Research Promotion Agency – FFG).
2005, 2008, 2010, 2012: Annex T of the Federal Finances Acts (in each case Part b, Outlays); 2014: Federal Finances Act 2016, Detailed overview of research-related appropriation of federal funds (Part b, Outlays).
2016, 2017: Federal Finances Acts 2018 and 2019, Detailed overview of research-related appropriation of federal funds (in each case Part b, Outlays).
2018, 2019: Federal Finances Act 2019, Detailed overview of research-related appropriation of federal funds (Part b, Financing proposal).
2005: including €84.4 million National Foundation for Research, Technology and Development and €121.3 million research tax premiums.
2008: including €91.0 million National Foundation for Research, Technology and Development and €340.6 million research tax premiums.
2010: including €74.6 million National Foundation for Research, Technology and Development and €328.8 million research tax premiums.
2012: including €51.3 million National Foundation for Research, Technology and Development and €574.1 million research tax premiums.
2014: including €38.7 million National Foundation for Research, Technology and Development and €493.2 million research tax premiums.
2016: including €51.7 million National Foundation for Research, Technology and Development and €527.7 million research tax premiums.
2017: including €48.2 million National Foundation for Research, Technology and Development and €585.6 million research tax premiums.
2018: Including €141.4 million National Foundation for Research, Technology and Development and €713.1 million research tax premiums.
2019: Including €138.7 million National Foundation for Research, Technology and Development and an expected €670.0 million research tax premiums (Source: Federal Ministry of Finance (BMF), based on the currently available information).
2) 2006, 2007, 2009, 2011, 2013, 2015: survey results. 2005, 2008, 2010, 2012, 2014, 2016–2019: Based on the R&D expenditure reported by the state government offices.
3) 2006, 2007, 2009, 2011, 2013, 2015: survey results. 2005, 2008, 2010, 2012, 2014, 2016–2019: Estimates made by Statistics Austria.
4) 2006, 2007, 2009, 2011, 2013, 2015: survey results. 2005, 2008, 2010, 2012, 2014, 2016–2019: Estimates made by Statistics Austria.
5) Financing by local governments (excluding Vienna), chambers, social insurance institutions and other public financing and from the private non-profit sector.
2006, 2007, 2009, 2011, 2013, 2015: survey results. 2005, 2008, 2010, 2012, 2014, 2016–2019: Estimates made by Statistics Austria.
6) 2005–2018: Statistics Austria, as of March 2019: Austrian Institute of Economic Research (WIFO), economic forecast March 2019.

Table 10-2: Global estimate for 2019: Gross domestic expenditure on R&D funding of research and experimental development carried out in Austria in 2005-2019 as a percentage of GDP

Funding	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1. Gross domestic expenditure on R&D (in % of GDP)	**2.37**	**2.36**	**2.42**	**2.57**	**2.60**	**2.73**	**2.67**	**2.91**	**2.95**	**3.08**	**3.05**	**3.13**	**3.11**	**3.17**	**3.19**
of which financed by:															
Federal government [1]	0.69	0.66	0.68	0.80	0.80	0.87	0.84	0.94	0.88	0.93	0.88	0.94	0.92	0.95	0.95
Regional governments [2]	0.13	0.08	0.09	0.12	0.09	0.14	0.10	0.13	0.09	0.14	0.10	0.13	0.13	0.14	0.14
Business enterprise sector [3]	1.08	1.14	1.18	1.18	1.22	1.23	1.23	1.33	1.44	1.47	1.52	1.51	1.52	1.54	1.56
Abroad [4]	0.43	0.43	0.43	0.42	0.44	0.44	0.45	0.47	0.49	0.50	0.50	0.50	0.50	0.50	0.50
Other [5]	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
2. Nominal GDP [6] (in € billions)	**254.08**	**267.82**	**283.98**	**293.76**	**288.04**	**295.90**	**310.13**	**318.65**	**323.91**	**333.15**	**344.26**	**356.24**	**369.90**	**386.09**	**400.66**

As at: 11 April 2019.

Source: Statistics Austria (Bundesanstalt Statistik Österreich). On the basis of R&D funding of research and experimental development carried out in Austria.

Footnotes see Table 10-1.

Table 10-3: Federal expenditure on research and research promotion, 2016–2019

Ministries[1]	Outturn				Budget			
	2016[2]		2017[3]		2018[3]		2019[3]	
	in € millions	in %	in € millions	in %	in € millions	in %	in € millions	in %
Federal Chancellery (BKA)[4]	40.289	*1.4*	43.112	*1.5*	44.255	*1.5*	44.069	*1.4*
Federal Ministry for Family and Youth (BMFJ)	1.095	*0.0*	1.138	*0.0*	.	.	.	.
Federal Ministry for the Civil Service and Sports (BMÖDS)	.	.	.	.	-	-	-	-
Federal Ministry for Europe, Integration and Foreign Affairs (BMEIA)	2.152	*0.1*	2.232	*0.1*	2.765	*0.1*	3.007	*0.1*
Federal Ministry of Labour, Social Affairs and Consumer Protection (BMASK)	5.747	*0.2*	7.111	*0.2*	.	.	.	.
Federal Ministry for Health and Women's Affairs (BMGF)	5.764	*0.2*	5.649	*0.2*	.	.	.	.
Federal Ministry of Labour, Social Affairs, Health and Consumer Protection (BMASGK)	.	.	.	.	12.860	*0.4*	13.064	*0.4*
Federal Ministry of Education (BMB)	39.927	*1.4*	34.304	*1.2*	.	.	.	.
Federal Ministry of Science, Research and Economy (BMWFW)	2,213.521	*77.0*	2,265.857	*78.5*	.	.	.	.
Federal Ministry of Education, Science and Research (BMBWF)	.	.	.	.	2,197.742	*75.5*	2,361.438	*76.7*
Federal Ministry for Digital and Economic Affairs (BMDW)	.	.	.	.	101.120	*3.5*	99.570	*3.2*
Federal Ministry of Finance (BMF)	30.683	*1.1*	31.714	*1.1*	32.307	*1.1*	32.026	*1.0*
Federal Ministry of the Interior (BMI)	1.234	*0.0*	1.327	*0.0*	1.447	*0.0*	1.428	*0.0*
Federal Ministry of Defence and Sports (BMLVS)	2.352	*0.1*	3.202	*0.1*	.	.	.	.
Federal Ministry of Defence (BMLV)	.	.	.	.	4.684	*0.2*	4.688	*0.2*
Federal Ministry for Agriculture, Forestry, Environment and Water Management (BMLFUW)	44.373	*1.5*	43.989	*1.5*	.	.	.	.
Federal Ministry for Sustainability and Tourism (BMNT)	.	.	.	.	38.948	*1.3*	39.191	*1.3*
Federal Ministry of Justice (BMJ)	0.082	*0.0*	0.063	*0.0*	.	.	.	.
Federal Ministry of Constitutional Affairs, Reforms, Deregulation and Justice (BMVRDJ)	.	.	.	.	0.019	*0.0*	0.059	*0.0*
Federal Ministry for Transport, Innovation and Technology (BMVIT)	488.487	*17.0*	450.081	*15.6*	477.134	*16.4*	482.547	*15.7*
Total	**2,875.706**	***100.0***	**2,889.779**	***100.0***	**2,913.281**	***100.0***	**3,081.087**	***100.0***

As at: 11 April 2019.

Source: Statistics Austria (Bundesanstalt Statistik Österreich).

1) In accordance with the applicable version of the Act Governing Federal Ministries of 1986 (2016, 2017: Federal Law Gazette. I No. 49/2016; 2018, 2019: Federal Law Gazette. I No. 164/2017).

2) Federal Finances Act 2018, Detailed overview of research-related appropriation of federal funds.

3) Federal Finances Act 2019, Detailed overview of research-related appropriation of federal funds.

4) Including the highest executive bodies.

Table 10-4: Detailed overview of research-related appropriation of federal funds, 2017–2019

Detailed overview
Research-related appropriation of federal funds

Federal expenditure on research by ministry, 2017 – 2019

The following overviews are broken down according to:

1. Contributions from federal funds paid to international organisations whose goals include research and research promotion **(Part a)**
2. Other federal spending on research and research promotion **(Part b, federal research budget)**

This list has been drawn up primarily with a view to the research impact, which is based on the research concept defined by the OECD's Frascati Manual. This concept is also used by Statistics Austria as a benchmark in carrying out surveys of research and experimental development (R&D).

BUNDESVORANSCHLAG 2019

Detailübersicht Forschungswirksame Mittelverwendungen des Bundes

(Beträge in Millionen Euro)

a) Beitragszahlungen an internationale Organisationen - Finanzierungsvoranschlag

VA-Stelle	Konto	Ugl	Bezeichnung	Anm	Finanzierungsvoranschlag 2019			Finanzierungsvoranschlag 2018			Erfolg 2017		
					Insgesamt	hievon		Insgesamt	hievon		Insgesamt	hievon	
						%	Forschung		%	Forschung		%	Forschung
			Bundeskanzleramt										
			UG10										
10010100	7800	100	Mitgliedsbeiträge an Institutionen im Ausland		0,113	100	0,113	0,113	100	0,113	0,180	100	0,180
10010100	7800	101	Mitgliedsbeitrag für OECD								3,755	20	0,751
10010100	7800	102	OECD-Energieagentur (Mitgliedsbeitrag)								0,225	20	0,045
10010100	7800	103	OECD-Beiträge zu Sonderprojekten										
10010100	7800	110	Mitgliedsbeitrag AV-Infostelle		0,032	5	0,002	0,032	5	0,002	0,030	5	0,002
10010200	7800	100	Mitgliedsbeiträge an Institutionen im Ausland		0,006	30	0,002	0,006	30	0,002	0,006	30	0,002
			Summe UG10		**0,151**		**0,117**	**0,151**		**0,117**	**4,196**		**0,980**
			Summe Bundeskanzleramt		**0,151**		**0,117**	**0,151**		**0,117**	**4,196**		**0,980**
			BM für Europa, Integration und Äußeres										
			UG12										
12020200	7800	101	Mitgliedsbeitrag für OECD	*	3,675	20	0,735	3,115	20	0,623			
12020200	7800	102	OECD-Energieagentur (Mitgliedsbeitrag)	*	0,225	20	0,045	0,225	20	0,045			
12020200	7840	000	Laufende Transfers an Drittländer	*	3,194	35	1,118	3,144	35	1,100	3,144	35	1,100
12020200	7840	002	Organisation der VN für industr.Entwicklung(UNIDO)		0,822	46	0,378	0,605	46	0,278	0,897	46	0,413
12020200	7840	003	Org. VN Erziehung,Wissensch.u.Kultur(UNESCO)		2,165	30	0,650	2,131	30	0,639	2,131	30	0,639
12020200	7840	056	Drogenkontrollprogramm der VN (UNDCP)		0,406	20	0,081	0,400	20	0,080	0,400	20	0,080
			Summe UG12		**10,487**		**3,007**	**9,620**		**2,765**	**6,572**		**2,232**
			Summe BM für Europa, Integration und Äußeres		**10,487**		**3,007**	**9,620**		**2,765**	**6,572**		**2,232**
			BM für Finanzen										
			UG15										
15010100	7800	000	Laufende Transferzahlungen an das Ausland		0,151	100	0,151	0,151	100	0,151	0,387	26	0,101
			Summe UG15		**0,151**		**0,151**	**0,151**		**0,151**	**0,387**		**0,101**
			Summe BM für Finanzen		**0,151**		**0,151**	**0,151**		**0,151**	**0,387**		**0,101**
			BM für Bildung, Wissenschaft und Forschung										
			UG30										
30010300	7800	104	OECD-Schulbauprogramm		0,031	100	0,031	0,031	100	0,031	0,023	100	0,023
30010400	7800	000	Laufende Transferzahlungen an das Ausland	*	0,037	100	0,037	0,037	100	0,037	0,039	100	0,039
			Summe UG30		**0,068**		**0,068**	**0,068**		**0,068**	**0,062**		**0,062**
			UG31										
31030100	7800	000	Laufende Transferzahlungen an das Ausland		0,750	100	0,750	0,750	100	0,750	0,729	100	0,729
31030100	7800	066	Forschungsvorhaben in internationaler Kooperation		0,802	100	0,802	0,802	100	0,802	0,237	100	0,237
31030100	7800	200	Beiträge an internationale Organisationen		1,570	50	0,785	1,570	50	0,785	1,389	50	0,695
31030204	7800	062	ESO		6,730	100	6,730	6,520	100	6,520	6,309	100	6,309
31030204	7800	063	Europ. Zentrum für mittelfristige Wettervorhersage		1,300	100	1,300	1,300	100	1,300	1,103	100	1,103
31030204	7800	064	Molekularbiologie - Europäische Zusammenarbeit		3,000	100	3,000	2,900	100	2,900	2,859	100	2,859

31030204	7800	065	World Meteorological Organisation		0,550	50	0,275	0,400	50	0,200	0,453	50	0,227
31030204	7800	200	Beiträge an internationale Organisationen		0,855	50	0,428	0,840	50	0,420	0,823	50	0,412
31030204	7800	242	Beitrag für die CERN		23,700	100	23,700	23,700	100	23,700	22,564	100	22,564
			Summe UG31		**39,257**		**37,770**	**38,782**		**37,377**	**36,466**		**35,135**
			Summe BM für Bildung, Wissenschaft und Forschung		**39,325**		**37,838**	**38,850**		**37,445**	**36,528**		**35,197**
			BM für Digitalisierung und Wirtschaftsstandort										
			UG40										
40020100	7800	100	Mitgliedsbeiträge an Institutionen im Ausland		0,900	11	0,099	0,900	11	0,099	0,925	11	0,102
			Summe UG40		**0,900**		**0,099**	**0,900**		**0,099**	**0,925**		**0,102**
			Summe BM für Digitalisierung und Wirtschaftsstandort		**0,900**		**0,099**	**0,900**		**0,099**	**0,925**		**0,102**
			BM für Verkehr, Innovation und Technologie										
			UG34										
34010100	7800	200	Beiträge an internationale Organisationen		0,050	100	0,050	0,050	100	0,050	0,070	100	0,070
34010100	7800	600	ESA-Pflichtprogramme		17,900	100	17,900	17,900	100	17,900	18,061	100	18,061
34010100	7800	601	EUMETSAT		9,580	100	9,580	9,580	100	9,580	9,867	100	9,867
34010100	7800	602	OECD-Energieagentur		0,010	100	0,010	0,010	100	0,010			
34010100	7800	603	ESA-Wahlprogramme		32,364	100	32,364	34,364	100	34,364	35,690	100	35,690
34010100	7830	000	Laufende Transfers an Drittländer		0,220	100	0,220	0,220	100	0,220	0,206	100	0,206
			Summe UG34		**60,124**		**60,124**	**62,124**		**62,124**	**63,894**		**63,894**
			UG41										
41010100	7800	200	Beiträge an internationale Organisationen		0,180	6	0,011	0,180	6	0,011	0,107	6	0,006
41020100	7800	200	Beiträge an internationale Organisationen		0,020	100	0,020	0,020	100	0,020			
41020402	7800	200	Beiträge an internationale Organisationen		0,064	15	0,010	0,064	15	0,010	0,046	15	0,007
41020500	7800	200	Beiträge an internationale Organisationen		0,030	15	0,005	0,030	15	0,005	0,035	15	0,005
41020500	7830	000	Laufende Transfers an Drittländer		0,482	15	0,072	0,482	15	0,072	0,440	15	0,066
41020601	7800	200	Beiträge an internationale Organisationen		0,050	50	0,025	0,050	50	0,025	0,035	50	0,018
41020700	7800	200	Beiträge an internationale Organisationen		0,585	20	0,117	0,585	20	0,117	0,590	20	0,118
			Summe UG41		**1,411**		**0,260**	**1,411**		**0,260**	**1,253**		**0,220**
			Summe BM für Verkehr, Innovation und Technologie		**61,535**		**60,384**	**63,535**		**62,384**	**65,147**		**64,114**
			BM für Nachhaltigkeit und Tourismus										
			UG42										
42010100	7800	100	Mitgliedsbeiträge an Institutionen im Ausland		0,020	50	0,010	0,020	50	0,010	0,003	50	0,002
42020202	7270	000	Werkleistungen durch Dritte	*							0,200	50	0,100
42020202	7411	000	Lfd Transfers an verbundene Unternehmungen	*							1,640	50	0,820
42020202	7800	080	FAO-Beiträge		3,400	50	1,700	3,400	50	1,700	3,001	50	1,501
42020202	7800	081	FAO Welternährungsprogramm, Beiträge										
42020202	7800	083	Int. Vertrag für pflanzengenetische Ressourcen		0,025	100	0,025	0,025	100	0,025	0,025	100	0,025
			Summe UG42		**3,445**		**1,735**	**3,445**		**1,735**	**4,869**		**2,448**
			Summe BM für Nachhaltigkeit und Tourismus		**3,445**		**1,735**	**3,445**		**1,735**	**4,869**		**2,448**
			Teil a -Summe		**115,994**		**103,331**	**116,652**		**104,696**	**118,624**		**105,174**

b) Bundesbudget Forschung - Finanzierungsvoranschlag

(ausgen. die bereits im Abschnitt a) ausgewiesen sind)

VA-Stelle	Konto	Ugl	Bezeichnung	Anm	Finanzierungsvoranschlag 2019			Finanzierungsvoranschlag 2018			Erfolg 2017		
					Insgesamt	hievon		Insgesamt	hievon		Insgesamt	hievon	
						%	Forschung		%	Forschung		%	Forschung
			Parlamentsdirektion										
			UG02										
02010500	7330	086	Nationalfonds für Opfer des Nationalsozialismus	*	3,858	1	0,039	3,726	2	0,075	3,723	3	0,097
			Summe UG02		**3,858**		**0,039**	**3,726**		**0,075**	**3,723**		**0,097**
			Summe Parlamentsdirektion		**3,858**		**0,039**	**3,726**		**0,075**	**3,723**		**0,097**
			Bundeskanzleramt										
			UG10										
10010100	7260	000	Mitgliedsbeiträge an Institutionen im Inland		0,002	28	0,001	0,002	28	0,001	0,785	50	0,393
10010100	7270	000	Werkleistungen durch Dritte		0,651	4	0,026	0,672	4	0,027	1,887	4	0,075
10010200	7260	000	Mitgliedsbeiträge an Institutionen im Inland		0,001	50	0,001	0,001	50	0,001		50	
10010200	7270	000	Werkleistungen durch Dritte		9,495	4	0,380	9,386	4	0,375	2,649	4	0,106
10010401	7340	001	Pauschalabgeltung gem. § 32 Abs.5 BStatG		49,891	1	0,499	50,891	1	0,509	50,630	1	0,506
10010402			Österr. Staatsarchiv		15,490	3	0,465	14,865	3	0,446	14,333	3	0,430
			Summe UG10		**75,530**		**1,372**	**75,817**		**1,359**	**70,284**		**1,510**
			UG25										
25010500	7270	006	Werkleistungen durch Dritte (zw)	*	0,676	42	0,284	0,732	61	0,447	0,333	89	0,295
25010500	7420	113	Familie und Beruf Management GesmbH. (zw)	*	2,140	33	0,706	2,140	33	0,706	2,140	38	0,804
25020100	7270	000	Werkleistungen durch Dritte	*	0,947	1	0,009	0,947	1	0,009	0,700	2	0,012
25020200	7270	000	Werkleistungen durch Dritte	*	1,787	2	0,036	1,787	2	0,036	1,327	2	0,027
			Summe UG25		**5,550**		**1,035**	**5,606**		**1,198**	**4,500**		**1,138**
			UG32										
32010300			Denkmalschutz		38,343	18	6,902	38,343	18	6,902	35,596	18	6,407
32030100			Bundesmuseen		128,162	27	34,604	128,162	27	34,604	126,362	27	34,118
			Summe UG32		**166,505**		**41,506**	**166,505**		**41,506**	**161,958**		**40,525**
			Summe Bundeskanzleramt		**247,585**		**43,913**	**247,928**		**44,063**	**236,742**		**43,173**
			BM für Inneres										
			UG11										
11010100	7278	020	Konzepte, Analysen und Gutachten (ADV)	*							0,009	100	0,009
11010200	7270	900	Werkleistungen durch Dritte	*				0,012	100	0,012	0,012	100	0,012
11020600			Bundeskriminalamt	*	13,904	8	1,112	14,182	8	1,135	12,664	8	1,013
11020600	7270	900	Werkleistungen durch Dritte	*							0,009	100	0,009
11020800	7270	900	Werkleistungen durch Dritte	*							0,121	100	0,121
11030100	7660	900	Zuschüsse f. lfd. Aufwand an private Institutionen	*							0,088	100	0,088
11030100	7672	009	Projekte des AMIF (Kofinanzierung)	*							0,028	100	0,028
11030500	7270	900	Werkleistungen durch Dritte	*							0,047	100	0,047
			Summe UG11		**13,904**		**1,112**	**14,194**		**1,147**	**12,978**		**1,327**
			UG18										
18010100	7660	900	Zuschüsse f. lfd. Aufwand an private Institutionen	*				0,017	100	0,017			
18010100	7672	009	Projekte des AMIF (Kofinanzierung)	*	0,316	100	0,316	0,283	100	0,283			
			Summe UG18		**0,316**		**0,316**	**0,300**		**0,300**			
			Summe BM für Inneres		**14,220**		**1,428**	**14,494**		**1,447**	**12,978**		**1,327**
			BM für Verfassung, Reformen, Deregulierung und Justiz										
			UG13										
13010100	7271	900	Werkleistungen (durch Dritte)	*	0,088	50	0,044	0,038	50	0,019	0,045	50	0,023
13030101	7271	900	Werkleistungen (durch Dritte)	*	0,030	50	0,015				0,079	50	0,040
			Summe UG13		**0,118**		**0,059**	**0,038**		**0,019**	**0,124**		**0,063**
			Summe BM für Verfassung, Reformen, Deregulierung und Justiz		**0,118**		**0,059**	**0,038**		**0,019**	**0,124**		**0,063**

			BM für Landesverteidigung											
			UG14											
14040100			Heeresgeschichtliches Museum	*	3,509	15	0,526	3,479	15	0,522	3,417	20	0,683
14050100	7270	000	Werkleistungen durch Dritte	*	0,258	58	0,150	0,258	58	0,150	0,103	58	0,060
14050100	7270	900	Werkleistungen durch Dritte	*	1,000	100	1,000	1,000	100	1,000	2,417	100	2,417
14050100	7411	028	FFG - Verteidigungsforschung		3,000	100	3,000	3,000	100	3,000			
14050202	4691	000	Versuche und Erprobungen auf kriegstechn. Gebiet		0,120	10	0,012	0,120	10	0,012	0,424	10	0,042
			Summe UG14		**7,887**		**4,688**	**7,857**		**4,684**	**6,361**		**3,202**
			Summe BM für Landesverteidigung		**7,887**		**4,688**	**7,857**		**4,684**	**6,361**		**3,202**
			BM für Finanzen										
			UG15										
15010100	6430	001	Arbeiten des WIIW		0,846	50	0,423	0,829	50	0,415	0,809	50	0,405
15010100	6430	002	Arbeiten des WSR		1,371	50	0,686	1,371	50	0,686	1,371	50	0,686
15010100	6430	003	Arbeiten des Wifo		4,250	52	2,210	4,167	52	2,167	4,085	50	2,043
15010100	7270	000	Werkleistungen durch Dritte	*	1,473	18	0,265	1,444	18	0,260	1,526	100	1,526
15010100	7661	002	Institut für Finanzwissenschaft und Steuerrecht										
15010100	7662	002	Institut für höhere Studien und wiss. Forschung	*	3,672	56	2,056	3,600	56	2,016	3,573	53	1,892
15010100	7663	005	Forum Alpbach										
15010100	7666	020	Europ.Zentrum f. Wohlfahrtspolit. u. Sozialforsch.										
15010100	7669	020	Sonstige Förderungsbeiträge	*	0,300	100	0,300	0,300	100	0,300	0,826	27	0,226
			Forschungswirksamer Lohnnebenkostenanteil		25,935	100	25,935	26,312	100	26,312	24,835	100	24,835
			Summe UG15		**37,847**		**31,875**	**38,023**		**32,156**	**37,025**		**31,613**
			Summe BM für Finanzen		**37,847**		**31,875**	**38,023**		**32,156**	**37,025**		**31,613**
			BM für Arbeit, Soziales, Gesundheit und Konsumentenschutz										
			UG20										
20010101	7340	302	Überweisung an das AMS gem. § 41 (2) (zw)	*	496,610	1	4,966	471,610	1	4,716	469,610	1	3,242
20010201	7270	006	Werkleistungen durch Dritte (zw)	*	314,021		0,471	335,145		0,503	387,099		0,646
20010201	7668	901	Nicht einzeln anzuführende Subventionen (zw)	*							138,202	1	0,701
			Summe UG20		**810,631**		**5,437**	**806,755**		**5,219**	**994,911**		**4,589**
			UG21										
21010100	7270	000	Werkleistungen durch Dritte		5,854	3	0,176	5,927	3	0,178	3,822	3	0,115
21010300	7270	000	Werkleistungen durch Dritte		1,026	16	0,164	0,894	16	0,143	0,894	16	0,143
21010300	7660	900	Zuschüsse f. lfd. Aufwand an private Institutionen		2,500	2	0,050	3,094	2	0,062	4,705	2	0,094
21010400	7262	001	Beitrag Europ. Zentrum Wohlfahrtspol.u.Sozialfor.		0,587	50	0,294	0,587	50	0,294	0,587	50	0,294
21010400	7270	000	Werkleistungen durch Dritte		1,972	4	0,079	2,153	4	0,086	1,446	4	0,058
21010400	7270	304	Werkleistungen EU-SILC		1,128	100	1,128	1,128	100	1,128	1,818	100	1,818
			Summe UG21		**13,067**		**1,891**	**13,783**		**1,891**	**13,272**		**2,522**
			UG24										
24010200	7420	012	Transferzahlungen, Ernährungsagentur (Ges.m.b.H)		49,878	11	5,487	49,878	11	5,487	49,878	11	5,487
24030100	7270	000	Werkleistungen durch Dritte		3,657	4	0,146	4,004	4	0,160	1,630	4	0,065
24030200	7270	000	Werkleistungen durch Dritte		5,165	2	0,103	5,165	2	0,103	4,830	2	0,097
			Summe UG24		**58,700**		**5,736**	**59,047**		**5,750**	**56,338**		**5,649**
			Summe BM für Arbeit, Soziales, Gesundheit und Konsumentenschutz		**882,398**		**13,064**	**879,585**		**12,860**	**1.064,521**		**12,760**
			BM für Bildung, Wissenschaft und Forschung										
			UG30										
30010400			Qualitätsentwicklung und -steuerung	*	32,395	8	2,592	41,277	8	3,302	35,206	8	2,816
30010400	7340	000	Transferzahlungen an sonst. Träger öffentl.Rechtes		0,261	100	0,261	0,247	100	0,247	0,119	100	0,119
30010400	7340	003	Basisabgeltung (BIFIE)		11,200	80	8,960	11,600	80	9,280	11,549	80	9,239

30010500			Lehrer/innenbildung		236,470	10	23,647	226,192	10	22,619	217,776	10	21,778
30020700			Zweckgebundene Gebarung Bundesschulen	*	7,967	3	0,239	7,967	3	0,239	9,658	3	0,290
			Summe UG30		**288,293**		**35,699**	**287,283**		**35,687**	**274,308**		**34,242**
			UG31										
31010100			Zentralstelle und Serviceeinrichtungen		58,662	20	11,732	56,761	20	11,352	52,289	20	10,458
31020100			Universitäten		3.510,927	49	1.720,354	3.244,194	49	1.589,655	3.252,957	49	1.593,949
31020100	7270	000	Werkleistungen durch Dritte		0,330	49	0,162	0,330	49	0,162	0,014	49	0,007
31020100	7353	440	Klinischer Mehraufwand (Klinikbauten)		75,612	50	37,806	62,149	50	31,075	43,627	50	21,814
31020200			Fachhochschulen		319,200	14	44,688	305,443	14	42,762	298,216	14	41,750
31020300	7270	900	Werkleistungen durch Dritte		2,432	22	0,535	2,432	22	0,535	1,461	22	0,321
31030100			Projekte und Programme	*	14,064	100	14,064	14,198	100	14,198	13,866	100	13,866
31030100	7260	000	Mitgliedsbeiträge an Institutionen im Inland		0,001	100	0,001	0,001	100	0,001		100	
31030100	7270	034	Ersatzmethoden zum Tierversuch		0,370	100	0,370	0,370	100	0,370	0,277	100	0,277
31030100	7270	900	Werkleistungen durch Dritte		6,794	100	6,794	7,393	100	7,393	5,501	100	5,501
31030100	7662	311	Institut für höhere Studien und wiss. Forschung		0,001	100	0,001	0,400	100	0,400	0,400	100	0,400
31030100	7665	007	Stiftung Dokumentationsarchiv		0,405	100	0,405	0,405	100	0,405	0,405	100	0,405
31030100	7679	120	Lfd. Transfers an sonstige juristische Personen		21,666	100	21,666	25,191	100	25,191	17,786	100	17,786
31030201			Zentralanstalt für Meteorologie und Geodynamik		24,497	37	9,064	24,167	37	8,942	25,603	37	9,473
31030202			Geologische Bundesanstalt		11,832	47	5,561	11,637	47	5,469	11,207	47	5,267
31030204			Forschungsinstitutionen	*	10,508	100	10,508	9,454	100	9,454	11,262	100	11,262
31030204	7270	031	Med Austron		1,600	100	1,600	1,600	100	1,600	0,360	100	0,360
31030204	7332	352	FWF Programme		194,000	100	194,000	181,000	100	181,000	188,500	100	188,500
31030204	7332	452	FWF Geschäftsstelle		12,000	100	12,000	12,000	100	12,000	10,500	100	10,500
31030204	7340	004	ISTA		55,800	100	55,800	51,300	100	51,300	60,592	100	60,592
31030204	7340	006	ÖAW Globalbudget		123,362	100	123,362	113,362	100	113,362	105,403	100	105,403
31030204	7340	010	ÖAW Beauftragungen und Programme		8,828	100	8,828	8,828	100	8,828	6,936	100	6,936
31030204	7348	900	Universitäten - Sonstige Tranferzahlungen					1,135	49	0,556	1,075	49	0,527
31030204	7661	022	Ludwig-Boltzmann-Gesellschaft		7,600	100	7,600	7,600	100	7,600	7,600	100	7,600
31030204	7679	007	Verein der Freunde der Salzburger Stiftung		1,000	100	1,000	1,000	100	1,000	1,000	100	1,000
31030204	7679	008	Inst. für die Wissenschaften vom Menschen								0,750	100	0,750
			Summe UG31		**4.461,491**		**2.287,901**	**4.142,350**		**2.124,610**	**4.117,587**		**2.114,704**
			Summe BM für Bildung, Wissenschaft und Forschung		**4.749,784**		**2.323,600**	**4.429,633**		**2.160,297**	**4.391,895**		**2.148,946**
			BM für Digitalisierung und Wirtschaftsstandort										
			UG33										
33010100			Kooperation Wissenschaft-Wirtschaft		37,000	100	37,000	37,000	100	37,000	41,265	100	41,265
33010200			Innovation, Technologietransfer		44,496	100	44,496	44,496	100	44,496	58,436	100	58,436
33010300			Gründung innovativer Unternehmen		17,975	100	17,975	19,525	100	19,525	16,215	100	16,215
			Summe UG33		**99,471**		**99,471**	**101,021**		**101,021**	**115,916**		**115,916**
			Summe BM für Digitalisierung und Wirtschaftsstandort		**99,471**		**99,471**	**101,021**		**101,021**	**115,916**		**115,916**
			BM für Verkehr, Innovation und Technologie										
			UG34										
34010200	7340	100	Rat f. Forschung und Technologieentwicklung		1,800	100	1,800	1,800	100	1,800	1,800	100	1,800
34010200	7413	001	Austrian Institute of Technology AIT-Förderungen		0,010	100	0,010	0,010	100	0,010	0,053	100	0,053
34010200	7413	002	Austrian Institute of Technology AIT		56,690	90	51,021	55,100	90	49,590	54,470	90	49,023
34010200	7413	003	Nuclear Engineering Seibersdorf NES		10,690	30	3,207	10,430	30	3,129	5,844	30	1,753
34010200	7413	004	Silicon Austria		12,500	100	12,500	12,500	100	12,500	0,950	100	0,950
34010200	7414	002	Austria Tech		1,400	100	1,400	1,400	100	1,400	2,261	100	2,261

34010200	7660	075	F&T-Förderung		0,300	100	0,300	0,300	100	0,300	0,233	100	0,233
34010200	7661	030	Österreichische Computergesellschaft		0,040	100	0,040	0,040	100	0,040	0,053	100	0,053
34010200	7662	341	Joanneum Research Forsch.ges.m.b.H(Techn.schwerp)		2,350	100	2,350	2,350	100	2,350	2,239	100	2,239
34010200	7666	005	Österreichisches Institut für Nachhaltigkeit		0,030	100	0,030	0,030	100	0,030	0,050	100	0,050
34010200	7667	006	Sonstige gemeinnützige Einrichtungen		1,610	100	1,610	1,610	100	1,610	1,668	100	1,668
34010200	7668	040	Salzburg Research		0,410	100	0,410	0,410	100	0,410	0,376	100	0,376
34010200	7668	050	Profactor		0,500	100	0,500	0,500	100	0,500	0,315	100	0,315
34010200	7690	002	Preisverleihungen		0,010	100	0,010	0,010	100	0,010	0,010	100	0,010
34010300	7260	000	Mitgliedsbeiträge an Institutionen im Inland		0,160	100	0,160	0,160	100	0,160	0,156	100	0,156
34010300	7270	000	Werkleistungen durch Dritte		2,000	100	2,000	5,500	100	5,500	5,841	100	5,841
34010300	7280	030	FTI-Projekte, Beauftragungen an Dritte		1,700	100	1,700	1,700	100	1,700	1,476	100	1,476
34010300	7330	352	Translational research (F&E)			100		0,095	100	0,095	0,430	100	0,430
34010300	7330	652	Fonds wissensch./Programmabw.			100		0,005	100	0,005	0,020	100	0,020
34010300	7411	001	FFG - Basisprogramme		95,000	100	95,000	95,000	100	95,000	77,000	100	77,000
34010300	7411	002	FFG - FTI-Programme, Förderungen		159,655	100	159,655	147,905	100	147,905	152,933	100	152,933
34010300	7411	003	FFG - FTI-Programme (F&E-Dienstleist.,Sonst.WV)		10,000	100	10,000	10,000	100	10,000	9,627	100	9,627
34010300	7411	004	FFG - Administrative Kosten		16,700	100	16,700	16,700	100	16,700	14,552	100	14,552
34010300	7412	001	Austria Wirtschaftsservice GmbH AWS - Förderungen		11,254	100	11,254	13,373	100	13,373	11,548	100	11,548
34010300	7412	003	Austria Wirtschaftsservice GmbH AWS - Admin.Kost.		0,250	100	0,250	0,250	100	0,250	0,734	100	0,734
34010300	7432	030	FTI-Projekte, Förderungen		0,350	100	0,350	0,350	100	0,350	0,610	100	0,610
			Summe UG34		**385,409**		**372,257**	**377,528**		**364,717**	**345,249**		**335,711**
			UG41										
41010200	7330	080	Transferzahlungen an Klima- und Energiefonds	*	47,000	95	44,650	47,000	95	44,650	49,500	95	47,025
41020100	7270	000	Werkleistungen durch Dritte		1,726	50	0,863	1,726	50	0,863	1,782	40	0,713
41020100	7270	800	Elektromobilität		0,200	60	0,120	0,400	60	0,240	0,038	60	0,023
41020100	7270	801	E-Mobilität für alle: Urbane Elektromobilität		0,001	20		0,001	20				
41020100	7411	002	FFG - FTI-Programme, Förderungen		1,000	100	1,000	1,000	100	1,000	1,383	100	1,383
41020100	7411	003	FFG - FTI-Programme (F&E-Dienstleist.,Sonst.WV)		0,010	100	0,010	0,010	100	0,010			
41020100	7411	004	FFG - Administrative Kosten		0,010	100	0,010	0,010	100	0,010			
41020100	7480	501	Progr.Kombinierter Güterverk.Straße-Schiene-Schiff		3,300	50	1,650	3,300	50	1,650	0,399	50	0,200
41020100	7660	000	Zuschüsse f. lfd. Aufwand an private Institutionen		1,030	95	0,979	1,030	95	0,979	0,360	95	0,342
41020100	7668	055	Technisches Museum Wien		0,601	80	0,481	0,601	80	0,481	0,500	80	0,400
41020300	7270	000	Werkleistungen durch Dritte										
41020300	7411	002	FFG - FTI-Programme, Förderungen		0,001	50	0,001	0,001	50	0,001			
41020300	7411	004	FFG - Administrative Kosten		0,001	50	0,001	0,001	50	0,001			
41020300	7489	001	Breitbandinitiative (admin. Aufwand)		0,001	50	0,001	0,001	50	0,001			
41020300	7489	002	Breitband - Förderungen		0,001	50	0,001	0,001	50	0,001	0,012	50	0,006
41020402	7270	000	Werkleistungen durch Dritte		1,029	5	0,051	1,159	5	0,058	0,552	5	0,028
41020402	7270	006	Werkleistungen durch Dritte (zw)		1,750	5	0,088	1,750	5	0,088	2,725	5	0,136
			Summe UG41		**57,661**		**49,906**	**57,991**		**50,033**	**57,251**		**50,256**
			Summe BM für Verkehr, Innovation und Technologie		**443,070**		**422,163**	**435,519**		**414,750**	**402,500**		**385,967**
			BM für Nachhaltigkeit und Tourismus										
			UG42										
42010100			Zentralstelle	*	0,200	100	0,200	0,200	100	0,200	0,190	100	0,190
42010200	7411	000	Lfd Transfers an verbundene Unternehmungen	*	37,303	33	12,310	37,303	33	12,310	37,302	33	12,310
42020300			Forschung und Sonstige Maßnahmen	*	2,000	100	2,000	2,000	100	2,000	1,964	100	1,964
42020401			Landwirtschaftliche Schulen	*	45,065	21	9,464	43,731	21	9,184	47,174	21	9,907
42020402			Landwirtschaftliche Hochschule		5,172	3	0,155	5,100	3	0,153	4,749	3	0,142

42020403			Landwirtschaftliche Bundesanstalten		3,371	60	2,023	3,152	60	1,891	3,205	60	1,923
42020405			HBLA u. Forschungsanst. f. Landw. Ernähr., Lebensm.- u. Biotechn. Tirol		6,934	1	0,069	4,633	1	0,046	4,391	1	0,044
42020501			HBLA für Wein- und Obstbau Klosterneuburg		10,814	30	3,244	10,700	30	3,210	11,099	30	3,330
42020502			Bundesamt für Weinbau		5,070	3	0,152	4,950	3	0,149	5,125	3	0,154
42030101	7270	000	Werkleistungen durch Dritte		0,268	20	0,054	0,268	20	0,054	0,248	20	0,050
42030104			Forschung und Sonstige Maßnahmen Forst	*	0,300	100	0,300	0,400	100	0,400	0,262	100	0,262
42030204	7270	000	Werkleistungen durch Dritte	*	0,010	100	0,010	0,010	100	0,010	0,109	100	0,109
42030205			Bundesamt für Wasserwirtschaft		6,467	25	1,617	6,900	25	1,725	4,831	25	1,208
			Summe UG42		**122,974**		**31,598**	**119,347**		**31,332**	**120,649**		**31,593**
			UG43										
43010200	7700	500	Investitionszuschüsse		43,631	1	0,436	44,621	1	0,446	56,734	1	0,567
43010300			Klima- und Energiefonds		37,300	12	4,476	37,400	12	4,488	37,720	12	4,526
43010500			Nachhaltiger Natur- und Umweltschutz	*	35,696	1	0,357	35,806	1	0,358	35,547	12	4,266
43010500	7270	080	Forschungsaufwendungen		0,140	100	0,140	0,140	100	0,140	0,140	100	0,140
43010500	7420	021	Transferzahlungen an die UBA Ges.m.b.H		14,956	3	0,449	14,956	3	0,449	14,956	3	0,449
			Summe UG43		**131,723**		**5,858**	**132,923**		**5,881**	**145,097**		**9,948**
			Summe BM für Nachhaltigkeit und Tourismus		**254,697**		**37,456**	**252,270**		**37,213**	**265,746**		**41,541**
			Teil b -Summe		**6.740,935**		**2.977,756**	**6.410,094**		**2.808,585**	**6.537,531**		**2.784,605**
			Gesamtsumme Teil a + b		**6.856,929**		**3.081,087**	**6.526,746**		**2.913,281**	**6.656,155**		**2.889,779**

BUNDESVORANSCHLAG 2019

Detailübersicht Forschungswirksame Mittelverwendungen des Bundes

Anmerkungen

Allgemeine Anmerkungen

*) F& E Koeffizienten geschätzt

Die Detailübersicht Foschungswirksame Mittelverwendung des Bundes:

a) Beitragszahlungen aus Bundesmitteln an internationale Organisationen, die Forschung und Forschungsförderung (mit) als Ziel haben,

b) Bundesbudget-Forschung - Finanzierungsvorschlag (ausgen. die bereits im Abschnitt a) ausgewiesen sind)

Für die Aufstellung dieser Ausgaben ist in erster Linie der Gesichtspunkt der Forschungswirksamkeit maßgebend, der inhaltlich über den Aufgabenbereich 99 "Grundlagen-, angewandte Forschung und experimentelle Entwicklung" hinausgeht und auf dem Forschungsbegriff des Fascati-Handbuches der OECD beruht, wie er im Rahmen der forschungsstatistischen Erhebungen der STATISTIK AUSTRIA zur Anwendung gelangt.

Forschungswirksame Anteile bei den Bundesausgaben finden sich daher nicht nur bei den Ausgaben des Aufgabenbereiches 99 "Grundlagen-, angewandte Forschung und experimentelle Entwicklung" sondern auch in zahlreichen anderen Aufgabenbereichen.

Finanzierungsvoranschlag

VA-Stelle	Konto	Ugl	Anmerkung
			Parlamentsdirektion
02010500	7330	086	*) Forschungsanteil liegt bei 2,600 % (System rundet).
			Bundeskanzleramt
25010500	7420	113	*) Forschungsanteil liegt bei 37,570 % (System rundet).
25010500	7270	006	*) Forschungsanteil liegt bei 88,589 % (System rundet).
25020100	7270	000	*) Forschungsanteil liegt bei 1,714 % (System rundet).
25020200	7270	000	*) Forschungsanteil liegt bei 2,035 % (System rundet).
			BM für Inneres
11010100	7278	020	*) Teilbetrag der Voranschlagsstelle.
11010200	7270	900	*) Teilbetrag der Voranschlagsstelle.
11020600	7270	900	*) Teilbetrag der Voranschlagsstelle.
11020600			* Teilbetrag der Voranschlagsstelle
11020800	7270	900	*) Teilbetrag der Voranschlagsstelle.
11030100	7660	900	*) Teilbetrag der Voranschlagsstelle. Aufgrund der Budgetstrukturänderung wurde die Voranschlagsstelle 11030100 ab 2018 in die Voranschlagsstelle 18010100 überführt.
11030100	7672	009	*) Teilbetrag der Voranschlagsstelle. Aufgrund einer Budgetstrukturänderung wurde die Voranschlagsstelle 11030100 ab 2018 in die Voranschlagsstelle 18010100 überführt.
11030500	7270	900	*) Teilbetrag der Voranschlagsstelle.
18010100	7672	009	*) Teilbetrag der Voranschlagsstelle
18010100	7660	900	*) Aufgrund einer Budgetstrukturänderung wurde die Voranschlagsstelle 11030100 ab 2018 in die Voranschlagsstelle 18010100 überführt.
			*) Teilbetrag der Voranschlagsstelle.
			BM für Europa, Integration und Äußeres
12020200	7840	000	Beiträge an die IAEO (Internationale Atomenergieorganisation) zur Förderung der internationalen Bemühungen um nukleare Sicherheit und Nichtverbreitung von Kernwaffen sowie zum Atomteststopp.
12020200	7800	101	*) BMG-Novelle
12020200	7800	102	*) BMG-Novelle .
			BM für Verfassung, Reformen, Deregulierung und Justiz
13010100	7271	900	*) Studie zum "Umgang mit Misshandlungsvorwürfen gegen Exekutivbedienstete" (Auftragnehmer:ALES) Auftragsvolumen 2018: 50.158 Euro + Studie des Instituts für Konfliktforschung zum Thema "Schutz der sexuellen Integrität" Auftragsvolumen 76.500 Euro (davon 2018: 38250 Euro und 2019: 38.250 Euro)
13030101	7271	900	*) Reduktion um €33.100,00 für Studie De-Radikalisierung im Gefängnis, Erhöhung um gesamt € 79.440,79 für Projekt Suizidprävention im Strafvollzug
			BM für Landesverteidigung
14040100			*) Teilbetrag (eigene Fistl);
14050100	7270	900	*) Teilbetrag der Voranschlagsstelle.
14050100	7270	000	*) Teilbetrag der Voranschlagsstelle.
			BM für Finanzen
15010100	7662	002	*) Forschungsanteil liegt bei 52,939 (System rundet)
15010100	7669	020	*) Teilbetrag der Voranschlagsstelle. Forschungsanteil liegt bei 27,361 % (System rundet).
15010100	7270	000	*) Teilbetrag der Voranschlagsstelle.
			BM für Arbeit, Soziales, Gesundheit und Konsumentenschutz
20010101	7340	302	*) Forschungsanteil liegt bei 0,69 % (System rundet auf 1%)
20010201	7668	901	*) Forschungsanteil liegt bei 0,51 % (System rundet auf 1%)
20010201	7270	006	*) Forschungsanteil im Erfolg 2017 liegt bei 0,17 % (System rundet auf 0 %)

			*) Forschungsanteil im BVA 2019 liegt bei 0,15 % (System rundet auf 0 %)
			BM für Bildung, Wissenschaft und Forschung
30010400	7800	000	*) Teilbetrag der VA-Stelle.
30010400			Teilbetrag der Voranschlagsstelle
30020700			Teilbetrag der Voranschlagsstelle
31030100			*) Der Restbetrag ergibt sich rechnerisch bei dieser VA-Stelle.
31030204			*) Der Restbetrag ergibt sich rechnerisch bei dieser VA-Stelle.
			BM für Verkehr, Innovation und Technologie
41010200	7330	080	* KLIEN: ab 2016 werden bei dieser Post nur mehr F&E-Projekte finanziert; daher die Erhöhung von 39 auf 95 %.
			BM für Nachhaltigkeit und Tourismus
42010100			*) PSP-Element 42P101010001, 42P101010002 und 42P101020002.
42010200	7411	000	Finanzstellen 90306 (AGES) und 90309 (BFW).
42020202	7411	000	*) Austrian Development Agency (ADA)
42020202	7270	000	*) Austrian Development Agency (ADA), Aufwandsentschädigung
42020300			PDP-Element 42P101010001 und 42P10102001
42020401			*) Finanzstellen 22010 (Francisco-Josephinum), 22013 (Raumberg-Gumpenstein), 22016 (Gartenbau).
42030104			*) PSP-Element 42P101020002
42030204	7270	000	*) Finanzstelle 701 (Nat. u. int. Wasserwirtschaft), Teilbetrag von 7270.000.
43010500			*) Teilbetrag der VA-Stelle.

Ergebnisvoranschlag			
VA-Stelle	Konto	Ugl	Anmerkung
			Keine Anmerkungen erfasst.

Table 10-5: Federal expenditure on research and research promotion by socioeconomic objectives, 2004–2019

Breakdown of Annex T of the Auxiliary Document and the "Detailed overview of research-related appropriation of federal funds" (Parts a and b) for the Federal Finances Acts

Reporting years		Total federal expenditure for R&D	of which												
			Promotion of research covering the earth, the seas, the atmosphere, and space	Promotion of agriculture and forestry	Promotion of trade, commerce and industry	Promotion of energy production, storage and distribution	Promotion of transport, traffic and communications	Promotion of schools and education	Promotion of the health care system	Promotion of social and socio-economic development	Promotion of environmental protection	Promotion of urban and physical planning	Promotion of national defence	Promotion of other objectives	Promotion of general knowledge advancement
2004[3]	in €1,000	1,537,890	84,670	61,182	308,316	25,716	41,489	10,846	362,961	73,670	41,336	13,260	163	15,724	498,557
	in %	*100.0*	*5.5*	*4.0*	*20.0*	*1.7*	*2.7*	*0.7*	*23.6*	*4.8*	*2.7*	*0.9*	*0.0*	*1.0*	*32.4*
2005[4]	in €1,000	1,619,740	85,101	57,618	347,841	28,320	35,275	9,557	362,000	73,978	46,384	13,349	243	16,165	543,909
	in %	*100.0*	*5.3*	*3.6*	*21.5*	*1.7*	*2.2*	*0.6*	*22.3*	*4.6*	*2.9*	*0.8*	*0.0*	*1.0*	*33.5*
2006[5]	in €1,000	1,697,550	76,887	57,698	411,462	20,951	42,795	18,997	379,776	81,812	53,279	9,602	126	-	544,165
	in %	*100.0*	*4.5*	*3.4*	*24.2*	*1.2*	*2.5*	*1.1*	*22.4*	*4.8*	*3.1*	*0.6*	*0.0*	-	*32.2*
2007[6]	in €1,000	1,770,144	80,962	64,637	435,799	28,001	40,013	19,990	373,431	90,639	56,075	9,673	27	894	570,003
	in %	*100.0*	*4.6*	*3.7*	*24.6*	*1.6*	*2.3*	*1.1*	*21.1*	*5.1*	*3.2*	*0.5*	*0.0*	*0.1*	*32.1*
2008[7]	in €1,000	1,986,775	87,751	66,273	525,573	24,655	39,990	37,636	422,617	90,879	57,535	12,279	142	-	621,445
	in %	*100.0*	*4.4*	*3.3*	*26.5*	*1.2*	*2.0*	*1.9*	*21.3*	*4.6*	*2.9*	*0.6*	*0.0*	-	*31.3*
2009[8]	in €1,000	2,149,787	104,775	66,647	538,539	32,964	47,300	42,581	456,544	97,076	67,985	14,522	133	-	680,721
	in %	*100.0*	*4.9*	*3.1*	*25.1*	*1.5*	*2.2*	*2.0*	*21.2*	*4.5*	*3.2*	*0.7*	*0.0*	-	*31.6*
2010[9]	in €1,000	2,269,986	103,791	67,621	587,124	39,977	56,969	50,648	472,455	99,798	67,114	12,792	123	-	711,574
	in %	*100.0*	*4.6*	*3.0*	*25.9*	*1.8*	*2.5*	*2.2*	*20.8*	*4.4*	*3.0*	*0.6*	*0.0*	-	*31.2*
2011[10]	in €1,000	2,428,143	107,277	63,063	613,692	41,294	54,043	59,479	510,359	115,792	77,578	20,170	99	-	765,297
	in %	*100.0*	*4.4*	*2.6*	*25.3*	*1.7*	*2.2*	*2.4*	*21.0*	*4.8*	*3.2*	*0.8*	*0.0*	-	*31.6*
2012[11]	in €1,000	2,452,955	103,432	60,609	607,920	55,396	47,934	65,537	499,833	121,570	86,776	20,338	120	-	783,490
	in %	*100.0*	*4.2*	*2.5*	*24.8*	*2.3*	*2.0*	*2.7*	*20.4*	*5.0*	*3.5*	*0.8*	*0.0*	-	*31.8*
2013[12]	in €1,000	2,587,586	108,966	70,897	641,851	76,014	53,713	83,087	542,560	117,714	83,556	21,985	280	-	786,963
	in %	*100.0*	*4.2*	*2.7*	*24.9*	*2.9*	*2.1*	*3.2*	*21.0*	*4.5*	*3.2*	*0.8*	*0.0*	-	*30.5*
2014[13]	in €1,000	2,647,489	113,173	60,714	689,214	64,582	64,675	81,354	566,058	119,780	48,381	22,639	961	-	815,958
	in %	*100.0*	*4.3*	*2.3*	*26.0*	*2.4*	*2.4*	*3.1*	*21.4*	*4.5*	*1.8*	*0.9*	*0.0*	-	*30.9*
2015[14]	in €1,000	2,744,844	124,648	58,414	678,572	122,624	51,785	78,241	584,254	128,733	49,176	26,817	1,949	-	839,631
	in %	*100.0*	*4.5*	*2.1*	*24.7*	*4.5*	*1.9*	*2.9*	*21.3*	*4.7*	*1.8*	*1.0*	*0.1*	-	*30.5*
2016[15]	in €1,000	2,875,706	131,240	60,828	747,264	122,903	46,654	82,610	592,407	135,709	49,586	28,435	2,610	-	875,460
	in %	*100.0*	*4.6*	*2.1*	*26.0*	*4.3*	*1.6*	*2.9*	*20.6*	*4.7*	*1.7*	*1.0*	*0.1*	-	*30.4*
2017[16]	in €1,000	2,889,779	128,279	66,718	725,123	106,311	50,725	74,493	614,757	142,571	50,574	29,327	3,897	798	896,206
	in %	*100.0*	*4.4*	*2.3*	*25.1*	*3.7*	*1.8*	*2.6*	*21.3*	*4.9*	*1.8*	*1.0*	*0.1*	*0.0*	*31.0*
2018[17]	in €1,000	2,913,281	128,383	65,366	723,277	105,377	63,527	75,866	627,844	142,397	48,187	29,156	5,573	772	897,556
	in %	*100.0*	*4.7*	*2.1*	*24.6*	*3.9*	*2.1*	*2.7*	*21.2*	*4.7*	*1.7*	*1.0*	*0.2*	*0.0*	*31.1*
2019[17]	in €1,000	3,081,087	133,867	68,339	754,063	108,814	64,728	79,082	679,685	151,294	50,910	31,375	5,637	824	952,469
	in %	*100.0*	*4.3*	*2.2*	*24.5*	*3.5*	*2.1*	*2.6*	*22.1*	*4.9*	*1.7*	*1.0*	*0.2*	*0.0*	*30.9*

As of March 2019. Source: Statistics Austria (Bundesanstalt Statistik Österreich).

3) Annex T of the Auxiliary Document for the Federal Finances Act 2006, outlays. Revised data. – 4) Annex T of the Auxiliary Document for the Federal Finances Act 2007, outlays. – 5) Annex T of the Auxiliary Document for the Federal Finances Act 2008, outlays. Revised data. – 6) Annex T of the Auxiliary Document for the Federal Finances Act 2009, outlays. – 7) Annex T of the Auxiliary Document for the Federal Finances Act 2010, outlays. – 8) Annex T of the Auxiliary Document for the Federal Finances Act 2011, outlays. – 9) Annex T of the Auxiliary Document for the Federal Finances Act 2012, outlays. – 10) Annex T of the Auxiliary Document for the Federal Finances Act 2013 (financing proposal), outlays. Revised data. – 11) Annex T of the Auxiliary Document for the Federal Finances Act 2014 (financing proposal), outlays. – 12) Annex T of the Auxiliary Document for the Federal Finances Act 2015 (financing proposal), outlays. Revised data. – 13) Federal Finances Act 2016, Detailed overview of research-related appropriation of federal funds, outlays. – 14) Federal Finances Act 2017, Detailed overview of research-related appropriation of federal funds, outlays. Revised data. – 15) Federal Finances Act 2018, Detailed overview of research-related appropriation of federal funds, outlays. – 16) Federal Finances Act 2019, Detailed overview of research-related appropriation of federal funds, outlays. – 17) Federal Finances Act 2019, Detailed overview of research-related appropriation of federal funds, financing proposal.

Table 10-6: Federal expenditure on research and research promotion by socio-economic objective and ministry, 2019[1]

Breakdown of the Auxiliary Document and the "Detailed overview of research-related appropriation of federal funds" (Part a and Part b)

Ministry		Total federal expenditure for R&D	of which												
			Promotion of research covering the earth, the seas, the atmosphere, and space	Promotion of agriculture and forestry	Promotion of trade, commerce and industry	Promotion of energy production, storage and distribution	Promotion of transport, traffic and communications	Promotion of schools and education	Promotion of the health care system	Promotion of social and socio-economic development	Promotion of environmental protection	Promotion of urban and physical planning	Promotion of national defence	Promotion of other objectives	Promotion of general knowledge advancement
BKA[2]	in €1,000	44,069	6,506	-	-	-	2	-	-	8,590	-	408	-	-	28,563
	in %	*100.0*	*14.8*	-	-	-	*0.0*	-	-	*19.5*	-	*0.9*	-	-	*64.8*
BMÖDS	in €1,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	in %	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BMEIA	in €1,000	3,007	-	-	-	1,163	-	-	-	1,844	-	-	-	-	-
	in %	*100.0*	-	-	-	*38.7*	-	-	-	*61.3*	-	-	-	-	-
BMASGK	in €1,000	13,064	-	-	-	-	-	-	5,736	7,328	-	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	*43.9*	*56.1*	-	-	-	-	-
BMBWF	in €1,000	2,361,438	98,872	32,408	392,575	30,187	24,085	77,879	642,765	116,963	30,070	28,525	1,475	824	884,810
	in %	*100.0*	*4.2*	*1.4*	*16.6*	*1.3*	*1.0*	*3.3*	*27.2*	*5.0*	*1.3*	*1.2*	*0.1*	*0.0*	*37.4*
BMDW	in €1,000	99,570	-	-	99,570	-	-	-	-	-	-	-	-	-	-
	in %	*100.0*	-	-	*100.0*	-	-	-	-	-	-	-	-	-	-
BMF	in €1,000	32,026	1,070	1,453	4,784	348	325	1,048	6,670	7,541	410	371	-	-	8,006
	in %	*100.0*	*3.3*	*4.5*	*14.9*	*1.1*	*1.0*	*3.3*	*20.8*	*23.5*	*1.3*	*1.2*	-	-	*25.1*
BMI	in €1,000	1,428	-	-	-	-	-	-	-	1,428	-	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-	-
BMLV	in €1,000	4,688	-	-	-	-	-	-	-	-	-	-	4,162	-	526
	in %	*100.0*	-	-	-	-	-	-	-	-	-	-	*88.8*	-	*11.2*
BMNT	in €1,000	39,191	654	30,243	237	-	-	155	-	1,700	5,858	-	-	-	344
	in %	*100.0*	*1.7*	*77.2*	*0.6*	-	-	*0.4*	-	*4.3*	*14.9*	-	-	-	*0.9*
BMVRDJ	in €1,000	59	-	-	-	-	-	-	-	59	-	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-	-
BMVIT	in €1,000	482,547	26,765	4,235	256,897	77,116	40,316	-	24,514	5,841	14,572	2,071	-	-	30,220
	in %	*100.0*	*5.5*	*0.9*	*53.2*	*16.0*	*8.4*	-	*5.1*	*1.2*	*3.0*	*0.4*	-	-	*6.3*
Total	**in €1,000**	**3,081,087**	**133,867**	**68,339**	**754,063**	**108,814**	**64,728**	**79,082**	**679,685**	**151,294**	**50,910**	**31,375**	**5,637**	**824**	**952,469**
	in %	***100.0***	***4.3***	***2.2***	***24.5***	***3.5***	***2.1***	***2.6***	***22.1***	***4.9***	***1.7***	***1.0***	***0.2***	***0.0***	***30.9***

As of March 2019.

Source: Statistics Austria (Bundesanstalt Statistik Österreich)

1) Based on the budget appropriation draft. – 2) Including the highest executive bodies.

Table 10-7: General research-related university expenditure by the federal government ("General University Funds"), 2000–2019[1]

Years	General university funds	
	Total	R&D
	in € millions	
2000	1,956.167	842.494
2001	2,008.803	866.361
2002	2,104.550	918.817
2003	2,063.685	899.326
2004	2,091.159	980.984
2005	2,136.412	1,014.543
2006	2,157.147	1,027.270
2007	2,314.955	1,083.555
2008	2,396.291	1,133.472
2009	2,626.038	1,236.757
2010	2,777.698	1,310.745
2011	2,791.094	1,388.546
2012	2,871.833	1,395.130
2013	3,000.004	1,453.596
2014	3,059.949	1,481.744
2015	3,117.320	1,509.576
2016	3,262.376	1,610.742
2017	3,319.288	1,638.460
2018	3,330.311	1,644.530
2019	3,610.048	1,781.501

As of March 2019.

Source: Statistics Austria (Bundesanstalt Statistik Österreich).

1) 2000–2019: Based on Annex T of the Auxiliary Document and the Detailed overview of research-related appropriation of federal funds" for the Federal Finances Act.

Table 10-8: Research promotion schemes and contracts awarded by the federal government in 2018, broken down by sector/area of performance and awarding ministry

Analysis of the federal research database[1] without "major" global financing[2]

Ministries	Partial amounts 2018	of which awarded to																				
		Higher education sector					Government sector							Private non-profit sector			Business enterprise sector					
		Universities (including teaching hospitals)	Art universities	Universities of applied sciences	Other higher education sector [3]	Total	Federal institutions (outside of the higher education sector)	AIT Austrian Institute of Technology GmbH	Austrian Academy of Sciences	Private non-profit facilities mostly run on public financing	Ludwig Boltzmann Society	Other public sector [4]	Total	private non-profit sector	Individual researchers	Total	Institutes' sub-sector ("Kooperativer Bereich") incl. competence centres (excluding AIT)	Company R&D sub-sector ("Firmeneigener Bereich")	Total	Austrian Science Fund (FWF)	Austrian Research Promotion Agency (FFG)	Abroad
	in €	in %																				
BKA	61,900	-	-	-	-	-	40.2	-	-	59.8	-	-	100.0	-	-	-	-	-	-	-	-	-
BMASK	62,468	-	-	-	-	-	-	-	-	78.9	-	-	78.9	-	21.1	21.1	-	-	-	-	-	-
BMASGK	3,064,242	20.5	-	-	-	20.5	41.6	-	-	14.2	-	-	55.8	2.1	1.1	3.2	5.2	11.5	16.7	-	-	3.8
BMBWF	52,385,703	3.7	0.2	0.1	0.1	4.1	6.6	0.1	0.1	10.6	-	-	17.4	0.9	-	0.9	0.1	0.1	0.2	-	14.2	63.2
BMDW	771,391	35.3	-	-	-	35.3	-	-	-	41.8	-	1.9	43.7	2.0	0.3	2.3	7.0	11.7	18.7	-	-	-
BMEIA	915,753	-	-	10.6	-	10.6	-	-	-	-	-	-	-	-	-	-	-	89.4	89.4	-	-	-
BMF	4,686,014	2.2	-	-	-	2.2	30.4	-	-	19.0	-	-	49.4	0.1	4.2	4.3	-	4.9	4.9	-	37.1	2.1
BMGF	34,940	-	-	-	-	-	100.0	-	-	-	-	-	100.0	-	-	-	-	-	-	-	-	-
BMI	1,176,938	10.5	-	29.5	-	40.0	-	-	-	36.5	9.0	-	45.5	9.7	0.8	10.5	-	2.0	2.0	-	-	2.0
BMLV	2,295,991	4.0	-	11.3	7.0	22.3	0.7	14.5	0.3	-	-	-	15.5	-	7.6	7.6	27.8	19.3	47.1	-	-	7.5
BMLVS	50,000	100.0	-	-	-	100.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BMNT	3,952,538	65.3	-	-	-	65.3	20.0	0.5	-	2.1	-	-	22.6	1.3	-	1.3	3.0	3.8	6.8	-	4.0	-
BMÖDS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BMVRDJ	179,574	42.9	-	-	-	42.9	-	-	-	45.5	-	-	45.5	-	-	-	-	11.6	11.6	-	-	-
BMVIT	1,227,892	-	-	-	-	-	-	-	-	32.1	-	-	32.1	6.8	-	6.8	12.6	48.5	61.1	-	-	-
BMWFW	525,376	6.3	0.7	1.0	-	8.0	1.8	-	0.2	3.5	-	-	5.5	9.4	-	9.4	-	2.3	2.3	-	-	74.8
Total	**71,390,720**	**8.3**	**0.1**	**1.1**	**0.3**	**9.8**	**10.0**	**0.5**	**0.1**	**11.6**	**0.1**	**0.0**	**22.3**	**1.2**	**0.6**	**1.8**	**1.7**	**3.9**	**5.6**	**-**	**13.1**	**47.4**

As of April 2019.

Source: Statistics Austria (Bundesanstalt Statistik Österreich).

1) Data as per: 18 March 2019. –2) i.e. excl. institutional financing with funding amounts higher than €500,000 –3) Private universities, university colleges of teacher education, testing agencies at technical federal colleges and other facilities categorised within the higher education sector. –4) State, local and chamber institutions as well as facilities of social insurance institutions.

Tables 10-9: Research promotion schemes and contracts awarded by the federal government in 2018, broken down by socio-economic objective and awarding ministry

Analysis of the federal research database[1] without "major" global financing[2]

Ministry		Partial amounts 2018	of which											
			Promotion of research covering the earth, the seas, the atmosphere, and space	Promotion of agriculture and forestry	Promotion of trade, commerce, and industry	Promotion of energy production, storage and distribution	Promotion of transport, traffic and communications	Promotion of schools and education	Promotion of the health care system	Promotion of social and socio-economic development	Promotion of environmental protection	Funding of urban and physical planning	Funding of national defence	Promotion of general knowledge advancement
BKA	in €	61,900	-	-	-	-	-	-	-	61,900	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-
BMASK	in €	62,468	-	-	-	-	-	-	-	62,468	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-
BMASGK	in €	3,064,242	45,000	150,000	-	-	-	-	180,596	2,503,153	24,938	-	-	160,555
	in %	*100.0*	*1.5*	*4.9*	-	-	-	-	*5.9*	*81.7*	*0.8*	-	-	*5.2*
BMBWF	in €	52,385,703	7,743,384	-	51,875	-	-	12,000	4,445,774	2,364,395	54,603	-	-	37,713,672
	in %	*100.0*	*14.8*	-	*0.1*	-	-	*0.0*	*8.5*	*4.5*	*0.1*	-	-	*72.0*
BMDW	in €	771,391	262,500	-	-	-	-	-	5,000	268,085	-	-	-	235,806
	in %	*100.0*	*34.0*	-	-	-	-	-	*0.6*	*34.8*	-	-	-	*30.6*
BMEIA	in €	915,753	-	-	-	-	-	-	-	915,753	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-
BMF	in €	4,686,014	-	-	-	-	-	-	-	2,794,384	70,000	-	-	1,821,630
	in %	*100.0*	-	-	-	-	-	-	-	*59.6*	*1.5*	-	-	*38.9*
BMGF	in €	34,940	-	34,940	-	-	-	-	-	-	-	-	-	-
	in %	*100.0*	-	*100.0*	-	-	-	-	-	-	-	-	-	-
BMI	in €	1,176,938	-	-	-	-	93,089	-	348,000	559,782	-	5,040	11,400	159,627
	in %	*100.0*	-	-	-	-	*7.9*	-	*29.6*	*47.5*	-	*0.4*	*1.0*	*13.6*
BMLV	in €	2,295,991	53,625	-	805,764	-	42,000	-	71,216	197,634	-	54,725	151,840	919,187
	in %	*100.0*	*2.3*	-	*35.1*	-	*1.8*	-	*3.1*	*8.6*	-	*2.4*	*6.6*	*40.1*
BMLVS	in €	50,000	-	-	-	-	-	-	50,000	-	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	*100.0*	-	-	-	-	-
BMNT	in €	3,952,538	260,074	2,913,072	152,041	40,000	-	-	103,856	152,044	157,283	60,179	-	113,989
	in %	*100.0*	*6.6*	*73.8*	*3.8*	*1.0*	-	-	*2.6*	*3.8*	*4.0*	*1.5*	-	*2.9*
BMÖDS	in €	-	-	-	-	-	-	-	-	-	-	-	-	-
	in %	-	-	-	-	-	-	-	-	-	-	-	-	-
BMVRDJ	in €	179,574	-	-	-	-	-	-	-	179,574	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-
BMVIT	in €	1,227,892	-	-	878,488	33,000	-	-	-	26,000	-	-	-	290,404
	in %	*100.0*	-	-	*71.5*	*2.7*	-	-	-	*2.1*	-	-	-	*23.7*
BMWFW	in €	525,376	393,421	-	-	-	-	-	-	52,775	-	-	-	79,180
	in %	*100.0*	*74.9*	-	-	-	-	-	-	*10.0*	-	-	-	*15.1*
Total	**in €**	**71,390,720**	**8,758,004**	**3,098,012**	**1,888,168**	**73,000**	**135,089**	**12,000**	**5,204,442**	**10,137,947**	**306,824**	**119,944**	**163,240**	**41,494,050**
	in %	***100.0***	***12.3***	***4.3***	***2.6***	***0.1***	***0.2***	***0.0***	***7.3***	***14.2***	***0.4***	***0.2***	***0.2***	***58.2***

As of April 2019.

Source: Statistics Austria (Bundesanstalt Statistik Österreich). 1) Data as per: 18 March 2019. –2) i.e. excl. institutional financing with funding amounts higher than €500,000.

Table 10-10: An international comparison of research and experimental development (R&D) in 2016

Country	Gross domestic expenditure on R&D as a % of GDP	Financing of gross domestic expenditure of R&D by		Employees in R&D in full-time equivalents	Gross expenditure on R&D by the			
		Government	Business		Business enterprise sector	Higher education sector	Government sector	Private non-profit sector
		in %			in % of gross domestic expenditure on R&D			
Belgium	2.55 e)	22.5 5)	58.6 5)	79,109 e)	70.1 e)	20.5 e)	8.9 e)	0.6 e)
Denmark	3.12	30.2 d)5)	59.1 5)	62,869	64.8	32.7	2.2	0.3
Germany	2.92	28.5 d)	65.2	657,894	68.2	18.0 b)	13.8 d)	.
Finland	2.74	28.9	57.0	47,429	65.8	25.1	8.2	0.9
France	2.25 p)	34.8 5)	54.0 5)	428,643 5)	63.6 p)	22.0 p)	12.9 p)	1.6 p)
Greece	0.99	42.6	40.2	41,790 d)	42.2	31.9	25.0	0.9
Ireland	1.16 e)	25.8 e)	49.0 e)	29,849	72.2 e)	23.6 e)	4.2 e)	.
Italy b)	1.37	35.2	52.1	290,040	60.8	24.2 e)	12.6	2.5
Luxembourg	1.30	47.7 5)	47.1 5)	5,312	54.1	19.7 e)	26.3 d)e)	.
Netherlands	2.00	31.3	52.0	132,867	58.3	30.4	11.3 d)	.
Austria	**3.13** 6)	**35.1** 6)	**48.4** 6)	**74,897** e)	**70.2** b)e)	**22.2** b)e)	**7.1** b)e)	**0.5** e)
Portugal	1.28	42.6	44.4	50,406	48.4	44.7	5.3	1.6
Sweden	3.27 p)	28.3 e)4)	57.3 5)	90,690 p)	69.6 p)	26.8 p)	3.4 p)	0.2 p)
Spain	1.19	40.0	46.7	205,873 d)	53.7	27.5	18.5	0.2
United Kingdom e)	1.68	26.3	51.8	417,390	67.1	24.3	6.6	2.1
EU 15 e)	**2.10**	**31.4** 5)	**55.9** 5)	**2,618,029**	**65.0**	**22.7**	**11.2**	**1.0**
Estonia	1.25	37.6	48.2	5,772	51.5	35.5	11.4	1.5
Latvia	0.44	47.7	21.6	5,120 d)	24.5	43.8	31.8	.
Lithuania	0.84	39.2	39.0	10,924	35.0	38.9	26.1	.
Poland	0.96	38.9	53.1	111,789	65.7 b	31.4	2.5 b)	0.4
Slovakia	0.79	41.0	46.2	17,768	50.4	27.7	21.4	0.5
Slovenia	2.01	20.2	69.2	14,403	75.7	10.8	13.4	0.0
Czechia	1.68	35.6	39.5	65,783	61.1	20.4	18.2	0.2
Hungary	1.20	26.2	56.4	35,757	74.1 d)	11.1 d)	13.4 d)	.
Romania	0.48	39.6	49.4	32,232	55.2	11.3	33.3	0.2
EU-28 e)	**1.94**	**31.8** 5)	**54.6** 5)	**2,957,034**	**64.9**	**22.8**	**11.4**	**1.0**
Australia	1.88 e)5)	34.6 1)	61.9 1)	147,809 e)2)	53.4 e)5)	30.6 e)5)	12.7 e)5)	3.2 e)5)
Chile p)	0.36 b)	46.4 b)	35.8 b)	16,633 d)	38.5 b)	41.8 b)	13.2 b)	6.5 b)
Iceland	2.03	34.2	35.0	3,247	63.0 d)	32.1	4.9	.
Israel d)e)	4.39	13.5	34.7	77,143 3)	85.6	11.8	1.6	1.0
Japan	3.14	15.0 e)	78.1	872,340 d)	78.8	12.3	7.5	1.4
Canada	1.70	31.3 e)	42.2	223,146	52.6	40.2	6.8	0.5
Korea	4.23	22.7	75.4	447,408	77.7	9.1	11.5	1.6
Mexico	0.49 e)p)	67.4 e)p)	20.7 e)p)	59,073 4)	30.6 e)p)	26.8 e)p)	36.5 e)p)	6.2 e)p)
New Zealand 5)	1.23	37.1	43.8	26,400	51.1	28.0	20.9	.
Norway	2.03	45.7	43.2	43,918	53.3	32.6	14.2	.
Switzerland 5)	3.37	24.4	63.5	81,451	71.0	26.7	0.9 d)	1.5
Turkey	0.94	35.1	46.7	136,953	54.2	36.3	9.5 d)	.
United States d)p)	2.76	23.6	63.2	.	72.6	13.1	10.2	4.1 e)
OECD total e)	**2.34**	**25.8**	**61.4**	.	**69.9**	**17.5**	**10.2**	**2.4**
People's Republic of China	2.11	20.0	74.7	3,878,057	77.5	6.8	15.7	.

Source: OECD (MSTI 2018-2), Statistics Austria (Bundesanstalt Statistik Österreich).

b) Break in the time series. – d) Different definition. – e) Estimated values. – p) Preliminary values.

1) 2008. –2) 2010. –3) 2012. –4) 2013. –5) 2015. –6) Statistics Austria; according to R&D global estimate 2019.

Full time equivalent = person year.

Table 10-11: Austria's path from the 4th European Framework Programme to Horizon 2020

	FP4	FP5	FP6	FP7	H2020
	1994–1998	1998–2002	2002–2006	2007–2013	2014 to 03/2019
Number of approved projects with Austrian participation	1.444	1.384	1.324	2.452	1.894
Number of approved Austrian participations	1.923	1.987	1.972	3.589	2.919
Number of approved projects with Austrian coordination	270	267	213	676	439
Approved budget in € million	194	292	425	1.192	1.108
Percentage of approved Austrian participations among all approved participations	2.3%	2.4%	2.6%	2.6%	2.8%
Percentage of approved Austrian coordinators among all approved coordinators	1.7%	2.8%	3.3%	2.7%	2.6%
Austrian share of approved development funds	1.99%	2.38%	2.56%	2.63%	2.81%

Source: Proviso Overview report from fall 2013 (FP4-FP6); EC 11/2015 (FP7) and Austrian Research Promotion Agency (FFG) (with data as per 03/2019 for Horizon 2020).

Table 10-12: Austrian projects, participations and coordination in Horizon 2020, differentiated by organisation type and regional government

	All countries	Austria	Burgen-land	Carinthia	Lower Austria	Upper Austria	Salzburg	Styria	Tyrol	Vorarlberg	Vienna
Projects	**21,472**	**1,894**	**18**	**79**	**200**	**190**	**60**	**455**	**131**	**22**	**1,151**
Participations	**104,427**	**2,919**	**20**	**106**	**220**	**248**	**67**	**611**	**150**	**24**	**1,473**
Higher education (HES)	34,443	813	4	16	51	40	28	157	77		440
Research organisations (REC)	21,799	660	9	5	36	61	11	189			349
Business enterprises (PRC)	36,229	1,109	7	75	117	121	22	240	65	20	442
Public institutions (PUB)	6,138	154		6		7	2	6	8	3	122
Other entities (OTH)	5,818	183		4	16	19	4	19		1	120
Not a declared SME	83,114	2,205	14	74	122	191	59	395	114	20	1,216
Declared SME	21,313	714	6	32	98	57	8	216	36	4	257

	All countries	Austria	Burgen-land	Carinthia	Lower Austria	Upper Austria	Salzburg	Styria	Tyrol	Vorarlberg	Vienna
Total coordinators	**21,472**	**558**	**1**	**28**	**56**	**33**	**8**	**112**	**31**	**1**	**288**
Higher education (HES)	10,243	229		2	35	6	4	29	23		130
Research organisations (REC)	4,512	120	1		6	11	2	28			72
Business enterprises (PRC)	5,879	182		26	14	15	2	55	7	1	62
Public institutions (PUB)	456	16							1		15
Other entities (OTH)	382	11			1	1					9
Not a declared SME	16,287	401		10	41	18	8	57	25		242
Declared SME	5,185	157	1	18	15	15		55	6	1	46

The above representations are based on contract data. (This is different from reports in previous years which were based on approvals.) Contract data contain allocations because the organisation type was reviewed by the European Commission.

Source: Austrian Research Promotion Agency (FFG) based on EC 03/2019 contract data.

Table 10-13: Austrian participations and projects in Horizon 2020 compared to the sum of all countries broken down by pillar and horizontal programme line

	Approved participations (all countries)	Approved Austrian participations	Austria's share of all countries [in %]
H2020	**104,427**	**2,919**	***2.8***
EC Treaty	103,302	2,907	*2.8*
Excellent Science	34,492	784	*2.3*
Industrial Leadership	23,613	726	*3.1*
Societal Challenges	42,327	1,287	*3.0*
Spreading excellence and widening participation	844	25	*3.0*
Science with and for society	1,381	75	*5.4*
Cross-theme	645	10	*1.6*
Euratom	1,125	12	*1.1*

	Approved projects (all countries)	Approved projects with Austrian participation	Share of projects with Austria of all projects (in %)
H2020	**21,472**	**1,894**	***8.8%***
EC Treaty	21,421	1,889	*8.8%*
Excellent Science	11,887	583	*4.9%*
Industrial Leadership	4,008	416	*10.4%*
Societal Challenges	5,064	803	*15.9%*
Spreading excellence and widening participation	204	22	*10.8%*
Science with and for society	129	56	*43.4%*
Cross-theme	129	9	*7.0%*
Euratom	51	5	*9.8%*

Source: Austrian Research Promotion Agency (FFG) based on EC 03/2019 contract data.

Table 10-14: Austrian Science Fund (FWF): Shares of new approvals by discipline (ÖFOS 2012 3-digit level), 2018

Discipline	2016		2017		2018	
	in %	in € millions	in %	in € millions	in %	in € millions
101*Mathematics	*14.14*	25.99	*11.51*	25.02	*8.30*	19.17
102*Computer Sciences	*4.41*	8.11	*5.68*	12.33	*4.93*	11.38
103*Physics, Astronomy	*10.85*	19.94	*10.8*	23.47	*11.85*	27.35
104*Chemistry	*4.36*	8.02	*4.52*	9.82	*4.42*	10.21
105*Geosciences	*3.35*	6.15	*3.49*	7.59	*3.20*	7.39
106*Biology	*20.04*	36.84	*19.94*	43.33	*23.43*	54.07
107*Other Natural Sciences	*0.31*	0.57	*0.24*	0.51	*0.09*	0.22
201*Construction Engineering	*0.46*	0.85	*0.42*	0.92	*1.37*	3.16
202*Electrical Engineering, Electronics, Information Engineering	*0.82*	1.51	*0.58*	1.25	*1.35*	3.11
203*Mechanical Engineering	*0.05*	0.09	*0.27*	0.59	*0.28*	0.64
204*Chemical Process Engineering	*0.03*	0.06	*0.14*	0.31	*0.03*	0.07
205*Materials Engineering	*0.57*	1.05	*0.37*	0.8	*0.32*	0.73
206*Medical Engineering	*0.2*	0.37	*0.5*	1.09	*0.61*	1.40
207*Environmental Engineering, Applied Geosciences	*0.24*	0.45	*0.48*	1.04	*0.53*	1.21
208*Environmental Biotechnology	*0.05*	0.1	*0.06*	0.13	*0.03*	0.08
209*Industrial Biotechnology	*0.22*	0.4	*0.45*	0.99	*0.10*	0.23
210*Nanotechnoloy	*1.04*	1.92	*0.55*	1.19	*0.74*	1.71
211*Other Technical Sciences	*0.16*	0.3	*0.19*	0.41	*0.22*	0.51
301*Medical-Theoretical Sciences, Pharmacy	*11.87*	21.82	*10.8*	23.47	*11.15*	25.73
302*Clinical Medicine	*4.43*	8.13	*4.07*	8.85	*3.40*	7.84
303*Health Sciences	*0.86*	1.58	*0.91*	1.97	*1.24*	2.85
304*Medical Biotechnology	*0.2*	0.36	*0.1*	0.22	*0.11*	0.26
305*Other Human Medicine, Health Sciences	*0.04*	0.08	*0.12*	0.27	*0.37*	0.86
401*Agriculture and Forestry, Fishery	*0.29*	0.54	*0.54*	1.17	*0.39*	0.9
402*Animal Breeding, Animal Production	*0.4*	0.73	*0.03*	0.06	*0.03*	0.06
403*Veterinary Medicine	*0.5*	0.92	*0.26*	0.57	*0.05*	0.12
404*Agricultural Biotechnology, Food Biotechnology	*0.05*	0.09			*0.04*	0.09
405*Other Agricultural Sciences			*0.14*	0.31	*0.14*	0.32
501*Psychology	*1.46*	2.69	*1.29*	2.8	*1.61*	3.72
502*Economics	*3.16*	5.81	*3.12*	6.79	*1.86*	4.29
503*Educational Sciences	*0.42*	0.76	*0.15*	0.33	*0.26*	0.59
504*Sociology	*1.39*	2.56	*1.74*	3.78	*2.62*	6.04
505*Law	*0.82*	1.51	*0.47*	1.02	*0.004*	0.01
506*Political Science	*0.4*	0.73	*0.4*	0.86	*0.58*	1.35
507*Human Geography, Regional Geography, Regional Planning	*0.51*	0.95	*0.27*	0.58	*0.44*	1.00
508*Media and Communication Sciences	*0.2*	0.37	*0.44*	0.96	*0.18*	0.41
509*Other Social Sciences	*0.3*	0.54	*0.24*	0.51	*0.93*	2.15
601*History, Archaeology	*3.35*	6.16	*3.71*	8.07	*2.93*	6.75
602*Linguistics and Literature	*2.89*	5.32	*4.03*	8.75	*3.49*	8.05
603*Philosophy, Ethics, Religion	*2.37*	4.35	*2.68*	5.83	*2.41*	5.57
604*Arts	*2.09*	3.84	*2.53*	5.5	*3.37*	7.78
605*Other Humanities	*0.66*	1.22	*1.77*	3.85	*0.62*	1.44
Total	***100.00***	**183.80**	***100.00***	**217.34**	***100.00***	**230.82**

Source: Austrian Science Fund (FWF).

Table 10-15: Austrian Science Fund (FWF): Shares of new approvals by organisation type, 2016–2018

Organisation type	2016		2017		2018	
	in %	in € millions	in %	in € millions	in %	in € millions
Universities[1]	*82.97*	152.5	*85.14*	185	*83.30*	192.3
Universities of applied sciences	*1.33*	2.4	*0.46*	1	*0.37*	0.9
Private universities	*1.13*	2.1	*0.56*	1.2	*1.12*	2.6
Academy of Sciences	*7.83*	14.4	*7.81*	17	*7.79*	18.0
Non-university research facilities[2]	*6.74*	12.4	*6.03*	13.1	*7.42*	17.1
Total	***100.00***	**183.8**	***100.00***	**217.3**	***100.00***	**230.8**

Source: Austrian Science Fund (FWF).

1 Including the University for Continuing Education Krems, 2 Including research facilities abroad.

Table 10-16: Austrian Research Promotion Agency (FFG): Shares of new approvals by topic area of the promotion, 2016–2018

	2016		2017		2018	
	in %	Total funding [in € millions]	in %	Total funding [in € millions]	in %	Total funding [in € millions]
Energy/Environment	*16.9*	88.0	*15.0*	84.2	*17.98*	111.0
ICT	*20.3*	105.7	*20.9*	117.8	*19.93*	123.1
Mobility	*11.6*	60.4	*12.5*	70.2	*10.63*	65.6
Production	*22.8*	118.7	*23.1*	129.9	*25.73*	158.9
Life Sciences	*10.7*	56.0	*10.6*	59.5	*12.19*	75.3
Safety	*1.6*	8.1	*1.5*	8.4	*1.28*	7.9
Space	*1.5*	7.6	*1.4*	8.0	*1.20*	7.4
Other	*14.8*	77.0	*15.0*	84.4	*11.06*	68.3
Total	***100.0***	**521.5**	***100.0***	**562.5**	***100.00***	**617.6**

Source: Austrian Research Promotion Agency (FFG).

Table 10-17: Austrian Research Promotion Agency (FFG): Funding by regional government, 2016–2018

Regional government	2016		2017		2018	
	in %	Total funding [in € millions]	in %	Total funding [in € millions]	in %	Total funding [in € millions]
Burgenland	*1.3*	6.7	*1.3*	7.6	*1.0*	6.0
Carinthia	*4.6*	23.7	*4.6*	25.6	*5.0*	30.9
Lower Austria	*8.9*	46.6	*7.3*	40.9	*8.6*	52.8
Upper Austria	*19.8*	103.2	*19.5*	109.5	*22.0*	136.0
Salzburg	*3.7*	19.1	*3.3*	18.4	*3.0*	18.6
Styria	*23.3*	121.4	*29.9*	168.0	*28.2*	174.0
Tyrol	*5.9*	31.0	*7.2*	40.4	*4.8*	29.6
Vorarlberg	*3.2*	16.8	*3.2*	18.2	*2.8*	17.1
Vienna	*28.1*	146.6	*22.9*	128.9	*23.2*	143.4
Abroad	*1.2*	6.3	*0.9*	4.9	*1.5*	9.2
Total	***100.0***	**521.5**	***100.0***	**562.5**	***100.0***	**617.6**

Source: Austrian Research Promotion Agency (FFG).

Table 10-18: Austrian Research Promotion Agency (FFG): Project costs and funding by Subject Index Code, 2018

	Total costs [in € millions]	Total funding [in € millions]	Cash value [in € millions]
Total SIC	**1,244.59**	**617.57**	**500.84**
Industrial manufacturing	196.06	89.19	64.93
Surface transport and technologies	160.83	69.47	48.72
Electronics, microelectronics	117.96	65.70	56.46
Advanced materials	131.80	56.23	48.01
ICT applications	99.76	49.75	40.14
Information processing, information systems	82.15	37.88	33.61
Energy storage, conversion and transport	49.29	28.15	27.14
Biosciences	66.36	27.46	21.50
Automation	39.52	19.03	13.46
Energy savings	32.57	16.95	13.10
Medicine, health	26.09	16.43	12.14
Medical biotechnology	33.48	15.38	12.84
Construction engineering	21.84	13.39	13.12
Renewable energy sources	18.58	12.74	11.23
Sustainable development	14.65	9.44	9.30
Safety	15.82	9.09	5.55
Space	13.23	7.28	3.66
Other technologies	10.13	7.15	4.61
Mathematics, statistics	9.50	7.02	7.02
Waste management	9.19	6.98	6.98
Measuring techniques	10.43	6.94	5.16
Food	5.57	3.70	3.56
Nanotechnologies and nanosciences	5.84	3.55	2.92
Aviation and air technologies	7.42	3.38	3.38
Agricultural biotechnology	7.99	3.35	2.57
Other energy topics	7.46	3.00	2.75
Environment	4.08	2.68	2.33
Robotics	4.21	2.59	2.59
Business aspects	3.72	2.18	1.61
Agricultural biotechnology	3.36	1.53	1.13
Quantum technologies	6.15	1.52	1.52
Geosciences	1.76	1.41	1.41
Information, media	2.01	1.36	1.27
Social aspects	1.68	0.96	0.96
Network technologies	1.22	0.74	0.65
Economic aspects	1.00	0.66	0.66
Employment	0.79	0.56	0.49
Coordination, cooperation	0.63	0.50	0.38
Industrial biotechnology	0.36	0.36	0.36
Meteorology	0.58	0.36	0.36
Research on climate change and the carbon cycle	0.26	0.26	0.26
Research ethics	0.57	0.18	0.18
Telecommunications	0.04	0.03	0.03
Standards	0.01	0.01	0.01
Regional development	0.01	0.01	0.01
Water resources and water management	0.00	0.00	0.00
Unclassified	18.60	11.06	10.80

Source: Austrian Research Promotion Agency (FFG).

Table 10-19: Austria Wirtschaftsservice (aws): Shares of new approvals by topic area of the funding (industry), 2016–2018

Discipline, topic area or industry sector	2016		2017		2018	
	in %	in € millions	in %	in € millions	in %	in € millions
Services	*19.3*	156.6	*24.7*	282.4	*13.3*	291.8
Electricity and water supply, sewerage	*0.2*	1.4	*0.8*	9.0	*0.6*	13.7
Trade, maintenance, repair	*14.9*	121.2	*13.3*	152.5	*10.3*	226.3
Food products, beverages and tobacco, LW, FW	*12.8*	104.0	*12.9*	147.6	*6.1*	133.9
Manufacturing	*37.7*	306.0	*36.1*	413.9	*29.8*	651.9
Other industries	*0.7*	6.0	*1.7*	18.9	*1.1*	24.6
Tourism	*9.8*	79.7	*6.5*	74.5	*2.8*	61.8
Transport and communication	*2.0*	15.9	*1.8*	20.1	*1.8*	39.1
Not classified	*2.5*	20.1	*2.3*	26.4	*34.1*	746.5
Total	***100.0***	**810.9**	***100.0***	**1,145.4**	***100.0***	**2,189.5**

Source: Austria Wirtschaftsservice (aws).

Table 10-20: Austria Wirtschaftsservice (aws): Shares of new approvals by enterprise size, 2016–2018

Organisation type	2016		2017		2018	
	in %	in € millions	in %	in € millions	in %	in € millions
Sole proprietorships	*7.7*	62.8	*8.5*	97.3	*9.3*	203.5
Microenterprises	*17.3*	140.2	*17.8*	204.3	*14.8*	324.9
Small enterprises	*15.1*	122.8	*28.0*	320.2	*22.2*	486.5
Medium-sized enterprises	*29.7*	241.0	*29.1*	333.5	*18.7*	409.1
Large enterprises	*27.6*	223.6	*14.4*	165.0	*30.6*	670.6
Not classified	*2.5*	20.6	*2.2*	25.2	*4.3*	95.0
Total	***100.0***	**810.9**	***100.0***	**1,145.4**	***100.0***	**2,189.5**

Source: Austria Wirtschaftsservice (aws).

Table 10-21: Austria Wirtschaftsservice (aws): Overview of funding performance by region, 2017-2018

Region	Confirmed		Total funding [in € millions]		Cash value of funding [in € million]		Total project costs [in € millions]		New jobs	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Burgenland	92	379	13.4	48.8	3.5	24.5	45.6	187.0	131	1,321
Carinthia	414	980	72.1	154.9	8.3	49.4	273.9	697.9	528	3,428
Lower Austria	790	2,538	206.7	404.9	45.2	230.4	662.5	966.4	1,841	16,710
Upper Austria	1,634	3,632	434.8	587.8	74.1	284.6	1,092.3	1,573.5	2,887	18,890
Salzburg	346	1,062	56.7	148.1	13.1	98.0	191.1	663.9	381	7,210
Styria	652	2,218	96.0	246.5	29.5	171.2	548.7	777.9	1,095	11,223
Tyrol	390	1,505	82.2	153.6	21.8	91.1	319.4	452.6	643	6,118
Vorarlberg	160	641	38.2	68.6	9.4	50.6	315.9	335.5	502	3,458
Vienna	958	3,260	118.8	331.1	43.8	265.9	487.3	1,091.7	1,380	16,842
Abroad and not classified	46	90	26.5	45.2	9.3	11.7	54.2	70.2	63	176
Total	**5,482**	**16,305**	**1,145.4**	**2,189.5**	**258.0**	**1,277.4**	**3,990.9**	**6,816.6**	**9,451**	**85,376**

Source: Austria Wirtschaftsservice (aws).

Table 10-22: CDG: CD laboratories by university/research institute 2018

University/research institute	Number of CD laboratories 2018	Budget 2018 [in €]
University for Continuing Education Krems	1	186,000.00
Medical University of Graz	1	220,000.00
Medical University of Innsbruck	6	1,583,000.67
Medical University of Vienna	10	3,454,469.00
University of Leoben	10	2,902,435.08
Graz University of Technology	10	3,586,636.48
Vienna University of Technology	17	5,797,743.05
University of Natural Resources and Life Sciences Vienna	7	3,507,646.22
University of Graz	1	27,105.00
University of Innsbruck	1	37,500.00
University of Linz	6	2,397,900.66
University of Salzburg	1	443,301.77
University of Vienna	6	1,494,869.36
University of Veterinary Medicine Vienna	4	1,171,114.75
Vienna University of Economics and Business	1	81,634.53
Austrian Academy of Sciences	1	267,279.00
Forschungszentrum Jülich	1	446,175.00
University of Cambridge	1	322,700.00
Total	**85**	**27,927,510.57**

Source: Christian Doppler Research Society (CDG), Note: Budget data 2018 are plan data as of 31 Dec. 2018.

Table 10-23: CDG: JR Centres by university of applied sciences, 2018

University of applied sciences	Number of JR Centres 2018	Budget 2018 [in €]
FH JOANNEUM University of Applied Sciences	2	337,769.00
Carinthia University of Applied Sciences	1	340,306.00
St. Pölten University of Applied Sciences	1	319,261.02
University of Applied Sciences Technikum Wien	2	154,021.99
Vorarlberg University of Applied Sciences	2	367,783.91
University of Applied Sciences Upper Austria	3	844,958.00
IMC University of Applied Sciences Krems	1	330,220.43
Total	**12**	**2,694,320.35**

Source: Christian Doppler Research Society (CDG), Note: Budget data 2018 are plan data as of 31 Dec. 2018.

Table 10-24: CDG: Development of the CDG 1989–2018 and JR Centres 2012–2018

Year	Expenditure of the CD laboratories and JR Centres [in €]	Active CD laboratories	Active JR Centres	Active member companies
1989	247,088	5		
1990	1,274,682	7		
1991	2,150,389	11		
1992	3,362,572	16		
1993	2,789,910	17		
1994	3,101,677	18		
1995	2,991,214	14		
1996	2,503,325	14		6
1997	2,982,793	15		9
1998	3,108,913	18		13
1999	3,869,993	20		15
2000	3,624,963	18		14
2001	4,707,302	20		18
2002	7,295,957	31		40
2003	9,900,590	35		47
2004	10,711,822	37		63
2005	11,878,543	37		66
2006	12,840,466	42		79
2007	14,729,108	48		82
2008	17,911,784	58		99
2009	17,844,202	65		106
2010	19,768,684	61		110
2011	20,580,208	61		108
2012	22,167,259	64	1	114
2013	23,666,522	73	4	131
2014	25,634,725	71	5	129
2015	24,954,856	73	7	145
2016	23,967,799	72	9	136
2017	26,196,507	76	11	147
2018	30,621,831	85	12	158

Source: Christian Doppler Research Society (CDG), Note: Budget data 2018 are plan data as of 31 Dec. 2018.

Table 10-25: CDG: CD laboratories by thematic cluster, 2018

Thematic clusters	Number of CD laboratories 2018	Budget 2018 [in €]
Chemistry	8	2,867,655.91
Life sciences and environment	17	6,975,680.99
Manufacture of machinery and equipment, instruments	7	2,338,898.81
Mathematics, informatics, electronics	18	6,305,235.34
Medicine	16	4,205,169.67
Non-metal materials	16	4,862,621.07
Economics, social sciences and jurisprudence	3	372,248.78
Total	**85**	**27,927,510.57**

Source: Christian Doppler Research Society (CDG), Note: Budget data 2018 are plan data as of 31 Dec. 2018.

Table 10-26: CDG: JR Centres by thematic cluster, 2018

Thematic clusters	Number of JR Centres 2018	Budget 2018 [in €]
Chemistry	-	-
Life sciences and environment	1	200,000.00
Manufacture of machinery and equipment, instruments	1	216,958.00
Mathematics, informatics, electronics	7	1,689,006.32
Medicine	1	330,220.43
Non-metal materials	2	258,135.60
Economics, social sciences and jurisprudence	-	-
Total	**12**	**2,694,320.35**

Source: Christian Doppler Research Society (CDG), Note: Budget data 2018 are plan data as of 31 Dec. 2018.