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Austrian Research and Technology Report 2022

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Preface

The Austrian Research and Technology Report 2022 provides an overview of Austria's federally funded research, technology and innovation (RTI). Besides the presentation of recent trends in research policy, the report addresses progress made in implementing the RTI Strategy 2030 adopted at the end of 2020, as well as sub-strategies with research relevance and the latest developments in the higher education sector. In addition, Austria's RTI performance is analysed at national and international level based on recent data from various international rankings, the 2019 R&D (research and development) survey and the 2022 global estimate.

In the third year of the coronavirus pandemic, estimates by Statistics Austria are pointing to another sharp increase in total R&D spending of 9.3 percent to a total of €14.2 billion and an R&D intensity of 3.26 percent for 2022. This positive trend is mainly due to the federal government's 12.8 percent increase in R&D expenditure compared to 2021, which is well above the total growth in R&D spending and growth in nominal gross domestic product (GDP) of 7.5 percent. The public sector is set to spend an estimated total of €4.7 billion in 2022, i.e. 33 percent of total R&D funding. Companies are spending almost two thirds of the total expenditure on research in Austria. At 51 percent (some €7.16 billion, including the research premium), the largest share of total research expenditure in 2022 is set to be contributed by Austrian companies. In addition, the 16 percent (€2.2 billion) financed from abroad mainly involves foreign firms with subsidiaries performing R&D in Austria. Fortunately, there has once again been an increasingly firm upward trend in location-specific R&D expenditure in the business enterprise sector following the decline in 2020 due to the crisis.

R&D intensity is an internationally recognised input indicator of a country's performance. Internationally, Austria's R&D intensity in 2020 ranks third in the EU, behind Sweden and Belgium, and ninth in the world. Thus, together with Sweden, Belgium, Germany and Denmark, Austria is one of the five countries that meet the European R&D intensity target of 3%.

Investment in science and research is a major factor and a key prerequisite for a country's innovation capability. Besides ensuring long-term competitiveness, it is also essential for overcoming societal challenges such as the climate crisis. On the one hand, the COVID-19 pandemic clearly showed the significance and importance of basic and application-oriented research for coping with crises. On the other hand, the latest Eurobarometer survey indicates that efforts to make the general public sufficiently aware of how important science and research are to society have not yet met with success. The scepticism shown by Austrians towards science and democracy is particularly high compared to other countries, the sceptical attitude to democracy is alarming given the war in Ukraine and the assault on European values and peace in Europe. By working together, we want to do all we can to strengthen public trust in science and democracy in the long term among all people. Age-appropriate educational measures are a key tool for persuading young people that democracy is the foundation of our peaceful coexistence and is worth defending. A whole package of measures is therefore being devised to boost Austrians' trust in science and democracy.

This year's report focuses on topics that will have considerable future relevance for Austria. Besides an overview of the people involved in science and research, from career entry through to excellence,

the report also includes selected topics such as quantum research and high-performance computing, the circular economy and sustainability as well as artificial intelligence.

One core chapter is devoted to monitoring the ten central research and research funding institutions, which must be accomplished annually in the Austrian Research and Technology Report in accordance with the Research Financing Act. This chapter attempts to paint a whole-of-system picture of the various institutions in all their diversity. The monitoring has been developed further compared to the previous year and, for some indicators, targets were set for 2023. Next year will see an eleventh central RTI institution included in the monitoring in accordance with the Research Financing Act which is the competence centre "GeoSphere Austria – the Federal Agency for Geology, Geophysics, Climatology and Meteorology" (Bundesanstalt für Geologie, Geophysik, Klimatologie und Meteorologie).

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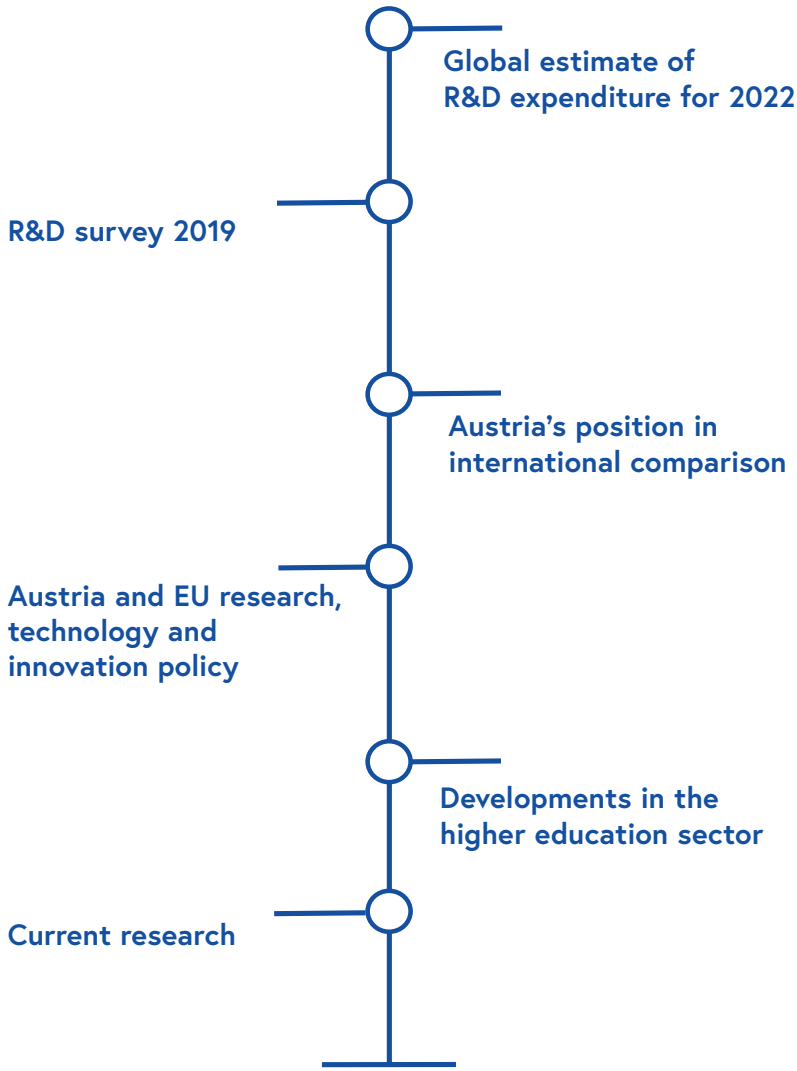
Executive Summary



The Austrian Research and Technology Report 2022 is a status report under Section 8(1) of the Research Organisation Act (FOG) on Austria's federally funded research, technology and innovation.

As in the previous years, the period covered by this Austrian Research and Technology Report 2022 was dominated by a series of societal challenges exacerbated by the COVID-19 pandemic and its challenges for society and the economy, as well as the increasingly apparent consequences of climate change and the humanitarian, economic and geopolitical fallout from Russia's invasion of Ukraine. All of these affect not only Austria's economy and society, but in particular Austria's key players in research, technology and innovation. The diverse effects of these multiple and, in some cases, overlapping crises are also reflected in the topics that researchers are focusing on. However, they are making their presence felt even more strongly in terms of the (tougher) conditions in which research is able to be conducted.

This Austrian Research and Technology Report 2022 presents recent developments in the RTI sector and introduces the **RTI Strategy 2030** and the **Research Funding Amendment**. Both are ushering in a systemic change and a long-term realignment of the system for funding research. Besides the progress made in implementing these, the report also explores RTI-relevant sub-strategies and outlines the latest developments in the higher education sector, which have been shaped most notably by a record-breaking budget for universities thanks to the performance agreements for 2022–2024.

The Austrian Research and Technology Report 2022 also presents the **global estimate for 2022 of developments in R&D expenditure in the country** and analyses the **performance of the Austrian innovation system compared to other countries**. In addition, the report describes numerous **strategic measures and innovations** in the areas of research, technology and innovation.

In terms of themes, the report focuses on those with particular future relevance for Austria. Specifically, these are **quantum research** and **high-performance computing**, alongside the **circular economy and sustainability** as well as **artificial intelligence**. Austria and Europe can already look back on decades of excellent research efforts in the field of quantum technologies, to which numerous Austrian institutions have contributed. Alongside quantum research, RTI is now focusing on the circular economy, with the aim of creating a socially and environmentally responsible economy by further developing material, energy and environmental technologies amongst other things. In the area of artificial intelligence (AI), an AI ecosystem is now emerging in Austria too, even though there is still scope for increasing the spread of AI in companies. Significant research potential has been identified in this area, making the funding of human resources essential. For the first time, therefore, this report provides a **general overview of funding programmes that are available to those working in research and development at all the stages of their careers** and that are geared towards promoting their talents in a targeted way.

The many different RTI measures and initiatives being pursued in Austria are underpinned by a deep-rooted **evaluation culture.** This report therefore also provides some insights into the evaluation culture and a synopsis of recent evaluations of RTI programmes and research institutions.

Finally, all ten central **institutions involved in non-university research and research funding** are portrayed in a monitoring context as required by the Research Financing Act. The Austrian Research and Technology Report 2022 builds on the model developed last year, albeit with a number of new developments. These relate primarily to the implementation of the target/actual comparison in respect of the indicators surveyed stipulated in the Research Financing Act (see section 8 (2) of the Act). For this purpose, not only the actual values for 2020 and 2021 were given for some indicators, but also target values for 2023 were defined.

Agreeing on uniform targets proved a challenge, as the ten institutions have very different roles and priorities, and different targets are also set in the performance agreements. The indicators used in this report were chosen for the presentation of targets after liaising with the ministerial departments and the central institutions. A distinction was made here between research funding institutions and research institutions, and account was taken of the fact that not all indicators can be applied equally to all institutions, or make equal sense for them. The targets will be developed further and harmonised as far as possible in the coming years. Next year will see the addition of an eleventh central institution in the form of the new national competence centre GeoSphere Austria, the Federal Agency for Geology, Geophysics, Climatology and Meteorology (Bundesanstalt für Geologie, Geophysik, Klimatologie und Meteorologie).

Global estimate of R&D expenditure for 2022

According to Statistics Austria's global estimate (as at April 2022), the **expenditure on research and development (R&D) carried out in Austria in 2022 will amount to €14.15 billion**, up 9.3% on 2021 (€12.95 billion). The **R&D intensity** (percentage of gross domestic expenditure on R&D relative to gross domestic product) is set to come to **3.26%** for 2022, higher than the previous year (3.21%). This said, Austria will have **exceeded the European target value of 3% for an impressive ninth consecutive year**.

The **federal government will spend about €3.9 billion on R&D in 2022**. This is 12.84% more than in the previous year in nominal terms and just **over a quarter (27.6%)** of all R&D expenditure. For 2022, Statistics Austria is forecasting R&D expenditure of some **€0.62 billion (4.3%)** from the **federal states** and €0.03 billion (1.8%) for other public financing by local governments, chambers, etc., resulting in total public-sector R&D expenditure of €4.7 billion. **At €6.16 billion, Austrian companies** are set to **finance 43.5% of all R&D expenditure overall** in 2022. In addition, some **€1 billion (around 7.1%) of R&D expenditure** will be financed via the research premium in 2022. **€2.22 billion (15.7%)** of R&D funding will come **from abroad** in 2022 and will mainly comprise R&D funded by foreign companies on behalf of their Austrian subsidiaries as well as return flows from the EU's research programmes.

R&D survey 2019

According to the latest available data from Statistics Austria's 2019 R&D survey, **€12.4 billion was invested in R&D** in that year. R&D expenditure had thus **risen by €1.151 billion or 10.2%** since the previous survey in 2017, significantly outstripping nominal GDP growth over the same period (7.6%). At 70.3%, the business enterprise sector was responsible for the largest share of R&D expenditure, followed by the higher education sector with 21.8%. Government research institutions accounted for 7.3% and the private non-profit sector for 0.5%.

Looking at R&D expenditure by economic sector, manufacturing dominates, with a combined total of almost two thirds (66.2%) of all R&D expenditure. In percentage terms, therefore, the sector contributes more than three and a half times as much to R&D as it does to Austria's total gross value added. **Overall, manufacturing in Austria is becoming increasingly research-intensive.** At 18.5%, the proportion of services segments classified as high-technology or knowledge-intensive is still very low compared to other European countries and is even lower than it was back in 2017 (19.6%).

R&D expenditure in the higher education sector varies significantly across different fields of science, with natural sciences contributing the most at €741 million. **Research at higher education institutions is largely funded by the public sector**, with self-financing by the institutions (including tuition fees and expert assessments commissioned by third parties) only accounting for a small proportion. At 10.1%, the largest share contributed by the business enterprise sector went towards the technical sciences, while the natural sciences received the most EU-funded R&D (5.9%).

The number of people employed in R&D has risen sharply over the past ten years. Whilst 96,502 people (56,438 FTEs) worked in R&D in 2009, this had risen to as many as 144,117 (83,660 FTEs) by 2019. This is a 48% increase in headcount in FTE terms. The **proportion of women employed in R&D compared to the total** fell slightly from 24.9% to 24.1% (in FTE terms) in Austria from 2009 to 2019, putting the country last amongst the OECD member states. Women make up 37.8% of researchers in the higher education sector and 36.6% of those in the public sector. In relative terms, therefore, these two sectors employ more than twice as many female researchers as the business enterprise sector, where women make up only 16.1% of the workforce, as in 2017.

Austria's position in international comparison

Austria is one of the world's leading nations in terms of expenditure on research and development. In the EU comparison, the country ranks third in 2020, ahead of Germany. Together with Sweden, Belgium, Germany and Denmark, Austria is one of the five countries that meet the European R&D intensity target of 3%.

The country enjoys a **strong upper midfield** position in terms of its **research and development performance**, which is measured against core quality-oriented parameters such as international patent applications and citation rate. Austria is performing particularly well in terms of the **number of ERC grants per 1 million inhabitants as part of Horizon 2020**, where it is in second place behind the Netherlands. From the **perspective of global innovation rankings**, which the new RTI Strategy 2030 uses as central measurement tools, **Austria holds positions in the upper midfield** (18th in the Global Innovation Index, up one place on last year, and 8th in the European Innovation Scoreboard). Although Austria has not managed to break into the group of Innovation Leaders in the overall rankings, it has enjoyed a top position amongst the Strong Innovators for some time now.

In the area of digitalisation, the European Commission's Digital Economy and Society Index (DESI) for 2021 places **Austria fairly significantly above the European average**. Austria has moved up one position year on year to tenth amongst the EU-27. The field continues to be led by the Nordic countries of Finland, Sweden and Denmark alongside the Netherlands. Compared to the previous year, Austria has made particular progress in the areas of "Connectivity" and "Integration of Digital Technology", where its scores were previously below average.

This report also covers additional indicators as compared to the previous years, such as the ability to apply technologies of the future (Readiness for Frontier Technologies Index 2021) and the use of the "Internet of Things" by the population (2020). Austria is above the EU average for both indicators. A particular emphasis is being placed on artificial intelligence and quantum technology. Austria's performance in terms of relevant key figures such as the percentage of scientific publications or patents is very good, putting it well above the EU average.

Including other indicators of **innovation capability**, such as knowledge, human capital, economic complexity and resilience, Austria can almost consistently record **scores above the EU-27 average**. Only in terms of companies' AI use, degrees completed in the tertiary sector and geopolitical resilience (capacities) is Austria slightly below the EU average. The country comes in above average for R&D indicators, AI research and quantum research as well as social, economic and green resilience.

Austria and EU research, technology and innovation policy

Performance in European programmes is a key indicator of the strength and competitiveness of Austria's knowledge and innovation system. The country has achieved a strong position over the years.

With the final calls for proposals in spring 2021, the European Union's eighth Research Framework Programme, Horizon 2020 ended. It has been replaced by the successor programme, Horizon Eu-

rope, with the first round of calls for proposals in autumn 2021. This report takes one final look at Horizon 2020 as not enough data on the new programme is available yet.

Overall, the data reaffirms Austria's good level of success in Horizon 2020. The **total amount of project funding allocated to Austria amounts to €1.95 billion.** With a **success rate of 17.3% in terms of participations**, Austria ranks significantly above the average success rate of 15.3% for Horizon 2020, ranking third amongst the member states of the European Union, after Belgium (19.0%) and France (17.5%).

The largest volume of funding for Austria was raised under Pillar III, Societal Challenges. This amounted to €733.3 million, or 2.8% of the total for Europe. In Pillar I, Excellent Science, researchers based in Austria raised €709.1 million, corresponding to a 2.8% share in this pillar. In Pillar II, Industrial Leadership, Austria raised €446.8 million, which is equivalent to a funding share of 3.2%. Austria is therefore much better represented in this pillar than in the other two.

All major types of institution contributed to this success. The **majority of Austrian participations under Horizon 2020 came from the business enterprise sector (36.8%), of which almost half were small and medium-sized enterprises (SMEs)**. Austrian companies raised total funds worth €584.5 million over the programme's duration (with a particular emphasis on the "Industrial Leadership" pillar). Besides companies, however, the **higher education institutions and non-university research institutions were also the most significant contributors to Austria's successes in Horizon 2020**. The higher education institutions acquired €771.8 million in funding (predominantly in the Excellent Science pillar), while the non-university research institutions raised €482.4 million (chiefly for the Societal Challenges pillar). In terms of number of participations, the list of the top 20 Austrian institutions in Horizon 2020 is headed by the University of Vienna (251), followed by TU Wien (230) and the Austrian Institute of Technology (AIT) (191) as the most successful non-university research institution.

At the beginning of 2021 the Ninth European Framework Programme for Research and Innovation was launched (duration: 2021–2027) under the title **Horizon Europe.** This new EU research and innovation programme will be supported by approximately €95.5 billion of funding for the period 2021–2027. This represents a budgetary increase of some 30% compared to Horizon 2020. The **key new features** of Horizon Europe are the European Innovation Council and the R&I Missions as well as the Important Projects of Common European Interest (IPCEIs). IPCEIs are an EU instrument under state aid law for providing targeted funding to consortium projects in strategically important value chains that are intended to make a significant contribution to sustainable economic growth, employment, competitiveness and resilience. Taking part in IPCEIs marks a major step towards a new, future-oriented industry policy. Austria is currently participating in two IPCEIs and is sounding out four other areas.

Developments in the higher education sector

The many varied societal challenges facing Austria and the rest of the world at present mean that the future will hinge on how successful we are in creating sustainable, resilient economies. Being of systemic relevance, higher education institutions have a particularly important role to play. Measures to improve the country's academic performance and implement the RTI Strategy 2030 were therefore introduced in this area too in a targeted way.

For instance, the **universities' budget for 2022–2024** was **ramped up by 12.5%** compared to the preceding period, reaching a **record high of €12.3 billion**. Austria's higher education institutions are currently members of eleven out of a total of forty-one alliances as part of the European Universities. At the same time, the "excellent=austria" excellence initiative launched by the federal government in 2021 is

designed to strengthen research and priority-setting at Austrian universities further.

Besides expanding research priorities and the associated priority-setting at the higher education institutions as well as further increasing the quality of student care, improving **knowledge and technology transfer** is another key aim of the performance agreements for 2022–2024. Creating and expanding innovation platforms is a main priority in this regard. The RTI strategy envisages a 100% increase by 2030 in the number of academic spin-offs that enjoy commercial success. The three regional knowledge transfer centres, which since 2013 have made it their mission to contribute to the value chain through networking and consulting services, are also continuing their activities.

In line with the RTI Strategy 2030, the universities are also setting priorities in terms of content; these include a strong focus education and training in the area of STEM subjects. Digitalisation and artificial intelligence are playing a key role in this regard, with sustainability and climate protection also set to gain in importance.

Current research

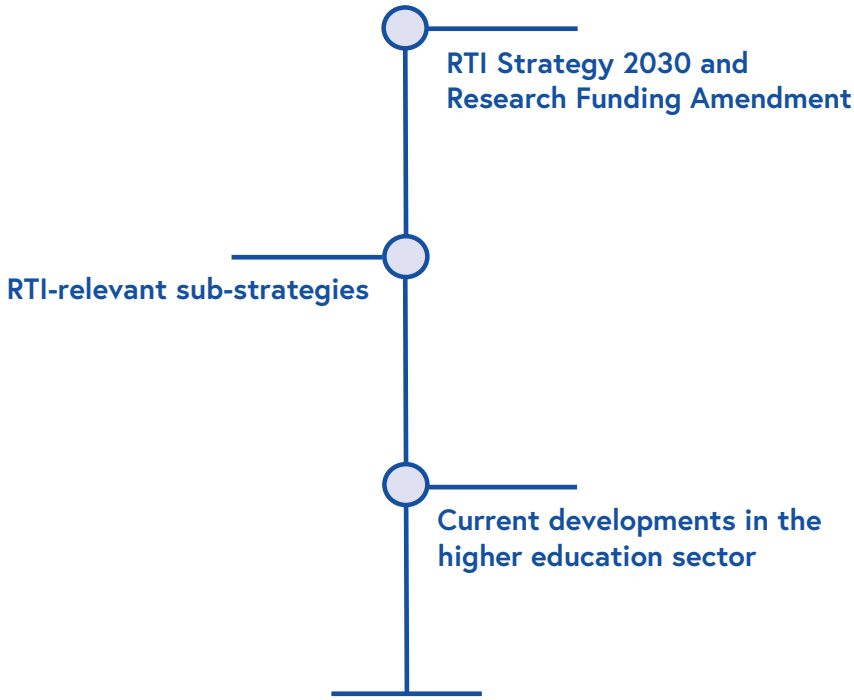
Artificial intelligence, quantum research and high-performance computing (HPC) as well as the circular economy and sustainability have all been identified as topics of future relevance. Outstanding achievements in these areas – as in others – rely on highly skilled human capital. The RTI Strategy 2030 thus views **promoting talented individuals** as one of its main aims and promoting human resources as one of its core areas of activity. Besides training and educating researchers at Austrian higher education and non-university institutions, supporting people engaged in research and innovation activities is key to these efforts. For the first time, therefore, this report provides a general overview of the range of funding schemes and instruments available in Austria for researchers at all stages of their careers.

Quantum technologies are currently at a major turning point in their evolution into key technologies with practical relevance. The underlying physical principles will open the door to completely new applications involving highly complex calculations in the future, such as in communication security or measurement technology. Amongst other things, the Quantum Austria funding initiative anchored in the RTI Strategy 2030 was launched to generate lasting economic momentum from the COVID-19 crisis and maintain Austria's competitive position. Similarly, investment in expanding Austria's High Performance Computing infrastructure (HPC) has been made over the past few years. HPC is a major driver of the digital transformation and an umbrella term for computing tasks that require a lot of processing power and memory. Austria is already home to a large number of HPC initiatives and corresponding participations in European projects.

The **circular economy** has also been set as a new focus area for RTI, resulting in a significant broadening of research and development projects, which have been supported in topic-based funding programmes to date. The circular economy is also already a core element of research and development projects forming part of twelve cluster initiatives. Although several existing RTI programmes already relate to the circular economy in some way, its introduction as a new RTI focus area will see the creation of more new programmes, initiatives and institutions dedicated to the topic.

Finally, **artificial intelligence** (AI) has been regarded as key technology for digitalisation in Austrian and international innovation systems for some years now and one whose growth is being accelerated further by advances in technology. Austria's AI strategy sets out to take account of the many different areas of use, of potentials and challenges of AI systems. Particular focus is being placed across Europe on the trustworthiness of AI – amongst other things, this calls for a new legal framework and standardisation efforts, which are currently being pursued.

1 Current Trends



Chapter 1 focuses on the current governance trends relating to Austria as a centre for research and innovation. It starts by taking a systemic look at the underlying objectives of the RTI Strategy 2030 and the Research Funding Amendment (Chapter 1.1), before going on to present the current status of selected RTI sub-strategies (Chapter 1.2) and to detail recent developments in the higher education sector (Chapter 1.3).

1.1 RTI Strategy 2030 and Research Funding Amendment: systemic change and long-term orientation of the funding system – status of implementation

Implementation of the RTI Strategy 2030 and the RTI Pact 2021–2023

Austria's RTI system enjoyed targeted and positive dynamics in 2021. Following the adoption of the Research Financing Act and the RTI Strategy 2030 in 2020, the first RTI Pact 2021–2023 was followed by the largest budget increase for the non-university sector and research funding, with a plus of 27%. The Research Financing Act also lays the foundations for a new governance system for ten central institutions for non-university research and research funding: the Austrian Academy of Sciences (OeAW), the Institute of Science and Technology Austria (ISTA), the Austrian Institute of Technology (AIT), Silicon Austria Labs, the Ludwig Boltzmann Gesellschaft – Austrian Association for the Promotion of Scientific Research (LBG), the Austrian Science Fund (FWF), the Austrian Research Promotion Agency (FFG), Austria Wirtschaftsservice (aws), the Christian Doppler Research Association (CDG) and the OeAD-GmbH – Agency for Education and Internationalisation (OeAD). With the establishment of GeoSphere Austria, the Federal Agency for Geology, Geophysics, Climatology and Meteorology (Bundesanstalt für Geologie, Geophysik, Klimatologie und Meteorologie; formalised in the GSA Act[1]), the Research Financing Act was amended and the GSA named the eleventh central research institution.

Strategic research, technology and innovation decisions are made based on the RTI Strategy 2030,[2] whose implementation is managed and supported by the RTI Task Force. This committee, which has coordinated RTI policy at federal government level for over ten years, is made up of high-level representatives of the following ministries, chaired by the Austrian Federal Chancellery (BKA): Federal Ministry of Finance (BMF) (deputy chair); Federal Ministry of Education, Science and Research (BMBWF); Federal Ministry of Labour and Economy (BMAW); and Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK).

One of the central tasks of the RTI Task Force, as the interministerial coordination and steering committee, is the monitoring the RTI strategy. The RTI Task Force explained the changes in the individual indicators at its 2021 spring meeting, supplementing its explanations with statements on relevant milestones. The RTI Task Force also serves as a point of contact for the European Commission in respect of "smart specialisation" in Austria – in this regard liaising closely with the Federal Ministry of Agriculture, Regions and Tourism (BMLRT) and the Austrian Conference on Spatial Planning.

Keeping the RTI Pact streamlined and precisely worded laid the necessary foundations on an interministerial basis for facilitating the planning and implementation of future projects in the federal ministries entrusted with research, technology development and innovation. "The RTI Pact is [thus] also significant for bringing those key players that are not central institutions into the scope of the Research Financing Act (FoFinaG). Even though the Act does not impose any additional rules on them, they still

1 Announced in the Federal Law Gazette Part I under number 60/2022 on 14 April 2022.
2 See Federal Government of the Republic of Austria (2020a).

get to benefit from greater planning and funding security."[3]

Although the first RTI Pact covers the entire RTI system, the fundamental principles of content and budgetary design are to be regarded as an indispensable element for the central institutions.[4] The RTI Pact 2021–2023 thus closes the gap between the (long-term) RTI Strategy 2030 and operational, institution-specific three-year planning and agreements at the level of the research and research funding organisations.

Following the adoption of the Research Funding Amendment 2020 and the RTI Pact 2021–2023, the preparation of and consensus on the performance and financing agreements mark the next step towards "full-scale operation" in line with the provisions of the Research Financing Act (FoFinaG):

A three-year financing agreement for 2021–2023 was signed in 2021 with the Austrian Science Fund (FWF) with a total budget for new approvals of €806 million. This is a 27% increase on the past three years and gives the Austrian Science Fund its largest budget for approvals to date. The Austrian Science Fund (FWF) has already launched one of the most important measures in the RTI Pact – the "excellent=austria" excellence initiative – during the current funding period. The goal is to further strengthen Austria as a leading science hub on the international stage. To this end, the Federal Ministry of Education, Science and Research (BMBWF) will be providing an approval volume of €150 million until 2024, with participating universities and other research facilities contributing 40% of their own funds. This means that a total of €250 million will be invested in "excellent=austria" over three years.

The first financing agreement has also been signed with OeAD-GmbH – Agency for Education and Internationalisation (OeAD), signalling a new phase in its partnership with the Federal Ministry of Education, Science and Research (BMBWF). At the same time, this also represents a transitional phase, because some of the BMBWF's previous responsibilities are now being passed on to the OeAD for the term of the financing agreement (e.g. the schools' culture budget, erinnern.at and the Children's and Youth Universities), and some new programmes and initiatives have also been launched (Sparkling Science 2.0, Digital Learning). As far as the OeAD is concerned, this first financing agreement provides longer-term planning security than the annual budgets that it has had in the past. The OeAD plays an important role in the internationalisation of Austria's education, higher education and research landscape and in turn is making a particularly significant contribution to positioning Austria as a science and research nation of international renown.

Pioneering research with an eye on the future is a guarantee of innovation. In this spirit, the federal government and the regional government of Lower Austria – the two bodies that maintain the Institute of Science and Technology Austria (ISTA) – agreed to continue funding the institute based on the Klosterneuburg campus for 2027–2036 and to expand it as well. No fewer than 150 research groups are planned on the ISTA campus in the years to 2036. The federal government and state of Lower Austria will be investing up to €3.28 billion in the international "ISTA" flagship project between now and 2036, with the former assuming 75% of costs and the latter 25%. A new performance agreement has been concluded between the Federal Ministry of Education, Science and Research (BMBWF) and the Institute of Science and Technology Austria (ISTA) for 2021–2023. The Institute of Science and Technology Austria (ISTA) will have up to €294.3 million at its disposal over this period, 34% more than in 2018–2020.

The 2021–2023 performance agreement with the Academy of Sciences (OeAW) envisages a budget of €412.57 million for 2021–2023 (up by €61 million on

3 See Pichler (2021).

4 See Section 3 of the Research Financing Act (FoFinaG).

the previous period, 2018–2020) and will enable various new projects including:

- a CORI Institute of Molecular and Computational Metabolism in Graz and
- a centre for research on Antisemitism.

The "Campus ÖAW" ("OeAW Campus") project will also be completed by 2022 with an additional €30 million of federal funds.

A paradigm shift has been instigated for the Ludwig Boltzmann Gesellschaft – Austrian Association for the Promotion of Scientific Research. In line with the government programme, it is to expand its role as research promoter more significantly in the future, particularly in the field of clinical research. A one-year funding agreement was signed with the Ludwig Boltzmann Gesellschaft (LBG) in 2021, followed by a two-part agreement for 2022–2023 (a performance agreement in its capacity as administrator and a processing agreement in its capacity as research promoter).

A performance agreement for 2022 and 2023 was signed between the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) and the Austrian Institute of Technology GmbH (AIT), geared towards its further development and securing its position as Austria's largest non-university research institution. Concluding this performance agreement ensures financial security in a field marked by uncertainty. This will allow public funds to be put to more efficient and impactful use within the bounds of competition and state aid law by injecting more flexibility into their application while also introducing effective, contractually agreed evaluation mechanisms. The performance agreement will accomplish three things: a) set out the conditions for providing public funding to the Austrian Institute of Technology (AIT); b) maximise the benefit for the national innovation system; and c) ensure the efficient use of public funds and a high level of performance for the AIT, and also document this using performance indicators. Under the performance agreement, the Austrian Institute of Technology (AIT) is set to receive federal funding in the form of a shareholder contribution of up to €128.7 million for the period 2022–2023.

The Federal Ministry of Labour and Economy (BMAW, formerly BMDW) and the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) also signed financing agreements for 2022–2023 with two other central research funding organisations – the Austria Wirtschaftsservice (aws) and the Austrian Research Promotion Agency (FFG). These financing agreements launch the operations of the RTI Pact 2021–2023, which has been adopted by the Austrian federal government and embedded in the Research Financing Act (FoFinaG), for the 2022 and 2023 calendar years. They set out in binding terms the objectives and targets the Austria Wirtschaftsservice (aws) and the Austrian Research Promotion Agency (FFG) have to achieve in each case, which action they are to take and which budgetary resources are available to support these efforts. This gives both research funding institutions – for the first time – several years of planning security. A transitional arrangement (in accordance with Section 10 Research Financing Act (FoFinaG)) is used here, making the two-year agreements as well as the overall contract ("Gesamtbeauftragung") for 2021 part of the first three-year funding period. From 2024 onwards, three-year agreements are to be concluded with the Austria Wirtschaftsservice (aws) and the Austrian Research Promotion Agency (FFG) – in each case as per the standard procedure. The financing agreements cover the whole range of promoting applied research, technology and innovation. Participation in the two Important Projects of Common European Interest (IPCEIs) – Microelectronics II and Hydrogen – also forms part of these financing agreements and is handled by the Austria Wirtschaftsservice (aws) together with the Austrian Research Promotion Agency (FFG). Its financing agreement provides the Austria Wirtschaftsservice (aws) with a funding budget of €264 million for the 2022–2023 funding period (€132 million from the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Tech-

nology (BMK) and €132 million from the Federal Ministry of Labour and Economy (BMAW)). Meanwhile, the Austrian Research Promotion Agency (FFG) has a funding budget of €929 million for 2022–2023 (€720 million from the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) and €209 million from the Federal Ministry of Labour and Economy (BMAW, formerly BMDW)). Both institutions were also issued with revamped funding guidelines to help them achieve their strategic objectives. These guidelines guarantee that the funding made available will be used transparently, independently and in a fair way, and that Austrian and European regulations on awarding state aid and funding will be complied with.

In addition, the Federal Ministry of Labour and Economy (BMAW, formerly BMDW) has signed a financing agreement for 2022–2023 with the Christian Doppler Research Association (CDG) research promotion institution. Two new sets of programme guidelines (for CD Laboratories and JR Centres) were also issued in this connection on the basis of Section 15 in conjunction with Section 12a of the Research and Technology Funding Act (FTFG). The financing agreement and the programmes that it transfers to the Christian Doppler Research Association (CDG) for implementation make a direct contribution to efforts to achieve the objectives in the RTI Pact 2021–2023. In line with the further aims of the Research Financing Act (FoFinaG), the new guidelines are also accompanied by a significant streamlining of administrative structures that was begun in the transitional year of 2021 and is set to be completed by the end of 2022. In particular, this will see a reduction in the levels of agreement signed with funding recipients. The financing agreement for 2022–2023 provides the Christian Doppler Research Association (CDG) with €28.974 million in operating resources from budget chapter 33. The Christian Doppler Research Association (CDG) is also applying for funding from the "Future Austria Fund" for 2022 (and subsequently for 2023).

The Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK, formerly the Federal Ministry for Transport, Innovation and Technology – BMVIT) signed a partnership agreement and framework agreement for 2018–2023 with Silicon Austria Labs (SAL) back in 2018. For this reason, in coordination with the Federal Ministry of Finance (BMF), no performance agreement was signed with Silicon Austria Labs (SAL) for 2021–2023. This will not be done until the next funding period, 2024–2026. However, a Special Investment Programme (SIP) for 2021–2024 was agreed with Silicon Austria Labs (SAL) for infrastructure measures at the centre for cutting-edge research. Stakes in SAL are held by the federal government, represented by the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK), as well as by the federal states of Upper Austria, Carinthia and Styria and the microelectronics industry, represented by the Fachverband der Elektro- und Elektronikindustrie (FEEI). Silicon Austria Labs (SAL) is intended to become a new centre for research, with three sites in Styria, Carinthia and Upper Austria and its headquarters in Graz. Its research work is set to focus on system integration, sensor systems, high-frequency applications and power electronics, and its R&D projects are to be funded and processed in compliance with competition and state aid law. The contractually agreed evaluation measures and a degree of flexibility that takes account of a project's progress and interim results will ensure that public funds are used effectively and efficiently.

Data-driven research is being highlighted as another key example of how the RTI Pact is being implemented to support the strategic objective "Become an international innovation leader and strengthen Austria as an RTI location": "Creating […] a microdata centre at Statistics Austria to improve access to microdata and register data for scientists and researchers"[5]

5 Federal Government of the Republic of Austria (2020b, 5).

Austrian Microdata Center AMDC

The legal foundations for the Austrian Microdata Center (AMDC) were created when the amendments to the Federal Statistics Act and the Research Organisation Act entered into force on 1 January 2022. On this basis, Statistics Austria is currently setting up the AMDC in compliance with stringent quality and security standards in terms of data protection and privacy and in close consultation with the Federal Ministry of Education, Science and Research (BMBWF), its in-house registry research working group and the research community. Under the Federal Statistics Act, the AMDC is set to begin operations and open its doors to scientists and researchers on 1 July 2022.

The OECD had identified this structural weakness in the Austrian RTI system in its "OECD Reviews of Innovation Policy: Austria 2018", observing that statistical data had been virtually impossible to access for scientific purposes in Austria up until that point. The AMDC will now enable scientific institutions to access and link up microdata from public registers. Austria is thus bringing itself into line with the international standard and eliminating the disadvantages that the country's researchers used to face as part of EU programmes, for instance.

The use of microdata from Statistics Austria and from administrative registers of government ministries as well as of registers of officials who are independent under the Austrian constitution[6] (which previously had to be released by decree by the Federal Minister of Education, Science and Research in agreement with the competent federal minister) will pave the way for answering new, innovative and more complex research questions and generating more precise results. Combining data records from various sources will enable researchers to be particularly effective in how they tackle the challenges currently facing society, such as climate change, combating diseases and pandemics, as well as demographic trends and labour market questions.

Future Austria Fund

The Future Austria Fund is another important government project that is being implemented: between 2022 and 2025 (until the interim evaluation of the implementation of the RTI Strategy 2030), the National Foundation for Research, Technology and Development (NFTE) will be endowed with €140 million a year and developed further into the Future Austria Fund as specified in the RTI Strategy 2030. This funding is in addition to the RTI Pact and thus supports the whole of Austria's RTI system.

The Future Austria Fund will serve to fund cutting-edge basic and applied research as well as technology and innovation development. Its aims are as follows: to facilitate pioneering research and disruptive innovations; to achieve or maintain technological leadership in suitable fields; to strengthen and improve the resilience of the Austrian innovation system; to step up cooperation between science, research, business and society, particularly in order to open up longer-term bottom-up research horizons; to broaden and deepen knowledge transfer; and to implement EU missions and EU partnerships insofar as they relate to research and its transfer to Austria.

Strategic coordination with regard to the annual setting of priorities is carried out by the federal government.

The following priorities were set for 2022 based on the objectives in the RTI Strategy 2030:

Objective 1 – Become an international innovation leader and strengthen Austria as an RTI location:

- Co-funding Austria's participation in EU partnerships;
- Co-funding Austria's participation in the Digital Europe Programme;
- Pandemic preparedness;
- Clinical research;
- Research infrastructures;
- Artificial intelligence;

6 Social insurance institutions, for example.

- Austria as a "chip factory" – R&D in the semiconductor segment.

Objective 2 – Focus on effectiveness and excellence:

- Data-driven research on societal subjects;
- Excellence in research groups;
- Application-oriented basic research;
- Disruptive/radical innovation.

Objective 3 – Focus on knowledge, talents and skills:

- Aid for young talents.

Applications to the Future Austria Fund can be submitted by any of the federal government's preferred research funding agencies: the Austrian Science Fund (FWF), the Austrian Research Promotion Agency (FFG), the Austria Wirtschaftsservice (aws), the Christian Doppler Research Association (CDG), the Austrian Academy of Sciences (OeAW) and the Ludwig Boltzmann Gesellschaft – Austrian Association for the Promotion of Scientific Research (LBG). The first tranche of funding from the National Foundation for Research, Technology and Development (NFTE) is set to be disbursed by summer 2022.

1.2 RTI-relevant sub-strategies

Besides the RTI Strategy 2030, the objective of establishing Austria as innovation leader has also given rise to a wide range of sub-strategies with relevance for RTI. Most of these RTI sub-strategies are focusing on topic-based priority areas, forward-looking issues (see also Chapter 2.4) and cross-cutting themes, and can thus be characterised as an effort to secure a larger number of well-qualified human resources and provide extensive yet targeted support to the digital and green transformation. To provide an overview of current trends, the latest RTI-relevant sub-strategies initiated at national level and recent developments from established sub-strategies are set out below alongside their objective and content in each case.

Excellence Initiative (excellent=austria)

The Excellence Initiative[7] is helping to reinforce areas of strength and develop new and innovative fields of research. It is being implemented by the Austrian Science Fund (FWF) and is promoting bottom-up, cutting-edge research in line with the highest international standards, as well as leaving scope for unconventional approaches. The aim is to leverage synergy effects by expanding sustainable partnerships between disciplines and institutions. "excellent=austria" is intended to create attractive career prospects for the next generation of scientists and strengthen Austria's universities, universities of applied sciences and non-university research institutions in the global competition. It is also focusing on the knowledge transfer of research results into business and society and on promoting gender equality and diversity.

In order to optimise its integration into the Austrian research landscape, "excellent=austria" is being implemented in three stages.

Starting with the call for proposals for "Clusters of Excellence" in 2021, which provide a platform for developing large-scale national and international projects, areas of outstanding research are also being strengthened via partnerships across institutional, discipline and national borders. A "Cluster of Excellence" is characterised by a successful combination of cutting-edge research, research-driven education and training, and national and international knowledge exchange. The first projects will be approved in early 2023.

The next step will be to establish a funding scheme – "Emerging Fields" – to ramp up basic research in fields with particularly significant potential for the future. This will enable Austrian research institutions to

7 https://www.fwf.ac.at/en/research-funding/excellentaustria

serve as international pioneers and strengthen priority-setting in the Austrian research area over the long term. The call for proposals begins in 2022, and decisions on funding will be made in 2023.

The third line of the programme, the "Austria Chairs of Excellence", offers universities and other research facilities more opportunities to support excellent researchers in all scientific disciplines, keep them in Austria and secure their services for the Austrian research system. The first call for proposals will be held in 2023.

Location Strategy 2040

The Location Strategy 2040[8] aims to turn Austria into one of the top ten places to do business anywhere in the world. It is focusing on three priority areas: digitalisation, sustainability and quality of life. Objectives and flagship projects are being devised in seven areas in line with these priorities.

The Industry 5.0 working group is exploring the next step in digitalisation in the industry landscape, focusing on human/machine interaction. It is looking at "servitisation" and the digitalisation of public administration and e-commerce in the context of expanding digital and service-based business models. The strategy is also considering aspects of specialised technological leadership, e.g. in what areas Austria is intended to lead the way and/or how it is to get into that position. While the "Energy and Mobility Transition" working group is tackling climate-neutral energy supply, decarbonisation and the potential for using alternative fuels, "Greentech/ Green Materials" is addressing environmentally friendly technologies and materials as well as the circular economy.

"Biotech, Life Science and Health" is discussing healthcare expertise, health data and the availability of nurses and doctors. Besides the future of tourism in Austria, the seventh working group, "Quality of Life, Tourism, Creativity and Culture", is also considering the major importance of the creative industries and the attractiveness brought to Austria through its high standard of life.

In addition, cross-cutting themes are being combined as a separate category entitled "Enablers". These are issues that come up in several of the working groups mentioned above. The following cross-cutting themes have been identified:

- The working environment and skilled labour;
- The capital market, taxes and funding;
- Research and education;
- Innovation in infrastructure;
- Internationalisation/exports/future-oriented competition;
- Climate neutrality by 2040.

Following the kick-off meeting in May 2021, the working groups held several rounds of discussions with a wide range of stakeholders from business and industry, science and research, politics and special-interest groups, which led to the aforementioned issues being identified. The Location Strategy is set to be unveiled in 2022 and then move into the implementation phase.

Digital Action Plan

As a far-reaching process of transformation, digitalisation affects all areas of our lives and thus needs to be accompanied by a process of awareness-raising and implementation. The importance of digitalisation is beyond dispute, which is why the issue is also being accorded high priority in the government programme. Introducing digitalisation successfully into business, industry, the working world, government and society is a key issue for the future. Austria will only be able to benefit from the fresh economic momentum and therefore create new jobs, prosperity, a secure quality of life and proximity to its citizens if it is a top digital location.

As part of the responsibility of the Federal Ministry of Labour and Economy (BMAW) for coordinating

8 https://www.bmaw.gv.at/en/Topics/Business-Location/Location-Business-Policy.html

digitalisation matters, several topic-specific action plans are being devised together with the functional departments responsible for each topic (open list of topics). An action plan is a hierarchy of strategic objectives, fields of activity and sub-objectives for which measures are defined. Stakeholders and experts are being fully involved in this process via various online workshops and interview formats, while academic expertise is also being brought in by having two universities support the project.

So far, digital action plans for the following topic areas have been completed:

- Data;
- Crisis resilience;
- Digital economic transformation;
- Digitally sustainable economic management;
- Digital school;
- Digitalisation of higher education institutions.

In addition, the digital action plans for the following topic areas are currently being drawn up:

- Digitalisation in tourism;
- Digital skills in the administration;
- Digitalisation in the cultural sphere;
- Safe and secure digitalisation.

Digital action plans for the following are in the pipeline:

- E-health;
- Digitalisation and secondary education;
- Digitalisation in agriculture.

"AIM AT 2030" AI Strategy

With its strategy for artificial intelligence[9] (AI), the federal government is laying the foundations for using AI in all areas of people's lives in a responsible way that fosters prosperity. In doing so, it is also creating the necessary legal framework for using AI safely and securely in line with European requirements in order to deploy it in a transparent, trustworthy and legally watertight form.

In Austria, AI is to be employed on the basis of fundamental European values, in consideration of people's privacy and the principle of equality, and to the greatest possible benefit of everyone. AI is expected to do its bit to position Austria as a centre for research and innovation and as a competitive location for technology and industry. To this end, it is to be harnessed across the board, i.e. also by Austria's small and medium-sized enterprises, as well as in administration.

The following areas of activity for ensuring trustworthy AI and an AI ecosystem have been defined in order to achieve the strategic objectives in the AI strategy:

- Specify ethical principles in line with European AI ethics guidelines;
- Strike a balance between legalities and day-to-day application, taking account of European activities in support of a common legal framework;
- Standardise AI applications;
- Establish safe and secure AI;
- Make data usable and increase its use;
- Forge long-term partnerships between education, research, business and industry;
- Strengthen AI in education and training, drive forward cutting-edge AI research in Austria and set up topic-based AI funding programmes;
- Use AI to modernise public administration;
- Improve access to capital and expand and further develop infrastructure;
- Make it easier to turn innovations into marketable products;
- Actively support the transformation of the world of work and strengthen the sharing of digital skills and expertise.

The 64 (horizontal) measures specified within these areas of activity will help Austria to create the best possible agile framework conditions for using AI in a human-centric way that is also focused on the common good. A further 27 measures have been proposed in 13 specific areas of application.

9 https://www.bmdw.gv.at/dam/bmdwgvat/content/Themen/Digitalisierung/Strategien/K%C3%BCnstliche-Intelligenz/2021-AIM_AT_2030_UA-bf.pdf

An interministerial working group (the "AI Policy Forum") chaired by the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) and the Federal Ministry of Labour and Economy (BMAW) has been set up in order to help implement the strategy across ministry boundaries and lay the groundwork for updating the strategy for 2023. This includes ongoing monitoring of the AI strategy measures, allocating them to the ministerial departments responsible and liaising on AI activities within the functional departments. The continuous involvement of relevant stakeholders and the general public is also being ensured.

Austrian Space Strategy 2030+ "Humanity, Climate, Economy: Space is There for EVERYONE"

The "Space Strategy" sets out to support sustainability on Earth and in outer space.[10]

Measures and activities are designed to strengthen the Austrian space sector and scientific excellence and ensure that space is used for all aspects of life. Talent and diversity are being promoted, and the public are being engaged in dialogue about the advantages and benefits of space technologies. Space is a key technology that is delivering a major contribution to efforts to meet the Austrian federal government's target of making the country climate-neutral by 2040.

Mobility 2040 – R&I Mobility Agenda 2026

The Mobility 2026 RTI agenda[11] is the plan for implementing (i.e. making more detailed specifications for) the Mobility 2040 RTI strategy over the next five years. Between now and 2026, the innovation policy measures in the mobility sector – funding for RTI, spaces for experimentation, strategic alliances and implementation partnerships, Austria's position in European and international rankings – will focus on the four mission areas specified in the agenda and thus drive forward efforts to make the overarching vision of "innovations in and from Austria for a climate-neutral mobility system in Europe" a reality.

As part of the R&I Mobility Agenda 2026, the four mission areas have each been assigned a target vision as well as three objectives that are intended to help achieve it. The target groups for each mission area have also been defined, as have the RTI topics that the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) will need to address in the coming years in order to realise the vision for the years to 2040.

Focusing on four mission areas covering the whole system – cities, regions, digitalisation and technology – will prevent individual fields of technology, sub-systems and forms of mobility from being considered in isolation and will support efforts to find integrated solutions for the current challenges facing mobility. The objectives of the various mission areas are as follows:

Cities:

1. Develop innovative concepts and mechanisms for climate-compatible usage and behaviour patterns in an urban mobility context;
2. Create innovative offerings for climate-neutral urban mobility;
3. Create innovative building blocks for overhauling the urban mobility system to make it fit for the future.

Regions:

1. Promote regional structures and mobility patterns that reduce traffic;
2. Establish innovations that will ensure a climate-friendly future and mobility for locations in the region;

10 https://austria-in-space.at/en/austria-in-space/austrian-space-strategy.php
11 https://www.bmk.gv.at/en/topics/innovation/publications/Mobility-of-the-Future.html

3. Develop innovations for climate-friendly mobility and transport systems beyond regional boundaries.

Digitalisation:

1. Use digitalisation to run transport infrastructure, traffic areas and the transport system safely, reliably and sustainably;
2. Use digitalisation to lay the foundations for safe, climate-neutral, reliable and attractive mobility and logistics services;
3. Use digitalisation to leverage mobility system data and facilitate its use.

Technology:

1. Develop technological system solutions, climate-neutral propulsion systems and environmentally compatible components;
2. Promote innovative technologies for automated, connected and autonomous driving in order to achieve society's aims;
3. Make renewable and climate-neutral energy supply, energy sources and the circular economy an established part of the mobility system.

FIT4UrbanMission

In 2021, the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) launched a nationwide initiative – "FIT4UrbanMission"[12] – that allows Austrian cities to build up expertise and knowledge about achieving the country's climate targets and take part in the European Commission's "Urban Missions". The EU's mission wants to make 100 European cities into pioneers of climate neutrality by 2030.

FIT4UrbanMission is the initial spark that will give Austrian cities the technology they need to become climate neutral and accelerate the process significantly from a structural perspective. Since climate protection is a key component of the Horizon Europe Research Framework Programme, two out of the five large-scale research missions are tackling efforts to achieve the climate targets head-on. The urban mission entitled "100 Climate-neutral Cities by 2030 – by and for the Citizens" wants to enable 100 European cities to achieve climate neutrality by as early as 2030. These 100 European model cities are to be elevated to pioneers of climate neutrality on the global stage. Successful measures and positive experiences are to be replicated and driven forward throughout Europe, while barriers and obstacles to implementation are to be removed before they can have an impact.

Nine Austrian cities are taking part in "FIT4UrbanMission": Vienna, St. Pölten, Graz, Klagenfurt, Villach, Linz, Salzburg, Innsbruck and Dornbirn. They have made it their objective to come up with a vision, strategy and measures and to promote capacity- and knowledge-building for a climate-neutral overall concept and climate-neutral urban districts.

The priority area "The climate-neutral city" was identified based on the FIT4UrbanMission initiative. The aim is for the cities involved to use RTI measures to plot and smooth their pathway to climate neutrality. Between now and 2030, it is hoped that this priority area will showcase climate-neutral neighbourhoods in the cities and devise and share practicable solutions for becoming climate-neutral.

RTI initiative "Circular Economy"

Launched in 2021, the nationwide RTI initiative "Circular Economy"[13] aims to use research, technological developments and innovations to help make a positive impact on the climate and environment, improve Austria's long-term competitiveness as a place to do business, ensure security of supply and foster closer partnerships along the value chain. It is thus a key cornerstone of efforts to implement national and European strategies for the circular economy and bio-

12 https://www.austriatech.at/assets/Uploads/Presse/2a1877344d/210616-Presseinformation-Fit4UrbanMission.pdf
13 https://nachhaltigwirtschaften.at/de/themen/kreislaufwirtschaft/#initiative

economy and to achieve the Sustainable Development Goals set by the United Nations (UN).

It is focusing on the following three RTI objectives:

- Closing materials cycles;
- Intensifying product use;
- Optimising the use of resources.

The RTI initiative "Circular Economy" is identifying and addressing relevant challenges at every stage of the value creation cycle in order to lay the foundations for a circular approach to the economy through innovation, technology and considering the system as a whole.

This requires new technologies, systems and processes to be developed and existing ones improved. This includes purchasing and using recyclable, harmless and, as far as possible, bio-based materials and covers all aspects of design (material selection and the ability of a product to be disassembled, repaired and reused) as well as the resource-efficient, low-emission manufacture of reusable products.

Developing new business models and strategies for preserving value (leasing, sharing, reuse, refurbishment, repair) are crucial, as are the recovery of raw materials (treatment) and recycling. Logging, using and providing data consistently and throughout a product's entire life cycle is also key to the success of the circular-economy concepts listed above.

The RTI initiative "Circular Economy" will form the core and the main measure of the Circular Economy RTI focus area in 2022, where dovetailed RTI measures for all RTI focus areas identified by the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) will be devised and launched. These measures will be based on the common RTI objectives within the priority area and will make extensive use of the RTI funding portfolio available to the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK).

Creative Industries Strategy for Austria

The Creative Industries Strategy for Austria[14] sets out to:

- Strengthen the Austrian innovation system and the competitiveness of its creative industries;
- Give the creative industries a more prominent role as a driver of innovation and transformation for other economic sectors and society;
- Burnish Austria's international image as a creative country for culture and innovation.

To achieve these objectives, the Creative Industries Strategy has defined three interconnected pillars – Empowerment, Transformation and Innovation – to which 22 measures and 43 specific implementation initiatives have been allocated across 8 fields of activity. Strategic support with implementing the strategy comes from the Creative Industries Advisory Board, which was set up at the Federal Ministry of Labour and Economy (BMAW, formerly BMDW) specifically for this purpose. Its independent experts are on hand to provide advice, assess the progress made in implementing the strategy every year and make up-to-date recommendations.

The Ninth Austrian Creative Industries Report[15] was published in early summer 2021 and contains the following key findings:

- The creative industries have been hit disproportionately hard by the COVID-19 crisis;
- National value added (GVA) has fallen by 10.9% (7.5% across the economy as a whole);
- The value of production has fallen by 10% (8.2% across the economy as a whole);
- Employment has fallen by 7% (5.2% across the economy as a whole);
- The software, gaming and advertising sectors are still the biggest creative industries;
- An analysis of the role played by the creative industries as a pioneer of the digital transformation.

Published in November 2021, the third progress re-

14 https://www.bmaw.gv.at/en/Topics/Business-Location/Creative-Industries.html
15 https://g2j8y9d5.rocketcdn.me/wp-content/uploads/2021/06/9KWB_barrierefrei_fin.pdf

port by the Creative Industries Advisory Board[16] shows that:

- A set of further seven measures have seen additional improvements over the previous year:
  - Measure 7 – Implementing initiative "Creating new jobs requiring vocational training"
  - Measure 13 – Implementing initiative "Making regional and job-specific initiatives visible"
  - Measure 14 – Implementing initiative "Raising awareness of the creative industries in schools"
  - Measure 17 – Implementing initiative "Setting up a digital marketplace for new innovation partnerships"
  - Measure 19 – Implementing initiative "Collaborating with the crowd"
  - Measure 20 – Implementing initiative "Strengthening regional innovation systems"
  - Measure 22 – Implementing initiative "Establishing a tax allowance for investment"
- Implementation activities have been launched or are making swift progress for five out of the Advisory Board's six recommendations.
- The Advisory Board's recommendation from 2020, namely to create a new line of communication for the sector, is being actioned. This is intended to shine a spotlight on the creative industries' innovative potential and expertise in solving challenges facing the whole of the economy and society and raise awareness of them amongst key decision-makers and the general public.

Open Innovation Strategy for Austria

The Open Innovation Strategy[17] for Austria has three main objectives:

1. Opening up, expanding and further developing Austria's research and innovation system, particularly by tapping into new sources of innovation, and strengthening the networking capability of key players and organisations taking part;
2. Getting citizens ("end users") more closely involved in generating innovations. This opening-up can also help to significantly raise the profile of innovation, research and development in the public's minds;
3. Sharpening the Austrian innovation system's focus on efficiency and results, e.g. through innovative forms of knowledge transfer and incorporating the needs of society, the economy and the public sector more strongly into the research and innovation system.

A total of 14 measures (listed in table form in Annex III) have been devised in three fields of activity – "Culture & Expertise", "Networks & Cooperation" and "Resources & Framework" – in order to achieve these objectives.

An interim report on implementing the Open Innovation Strategy for Austria was published at https://openinnovation.gv.at/ in 2021 on behalf of the Federal Ministry of Education, Science and Research (BMBWF) and the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK). Most of the measures have been implemented to a moderate extent, with the authors identifying significant progress with two: "Develop and implement co-creation and Open Innovation training programmes for interested parties" and "Embed principles of Open Data and Open Access in research". Besides bringing new stakeholders on board, the interim report also recommends setting more, mainly cross-measure, priorities for implementation by 2025 resulting from the overall consideration of implementation progress to date and the trends in the ecosystem. According to the report, the pandemic has shown that sharing knowledge can help solve problems faster, specifi-

16 https://www.kreativwirtschaft.at/wp-content/uploads/2021/12/DRITTER_FORTSCHRITTSBERICHT-2021_FINAL_Barrierefrei.pdf
17 https://openinnovation.gv.at/

cally in the case of active substances, mechanisms of action and vaccines.

The Austrian federal government's intellectual property strategy (the "IP Strategy 2017")

Creativity and ingenuity are key to innovative potential and competitiveness. Inventors, entrepreneurs and research institutions are to be given appropriate protection and freedom in handling their intellectual property in order to improve their innovation performance. The IP Strategy[18] is thus focusing on intellectual property rights as a key pillar of the knowledge society and the basis for economic prosperity. Digitalisation and globalisation are posing new kinds of challenges for dealing with IP.

The key trends thus include:

- The strategic further development and expansion of the "National Contact Point for Knowledge Transfer and Intellectual Property" (NCP-IP);
- Strengthening technology transfer from academia to business and industry and increasing the number of spin-offs in the current performance agreements between the Federal Ministry of Education, Science and Research (BMBWF) on the one hand and the universities, the Institute of Science and Technology Austria (ISTA) and the Austrian Academy of Sciences (OeAW) on the other, and extending the Spin-off Fellowship programme;
- IPR support and consultancy services from the Austria Wirtschaftsservice (aws) for companies, with a new focus on green IP;
- Further expanding the services offered by the Austrian Patent Office and the Patent Voucher provided by the Austrian Research Promotion Agency (FFG);
- Expanding the information given to specific target groups by the Austrian Patent Office to help young people handle IP.

Foreign Trade Strategy

The Austrian federal government adopted its Foreign Trade Strategy – "An innovative foreign trade policy for a successful Austria"[19] – in December 2018. The strategy is geared towards boosting Austrian exports by giving the country a coordinated and harmonised presence in economically attractive growth regions and supporting local companies looking to operate abroad by providing them with targeted assistance.

There are 63 measures in the Foreign Trade Strategy. These focus not only on leading firms, but also on SMEs and startups and on the topics of innovation and digitalisation. The following measures are planned:

- Formulating an implementation roadmap for EU trade and investment agreements to make it easier for companies to get the most out of them;
- Expanding the International Economy Research Platform (Forschungsplattform Internationale Wirtschaft – FIW) into a centre of expertise for applied foreign trade research;
- Strengthening Austria's national contact point for corporate responsibility and making it a "one-stop shop";
- Promoting sustainable and fair business partnerships;
- Expanding the Austrian Business Agency "ABA – Invest in Austria" into an agency for promoting Austria as a place to do business, including to attract skilled workers;
- Setting up a cooperation platform to connect SMEs with industrial companies;
- Driving forward the internationalisation of dual qualifications and "exporting" the Austrian system;
- Expanding Austria's presence in growth markets;
- Providing targeted support at government level, particularly for large-scale strategic projects;
- Further developing "go-international" and, in par-

18 https://www.bmaw.gv.at/Themen/Innovation/IP-Strategie.html
19 https://www.bmaw.gv.at/en/Topics/International.html

ticular, defining systematic priority areas for specific federal states and industries to give local companies targeted support;
- Setting up a business intelligence platform for global infrastructure projects in order to enable Austrian firms to access better information on projects;
- Helping Austrian companies to use digital sales channels;
- Expanding Austria's network in global innovation hubs;
- Establishing a coordination committee in order to coordinate measures relevant to foreign policy in the best possible way;
- Creating a meta-portal (landing page) for Austria's international online presence;
- Standardising the image that relevant stakeholders present to the outside world in order to improve Austria's recognition value.

The Foreign Trade Strategy 2018 likewise makes reference to "sustainable development as an opportunity for companies and Austria as a location". Implementation of the individual measures began in 2019 and is being given external process support. The success of its impact at the level of individual measures and the economy as a whole is being assessed in an external evaluation that was commissioned by the Federal Ministry of Labour and Economy (BMAW) and is being lent academic support.

Crisis-induced changes on an international scale and the priorities set in the government programme for 2020–2024 required the existing Foreign Trade Strategy to be developed further by means of an addendum. The newly defined objectives and measures for supporting Austrian exports are focused on the key issues of supply resilience, a "green economy" internationalisation strategy and strengthening export business through coordinated diplomatic visits, "ReFocus Austria", "go-international" and the "export offensive".

1.3 Current developments in the higher education sector

In the face of the current problem complexes, a well performing higher education sector in terms of strong teaching and research is required in order to tackle the big challenges of our times, including climate change, digital transformation, the ageing population, the COVID-19 pandemic and its economic and social consequences, and the fallout from the Russian invasion of Ukraine. The future will hinge on how successful we are in creating sustainable, resilient economies. Being of systemic relevance, higher education institutions have a particularly important role to play by safeguarding education and training, increasing innovation, training highly qualified staff and strengthening entrepreneurship. In its "European Strategy for Universities", the European Commission also stipulates that the higher education sector has tasks to perform on four missions – higher education, research, innovation and service to the community – and that excellence and innovation need to be taken into consideration. The following objectives have been set for higher education institutions at European level: i) strengthening the European dimension in higher education and research; ii) supporting higher education institutions in their capacity as pioneering symbols of our European way of life; iii) improving the perception of higher education institutions as key actors in the green and digital transformations; and iv) strengthening the higher education institutions as the driving force behind the EU's role as a global leader.

These objectives are reflected at national level in the instruments of higher education governance such as the national university development plan and the performance agreements with the individual public universities. The performance agreements for 2022–2024 endowed the universities with a record-breaking budget, set knowledge transfer as one of the key priorities and laid out a whole series of projects and objectives for STEM subjects. Participation in the European Universities initiative is being explicitly sup-

ported, as is engagement in research conducted into climate change, sustainability and transformation. A uniform framework for training at higher education institutions was established back in 2021 with an extensive package of reforms.

Record-breaking budget for the universities thanks to the performance agreements for 2022–2024

The universities will be able to draw on a total of €12.3 billion over the next three years, €1.3 billion (12.5%) more than in the previous period. The capacity-oriented and student-related method of university funding is now being applied for the second time.

Of this €12.3 billion, a total of €11.1 billion is being awarded via the performance agreements as a global budget, with the remaining €1.2 billion covering construction projects, ongoing clinical overheads and federal funding for the University for Continuing Education Krems as well as a ring-fenced sum for special projects to supplement the performance agreements, including the planned call for proposals for funding digital research infrastructures. Individual universities are seeing their budgets increase by between 8.8% and nearly 16.9%. How much each university will receive depends on factors such as their size and student numbers but also their strategic objectives.

The three medical universities and the University of Linz saw their budgets increase the most (by between 12.6% and 16.9%) as a result of the "Medimpuls2030" programme, which aims to strengthen medical research and education at Austrian universities. The performance agreements will see 30 to 60 newly funded professorships (or equivalent posts) filled as part of this programme, which also involves the University of Veterinary Medicine Vienna and the University of Salzburg in addition to the four mentioned above. The Medical University of Graz has thus been able to increase its budget by 16.9%, followed by the Medical University of Innsbruck (+15.6%) and the Medical University of Vienna (+12.6%). Joining them towards the top end are the University of Linz (+13.1%), the University of Veterinary Medicine Vienna (+12.4%), Graz University of Technology (+12.0%), the University of Vienna (+11.4%) and the University of Art and Design Linz (+10.9%).

As in the past, the significant increase in budgets during the 2022–2024 performance agreement periods is also being accompanied by specific objectives for the individual universities. Besides expanding medical research and education, the focus is on stepping up involvement in the EU's Horizon Europe Framework Programme for Research and the "excellent=austria" national excellence initiative, on increasing knowledge and technology transfer activities and on digitalisation. As in the previous performance agreement period, key objectives also include ramping up auditing activity, improving supervision ratios by taking on more staff, and expanding research priorities.

Strengthening research and excellence

Austria's universities successfully obtained numerous funding commitments in Horizon 2020, the EU's eighth Research Framework Programme, and are aiming to be closely involved in its successor programme Horizon Europe. In particular, this means obtaining funds for developing excellence, promoting innovation and strengthening innovation capability. Austria's universities are especially interested in funding from the European Research Council (ERC), participating in programmes to strengthen the competitiveness of Europe's industry and achieve the Sustainable Development Goals (EU partnerships and missions), promoting innovation via the European Innovation Council (EIC) and making use of the opportunities presented by the European Innovation and Technology Institute (EIT) as part of knowledge and innovation communities (KICs).

The European Universities,[20] which are largely

20 https://education.ec.europa.eu/education-levels/higher-education/european-universities-initiative

funded via the Erasmus+ Programme, are another major European initiative, geared towards strengthening excellence through long-term strategic partnerships between higher education institutions in Europe. The European Commission launched this initiative in 2017 with the hope that at least 20 of these cooperation arrangements would be in place by 2024. A total of 41 alliances have been formed to date, more than twice as many as originally planned. These alliances are expected to pursue a long-term vision containing the following key elements:

- An integrated, long-term, common strategy for education with links to research, innovation and society;
- A European "inter-university" campus;
- European teams of students and scientists coming together to build knowledge, ideally in partnership with researchers, companies, regional and civil-society actors; the teams should be assembled in a bottom-up, challenge-based, interdisciplinary and intersectoral way.

Of the 41 European Universities, 17 received a total budget of up to €85 million (in EU funds) from the first pilot call (2019), with a further 24 being allocated a total budget of €120 million (in EU funds) in the second pilot call (2020). The pilot projects last three years, with each alliance being handed up to €5 million in funding by the European Commission from the Erasmus+ Programme for the duration of the project. The alliances were also able to apply for additional funds from the EU's Horizon 2020 Research Framework Programme (up to €2 million) to support activities relevant to research. All 41 alliances received these additional funds.

Austria's higher education institutions are currently involved in eleven of these alliances, i.e. more than a quarter. Seven of the institutions involved are public universities. For transferring the success of the European Universities projects to the national level too, the Federal Ministry of Education, Science and Research (BMBWF) provided additional funding totalling €2.1 million for the pilot projects via the OeAD. All seven participating universities also included relevant projects for continued implementation and consolidation in their performance agreements for 2022–2024. In addition, a national supervision group has been supporting efforts to implement the initiative since 2020.

Excellence, visibility and greater cooperation are not only setting the trend for the development of higher education at international level, the 22 public universities are also actively collaborating on a national level within Austria. To this end, priority-setting has been a focus for many years: the universities define their research priorities and thus work to hone their identity and visibility. The underlying idea is that all the universities will ultimately come together to form the "University of Austria", covering the whole of the Austrian teaching and research area.

One of the most successful partnerships in this regard has been NAWI Graz – a natural sciences alliance between the University of Graz and Graz University of Technology – which has focused on joint teaching, joint research and joint research infrastructures since it was set up in 2004. This success story is now to be continued through measures including shared appointment procedures and infrastructure investments. More inter-university partnerships are also to be strengthened, developed further and institutionalised in the coming years. These include: the new Cori Institute for Molecular and Computational Metabolism Research at the Austrian Academy of Sciences (OeAW) in partnership with BioTechMed Graz; the biomedicine and biotechnology alliance between the University of Graz, Graz University of Technology and the Medical University of Graz; the further development of the Centre for Technology and Society, which is based at TU Wien and was established together with the University of Vienna, FH Campus Wien and the University of Applied Sciences Technikum Wien; and the new Ignaz Semmelweis Institute, which is to serve as a central hub for epidemiology, infectiology and public health issues and which involves contributions from the medical universities in Vienna, Graz and Innsbruck as well as the Faculty of

Medicine at the University of Linz and the University of Veterinary Medicine Vienna.

At the same time, the "excellent=austria"[21] excellence initiative launched by the federal government in 2021 is designed to strengthen research and priority-setting at Austrian universities. This is linked to the expectation that success will make Austria more visible and attractive internationally as a centre for knowledge and research, as reflected not least in international higher education rankings.

Expanding knowledge transfer and entrepreneurship

As well as strengthening excellence and basic research, the main aims of the performance agreements for 2022–2024 also include ramping up knowledge and technology transfer and therefore maximising the transfer of research results into innovations. In the future, Austria's universities will focus even more strongly on the impact and valorisation of their research work in terms of both commercialising research results and communicating knowledge, as well as fulfilling their "third mission" vis-à-vis society. Ongoing knowledge transfer activities are to be combined in a holistic, whole-of-system approach and, where possible, further developed in cooperation with relevant stakeholders at the location. Entrepreneurship and the skills required for it are also to be given extensive support. This means that creating and expanding innovation platforms – not least to further improve inter- and transdisciplinarity and the interplay between basic research, applied research and prototype development – is becoming particularly important, as is the establishment of spaces for innovation such as "maker spaces" and joint labs and the promotion of academic spin-offs.

The federal government's current RTI strategy envisages a 100% increase by 2030 in the number of academic spin-offs that enjoy commercial success. There were 90 such businesses started up in 2020, 16 more than in the previous year. Universities are also expected to create more incentives for researchers to pursue entrepreneurial careers. The "Spin-off Fellowship" programme for spin-offs from universities, universities of applied sciences and non-university research institutions, which enjoyed success and high demand throughout its first run, is therefore to be developed further and will relaunch in May 2022 with a €15 million budget.

The three regional knowledge transfer centres (East: Lower Austria and Vienna; South: Styria and Carinthia; West: Upper Austria, Salzburg, Tyrol and Vorarlberg), which have been making a valuable contribution to the value chain since 2013 through their networking and consulting services, are also continuing their activities. They are to receive additional funding via the Austria Wirtschaftsservice (aws) from 2022 onwards. Many of the universities also have their own knowledge and technology transfer centres to advise and support students and researchers who are interested or already active in entrepreneurship.

Three areas of focus: STEM, digitalisation and artificial intelligence

Austria is facing the challenge of persistently high demand on the labour market for STEM specialists, particularly engineers, while computer scientists are also increasingly sought after.[22] In order to attract more graduates, therefore, the number of students starting a degree in a STEM subject and the success rates in these subjects will need to be increased. The RTI Strategy 2030 also sets overarching objectives for this; specifically:

- Increase the proportion of STEM graduates by 20%, and the proportion of women amongst graduates in technical subjects by 5%;
- Double the number of Austrian students of STEM subjects who complete a study programme or

21 See Chapter 1.2 and Chapter 3.8.

22 See Binder et al. (2021).

study semester abroad with support from funding programmes;
- Strengthen training and ongoing education, particularly in STEM subjects.

As in the previous performance agreement period (2019–2021), the performance agreements for 2022–2024 also make STEM a priority. The universities that offer STEM degrees have therefore enjoyed a significant increase in their budgets in order to improve, amongst other things, their supervision ratios and STEM offering. The STEM focus area of "computer science" and "engineering" is of particular importance here due to of the shortage of skilled workers.[23] The projects and objectives agreed with the universities can be divided into the following categories: creation of new study programmes to strengthen STEM, measures to recruit students and to operate at the school/higher education institution interface, recruitment and promotion of women in STEM studies, (supporting) measures at the start of studies, and (supporting) measures to increase studying feasibility and to reduce dropouts and "job-outs".

The number of places available on computer science courses was increased during the last performance agreement period. The public universities currently offer a total of 2,800 places on computer science courses. Under the performance agreements for 2022–2024, around a third of the 60 additional professorships or equivalent posts (in FTEs) being funded by the Federal Ministry of Education, Science and Research (BMBWF) are to be created in subject groups 2 and 3, which include the STEM focus area.[24]

Corresponding priorities have also been set for the universities of applied sciences. For instance, the development and funding plan for these universities for 2018/19–2022/23 envisages creating 1,450 new places for first-year students over four years. The fourth and final stage of the expansion will be implemented by the start of the 2022/23 academic year with the allocation of the 347 remaining extra course places. This means that more than 3,700 additional places on digitalisation and STEM courses will have been created at the universities of applied sciences in total by 2024.

The focus on digitalisation during the 2019–21 performance agreement period and on the digital transformation at the universities promoted via the 2019 call for proposals entitled "Digital and social transformation in higher education" of the Federal Ministry of Education, Science and Research (BMBWF) is being maintained over the current performance agreement period. For example, there are plans for a new call for proposals designed to drive forward the expansion of digital research infrastructures. Numerous initiatives have also been agreed with the universities to advance the digital transformation in teaching, research and administration. In the field of AI, some universities are designing new courses (e.g. the BA in Robotics and Artificial Intelligence at the University of Klagenfurt and the BA in Artificial Intelligence at the University of Salzburg) and are expanding their research in this area.

In addition, the establishment of a new technical university in Linz specialising in digitalisation and digital transformation offers the opportunity to create state-of-the-art structures, explore new research questions and adopt pioneering teaching methods. As a "digital university", the new institution is to serve as a scientific flagship project and driver of innovation. The new Technical University for Digitalisation and Digital Transformation will open gradually, starting in the 2023/24 academic year.

Sustainability and climate protection at Austria's higher education institutions

Higher education institutions have a key role to play in the quest for solutions to the major challenges

23 The STEM focus area covers degree programmes in "engineering sciences" and "computer science", both of which are very much in demand on the labour market.

24 See Annex 4 of the Intellectual Capital Reporting Regulations (WBV) 2016
link: https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20009519

facing society. This is because they provide the very expertise that is needed to solve problems and suggest new approaches and pathways through their teaching, research and innovation. Given the complexity of the challenges, transdisciplinary and inter-university partnerships are extremely important here, too.

As long ago as 2012, the University of Natural Resources and Life Sciences Vienna and the University of Graz launched the "Alliance of Sustainable Universities in Austria" with support from the Federal Ministry of Education, Science and Research (BMBWF). Out of a total of 22 public universities, 19 – soon to be 20[25] – have now signed up to the initiative. This alliance aims to facilitate inter-university activities and thus enable synergy effects to be leveraged in teaching, research, university management, knowledge sharing and sustainability strategies. The projects that have emerged from it include "UniNEtZ – Universities and Sustainable Development Goals", in which 16 universities plus the Climate Change Center Austria (CCCA), the "forum n" student initiative and the Geological Survey of Austria (GBA) are currently taking part. In spring 2022, UniNEtZ presented a set of some 150 options and around 950 specific measures for achieving the 17 Sustainable Development Goals in Austria. This document was the fruit of three years' labour involving over 300 people from different disciplines and institutions working together for the benefit of society.

The establishment of the Austrian Centre of Transformation (ACT), a joint venture between the University of Natural Resources and Life Sciences, the University of Graz, the University of Innsbruck and the University of Applied Arts, was agreed for the 2022–2024 performance agreement period. The ACT is intended to create a common platform for research into climate change, sustainability and transformation, promote education in the field of sustainable development, bring all university-level activities, existing networks and projects such as the Sustainable Universities Alliance, the UniNEtZ project and the Climate Change Center Austria (CCCA) climate research network under one roof and raise their profile.

The performance agreements for 2022–2024 also set out many more projects for strengthening existing research priorities and identifying new ones, for new sustainability degree programmes, for ideas to improve universities' social responsibility and also for partnerships and participation in sustainability initiatives and national and international university networks.

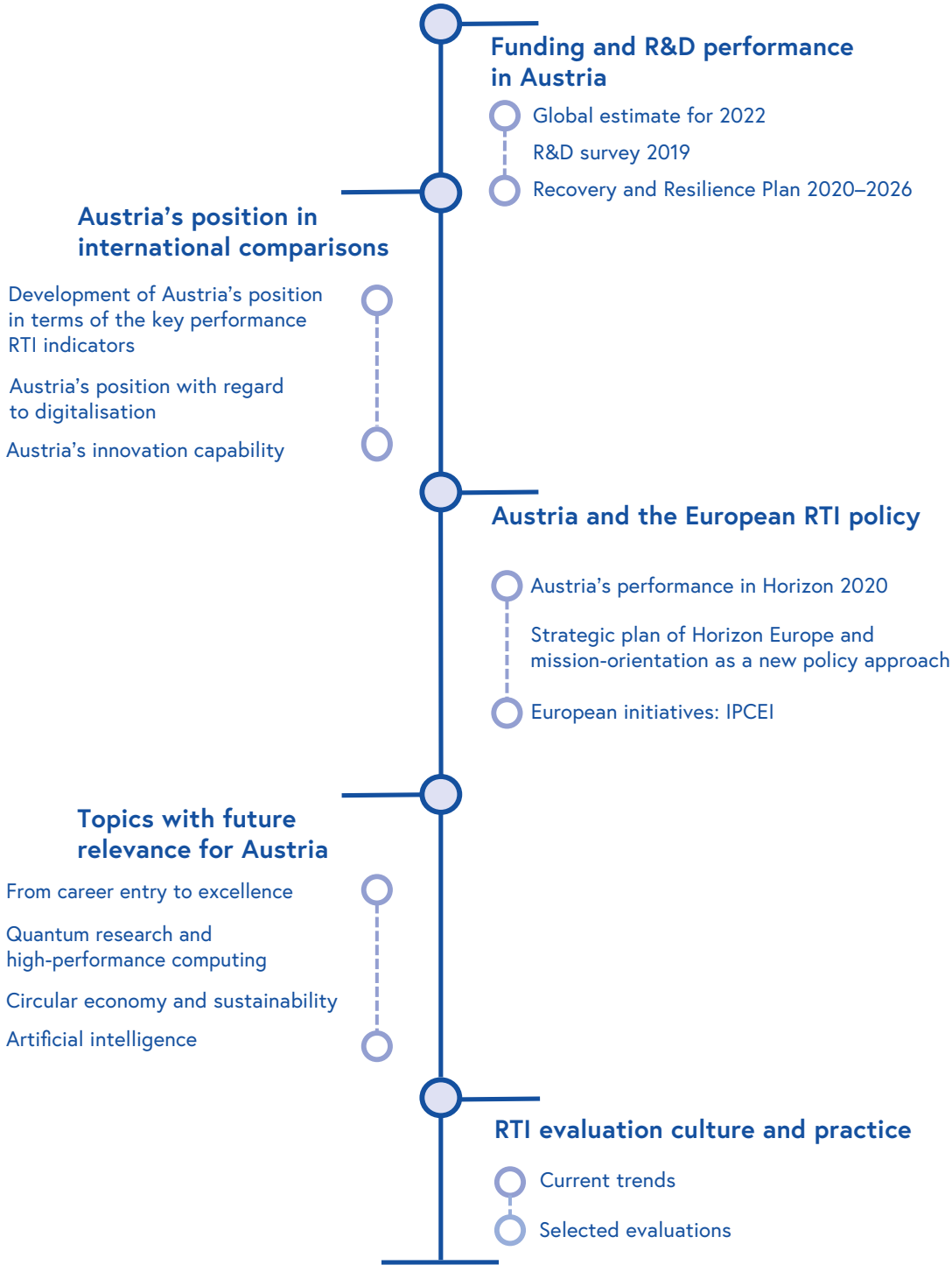
Reforms arising from the package of legislative measures for higher education institutions

Lifelong learning requires a constant supply of suitable courses, meaning that this segment is becoming increasingly important both within the education system and in Austria as a centre for research. Over the past few years, an excessive – and, in some cases, confusing – variety of courses has increasingly been offered by both the public and private sectors, leading the federal government to call for more transparency and a system of quality assurance. The Federal Ministry of Education, Science and Research (BMBWF) thus adopted a package of reforms that entered into force on 1 October 2021. In particular, these establish a uniform framework for training at higher education institutions, i.e. universities, university colleges of teacher education, universities of applied sciences and private universities.

Getting into teaching has also been made more attractive through the creation of new, transparent and high-quality models for lateral entry. The package of reforms also contains some important provisions governing how studying is regulated. Admission regulations and the so-called study entry and orientation phase have been extended by a further six years.

25 The Medical University of Innsbruck has now confirmed its participation in its performance agreement for 2022–2024.

2. Facts, Figures and Trends in Research, Technology and Innovation



Chapter 2 spans a wide range of topics, beginning with a look at the funding and R&D performance in Austria (Chapter 2.1) and an examination of innovation performance in international comparison (Chapter 2.2), and ending with the orientation of the Austrian RTI policy with regard to European goals (Chapter 2.3). Chapter 2.4 identifies thematic highlights that all have future relevance for Austria as an RTI location.

2.1 Funding and R&D performance in Austria

Austria's R&D intensity will continue to rise in the 2020s, thus continuing a decades-long growth trend. That said, companies tend to reduce their R&D expenditure during crises, as the projects financed with it are inherently risky and the return is difficult to assess. However, the public sector has increased its expenditures strongly and compensated for the preliminary decline in business enterprise expenditures. The EU's Recovery and Resilience Facility is also helping to cushion the pro-cyclicality of R&D expenditure.

R&D input factors

- **R&D funded by the public sector increased by 44.3% in nominal terms in 2009–2019, and by 8.3% in 2017–2019 (incl. higher education sector, excluding research premium).**
- **The number of companies performing R&D increased by 31.4% in 2009–2019 and by around 11% in 2017–2019.**
- **Austria ranks ninth in the OECD ranking for 2019 with a R&D intensity of 3.13%; the gap to the fifth-placed country (currently the USA) is very small at 0.05 percentage points.**

2.1.1. Global estimate for 2022

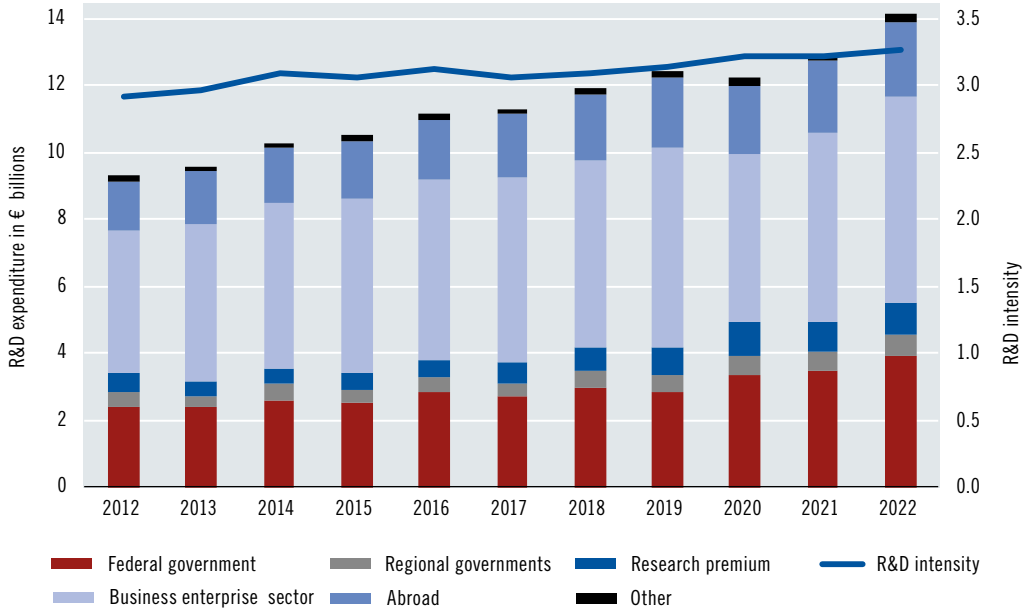
Austria has an R&D intensity (= expenditure on research and experimental development as a percentage of gross domestic product) of 3.21% for 2021, and Statistics Austria projects 3.26% for 2022 as of April 2022. Therefore, the R&D intensity in 2020–2021 has virtually not changed (2020: 3.22%), which is remarkable in that the gross domestic product (GDP) has significantly decreased in 2020, yet increased again in 2021. While the increase in the R&D intensity in 2020 compared to 2019 is due to expenditure on research and experimental development (R&D expenditure) declining by a smaller percentage than GDP, it increased significantly in 2021 compared to 2019. The nominal change in 2019–2021 is informative: While GDP has grown by 1.5% in nominal terms, R&D expenditure has increased by 4.1% in nominal terms. In 2022, compared to 2021, nominal growth of R&D expenditure is also projected to be higher than GDP growth: 9.3% compared to 7.5%.[26]

Fig. 2-1 shows the development of the R&D intensity as well as the sources of funding since 2012. The fact that the research ratio is visually stagnant, while expenditure in detail is rising prominently, is due to the fact that inflation is automatically factored out of the R&D intensity, while it is still included in the euro amounts. In fact, a time series analysis for the R&D intensity shows a statistically significant growth trend since 2017, from when it was 3.06%.[27] The categories of funding sources are composed as follows: "Federal government" and "Regional governments"; "Business enterprise sector", which includes expenditure by domestic companies excluding the research premium, which is reported separately; the category "Abroad", which includes mostly funding by foreign firms, plus spending by the EU and international organisations; and the "Other" category, which includes expenditures by local governments (excluding

26 The reason for the growth rates being so high is attributable to the fact that inflation is also expected to be high in 2022.

27 The slope of the regression line is 0.0423, with a coefficient of determination of $R^2 = 0.9544$.

Fig. 2-1: Development of R&D funding and R&D intensity in Austria, 2012–2022



Source: Statistics Austria, Global Estimate of 22 April 2022. Graphic: WPZ Research; the category "Other" combines the two categories "Other public funding" (incl. the higher education sector) and "Private non-profit sector".

Vienna), chambers, social insurance institutions, the higher education sector and other public funding, as well as funding by the private non-profit sector.

To better illustrate the relative development, Fig. 2-2 presents the nominal growth of individual categories since 2012, whereby the research premium is attributed to (domestic) business enterprises here in accordance with the Frascati Manual[28], while the category "Other" is assigned to the "Public sector". It is clear to see that all sources of funding have grown faster than GDP, i.e. all categories have contributed to an increasing R&D intensity.

Noteworthy is that up until 2019, the public sector was growing the slowest, but since 2020 it has been outperforming all other categories, and since 2022 it is also the only category to have outperformed the development of total research expenditure ("Total R&D").[29] The contribution of the business enterprise sector fell noticeably in the 2020 pandemic year, but has continued to rise ever since. In contrast to this, the contribution from abroad slumped less in 2020, but subsequently also grew less; in relation to 2012, the nominal growth of both categories is virtually identical in cumulative terms (business enterprise sector 48.6%, abroad sector 48.7%).

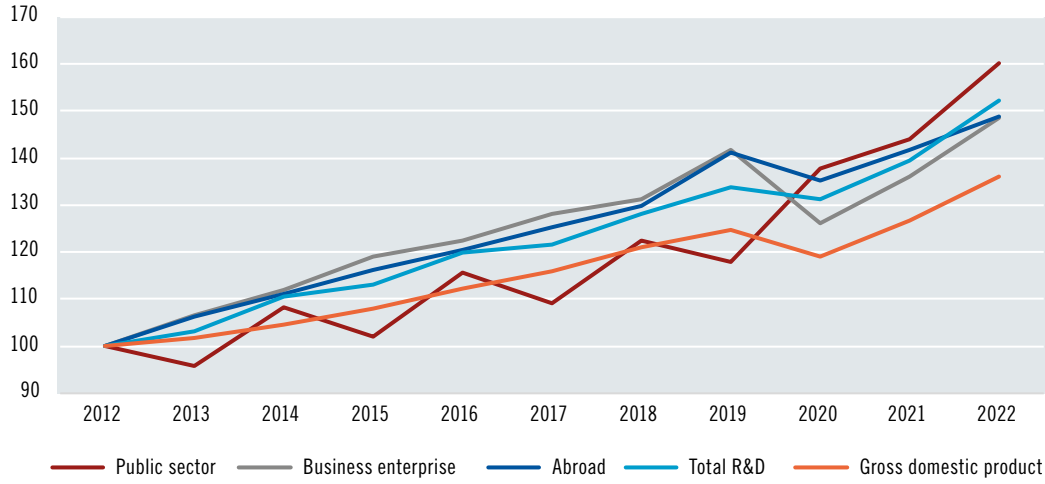
Fig. 2-3 supplements Figs. 2-1 and 2-2 in that the shares in the sources of funds are shown individually in the respective years. Once again, this illustrates how the share of the business enterprise sector has decreased in 2020, while that of the public sector has increased. This also applies if the research premium is added to the business enterprise sector. The share from abroad has also decreased, however no statistical trend can be discerned over the entire period.

Overall, the contribution of the business enterprise sector is increasing, as illustrated in Fig. 2-4. Here, the shares of R&D expenditure of the individu-

28 See OECD (2018).

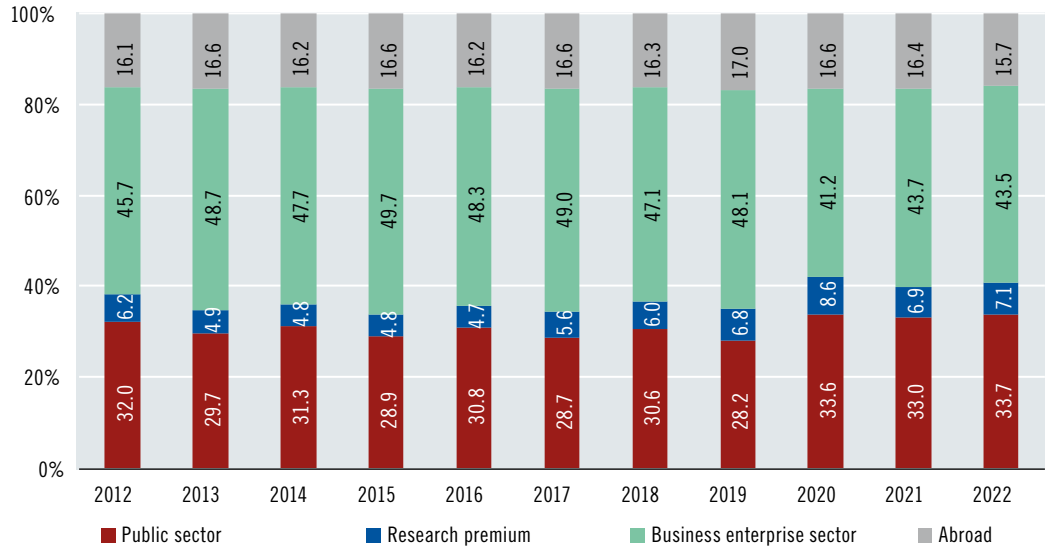
29 The fact that the figures are mostly higher in even years than in odd years is due to the fact that the R&D survey is carried out in odd years; in even years, the funding figures of the regional governments are taken from the regional budgets, structurally resulting in a quantitative difference that is also reflected in the R&D intensity due to its size.

Fig. 2-2: Development of R&D funding, 2012–2022 (index, 2012=100)



Source: Statistics Austria, Global Estimate of 22 April 2022. Calculation and graphic: WPZ Research; the category "Public sector" includes the categories "Federal government", "Regional governments", "Other" (= "Other public-sector funding" incl. the higher education sector + "Private non-profit sector"), the category "Business enterprise" includes the categories "Business enterprise sector" and "Research premium".

Fig. 2-3: Share of R&D funding by sources of funds, 2012–2022

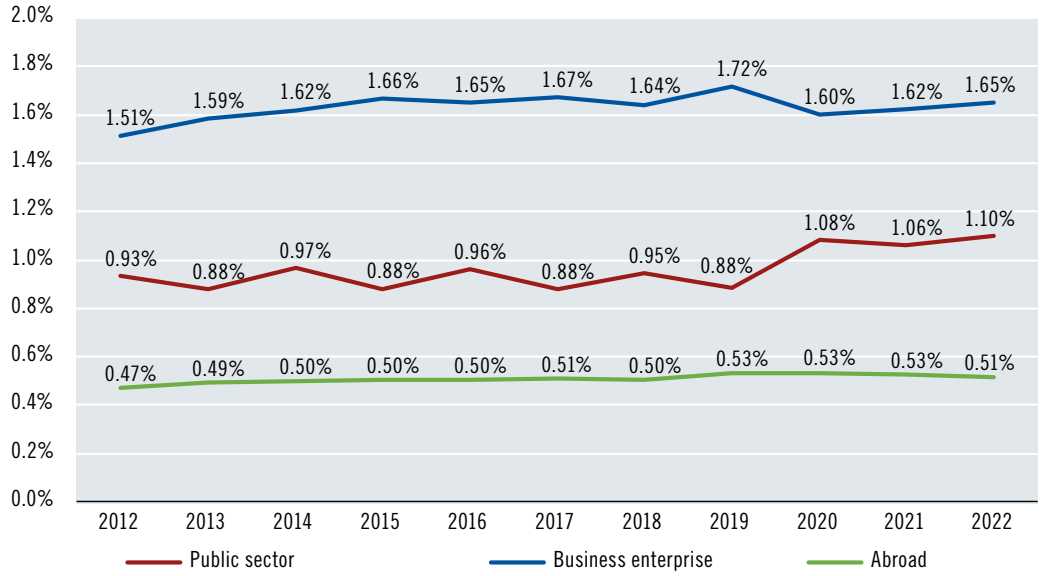


Source: Statistics Austria, Global Estimate of 22 April 2022. Calculation and graphic: WPZ Research; the category "Public sector" includes the categories "Federal government", "Regional governments", "Other" (= "Other public-sector funding" incl. the higher education sector + "Private non-profit sector").

al categories in GDP are given for the period 2012–2022 (i.e. the sums of the shares result in the R&D intensity). The research premium is assigned here to the business enterprises – at 1.65%, the value in 2022 is lower than in 2019 (1.72%) due to the crisis, but higher than in 2012 (1.51%). The same applies for abroad, with a similar growth of shares: the share of the business enterprise sector grew cumulatively by 9.2% in 2012–2022, and that of the abroad sector by 9.3%. Due to the strong increase since 2020, the public sector in Fig. 2-4 shows the highest cumulative growth rate, at 17.8%.

To summarise, it can be stated that the public sector has ensured that Austria's R&D intensity has con-

Fig. 2-4: R&D expenditure as a percentage of gross domestic product (GDP) by sources of funds, 2012–2022



Source: Statistics Austria, Global Estimate of 22 April 2022. Calculation and graphic: WPZ Research; the category "Public sector" includes the categories "Federal government", "Regional governments", "Other" (= "Other public-sector funding" incl. the higher education sector + "Private non-profit sector"), the category "Business enterprise" includes the categories "Business enterprise sector" and "Research premium".

tinued to rise through a strong increase in expenditure since 2020. Since then, business enterprise expenditure has also been on the rise again, and will reach the level in 2022 at which it had previously settled in the years before the outbreak of the pandemic. Indicators of corporate innovation activities show that the corresponding activities of Austrian companies have been recovering again since 2021 thanks to better economic prospects.[30] The economic development will have a significant influence on the extent to which the business enterprise sector will further increase its R&D expenditure in the future.

2.1.2 R&D Survey 2019

In 2019, as in 2017, the biennial R&D survey is methodologically based on the 2015 revised version of the Frascati Manual.[31] This survey is conducted by Statistics Austria and corresponds to a complete survey: all R&D-performing institutions are surveyed about their R&D activities, and participation is legally obligatory. "Research and experimental development (R&D)" is defined as "creative and systematic work undertaken to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge".[32]

It follows from the definition that not every scientific task is defined as R&D. The Frascati Manual lists five core criteria that an activity defined as R&D activity must satisfy: it must be (i) novel, (ii) creative, (iii) uncertain, (iv) systematic, and (v) transferable and/or reproducible. These core criteria also allow a segregation to be made between R&D and all activities that are not deemed to be R&D. The five criteria can be summarised as follows:[33]

(i) To be aimed at new findings (novel): research projects (e.g. at universities and research institutes) must aim to pursue "entirely new ad-

30 See Reinstaller (2022).
31 See OECD (2018).
32 Ibid, 48ff.
33 Ibid, 47.

vancements in knowledge". This is fundamentally about achieving progress or building on the existing stock of knowledge. This also includes reproducing an existing study and testing it for potential discrepancies. In the business enterprise sector, the R&D task must result in findings that are new to the business and not already used in the industry concerned. Copying, imitating or "reverse engineering" are therefore not included.

(ii) To be based on original, non-obvious, concepts and hypotheses (creative): an R&D project must have objective new concepts or ideas that improve on existing knowledge. Here, R&D is distinguished from routine changes (unless the objective is to develop new methods to perform common tasks). By requiring "creativity", human contribution is mandatory.

(iii) To be uncertain about the final outcome (uncertain): Fundamental here is that, at the outset, outcome and costs cannot be precisely determined relative to the goals, even if the goals themselves are identifiable. In the case of basic research, the outcome is open from the outset, implying that one can approach certain goals but may not achieve them. In business R&D, a distinction can be made between the development of prototypes that are used for technical tests and which may fail (considered as R&D), and prototypes used to obtain approvals or licenses (not considered as R&D).

(iv) To be planned and budgeted (systematic): the R&D process is performed in a systematic way and documented, which means that purpose and sources of funding can be identified.[34]

(v) To lead to results that could be possibly reproduced (transferable and/or reproducible): Results must, in any case, be recorded in codified form, even if it is not absolutely necessary that every researcher can access them (e.g. there may be restrictions on publication). However, third parties must be in a position to reproduce the results, i.e. these must not exist solely in the minds of the researchers. This means that even if competitive firms do not share their results with other firms, they are documented in-house and are available to other researchers.

Institutions conducting R&D activities are divided into four sectors of performance: business enterprise, government, private non-profit, and higher education. The distinction between business and government follows the European System of Accounts (ESA), i.e. the decisive criterion is whether more or less than 50% of the funding is provided by markets or directly by the government. Funding via the market may ultimately come from the government, however it must be performance-related. The higher education sector is counted separately, regardless of ownership and funding. The private non-profit sector includes non-profit institutions that are not owned by the government.[35]

With regard to funding, five different sectors are identified: business enterprise, public, the private non-profit sector, higher education and funding from abroad. In the case of business enterprises, there is the institutes' sub-sector (*kooperativer Bereich*), which is understood to mean service institutions that conduct research and experimental development for companies, without the intention of generating a profit or other economic advantage; the much larger share is accounted for by the company R&D sub-sec-

34 Note that the German-language Frascati Manual (OECD 2018, 50) speaks here of a "*fester Plan*" (fixed plan), but this contradicts the first and third criteria, according to which new advancements in knowledge must be pursued and the outcome and costs must be uncertain at the outset. In fact, the English-language version of R&D speaks of "conducted in a planned way", which is by no means the same as a "fixed plan". There are also other parts that are translated unsatisfactorily; referring to (i) above, the "*völlig neue Erkenntnis*" ("entirely new knowledge") in the German version was "entirely new advancements in knowledge" in the English language version. For this reason, the wording of the German summary and interpretation may differ from OECD (2018).

35 For details, see the Austrian Research and Technology Report 2020, p. 18.

Table 2-1: R&D expenditure by sector of performance and source of funds, 2019

Sector of performance	in € millions	Share in %	Sources of funds	in € millions	Share in %
Business enterprise sector	8,749	70.3	Business enterprise sector	6,824	54.8
Institutes' sub-sector	193	1.6	Public sector	3,355	27
Company R&D sub-sector	8,556	68.8	Private non-profit sector	34	0.3
Higher education sector	2,711	21.8	Higher education sector	117	0.9
Government sector	913	7.3	Abroad	2,111	17
Private non-profit sector	67	0.5	Foreign firms	1,799	14.5
			Other Abroad excl. EU	64	0.5
			EU	248	2
Total	**12,441**	**100**	**Total**	**12,441**	**100**

Source: Statistics Austria. Calculations: WPZ Research.

tor (*firmeneigener Bereich*). The category abroad includes funding via international organisations, especially the EU, as well as funding by foreign-based firms. Even though research funding by the EU is quite extensive, the main share is accounted for by foreign-based firms that fund R&D in Austria. The remainder of funding from abroad is distributed among international organisations and other international providers of funds.[36]

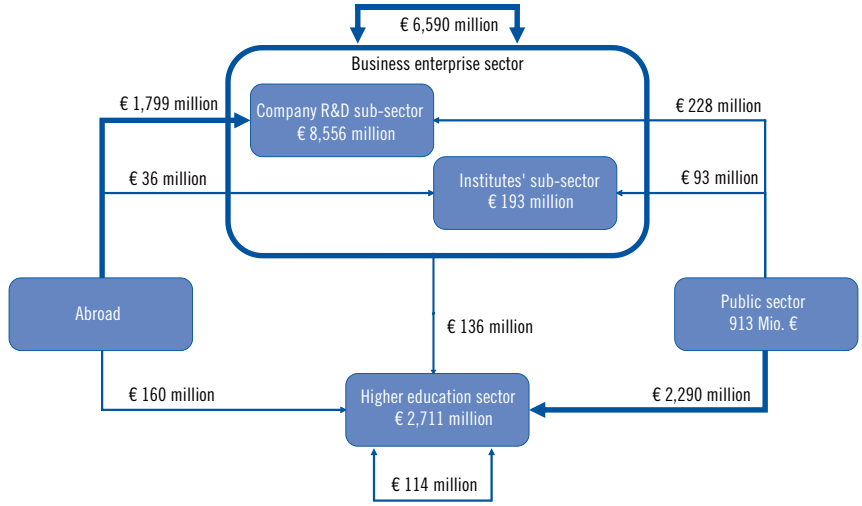
Table 2-1 shows the corresponding data for 2019. Differences to 2017 are only in the decimal range, but – as can also be seen from Fig. 2-1 – the volume has increased strongly, by €1.151 billion in nominal terms, which corresponds to 9.8% in two years and significantly exceeds the nominal GDP growth of 7.6% in the same period (this mean that the R&D intensity has increased). Fig. 2-5 shows the sources of funding in detail, indicating that, for example, of the €8,556 million spent on the business enterprise sector's R&D sub-sector, €1,799 million was funded from abroad – or of the €2,111 million funded from abroad (here including the EU), €1,799 million went to the business enterprise sector's R&D sub-sector.

Fig. 2-6 is based on the same data as Table 2-1 and Fig. 2-1, but shows all funding sources in detail and compares them with those of 2009. The right bar "Total" corresponds to all expenditure and thus to the research activity sector in 2019 in Table 2-1. The percentage proportion of all expenditure has increased most for the government, from 5.3% to 7.3%, which corresponds to a growth in proportion (not a growth in volume) of 38.3%. The share of the business enterprise sector grew by 3.3% (from 68.1% to 70.3%), that of the private non-profit sector by 12.8% (from 0.48% to 0.54%), and that of the higher education sector by 16.5% (from 26.1% to 21.8%). When interpreting these figures, it is important to bear in mind that R&D expenditure has increased enormously over the same period, from 2.60% to 3.13% of GDP (in 2019). A decline in the share of the higher education sector therefore does not mean that less research was carried out at higher education institutions in 2019 than in 2009.

The other bars show funding by research activity sector. For example, the second bar, "business enterprise sector", represents the percentage of funding for R&D that is financed by domestic enterprises; in the right-hand diagram in Fig. 2-6, this bar indicates that in 2019, 96.6% of the €6,824 million financed by domestic enterprises in Austria was spent by the business enterprise sector. What is remarkable about the next bars appearing in the same figure is that public funding of the business enterprise sector has decreased significantly, especially by the federal government (decline of 74.4%), regional governments (decrease of 33.3%) and local governments (decline

36 The international organisations from which the funds come are not surveyed, however the following institutions can still be mentioned as examples: European Organisation for Nuclear Research (CERN), European Southern Observatory (ESO), European Synchrotron Radiation Facility (ESRF), European Molecular Biology Laboratory (EMBL), World Meteorological Organisation (WMO).

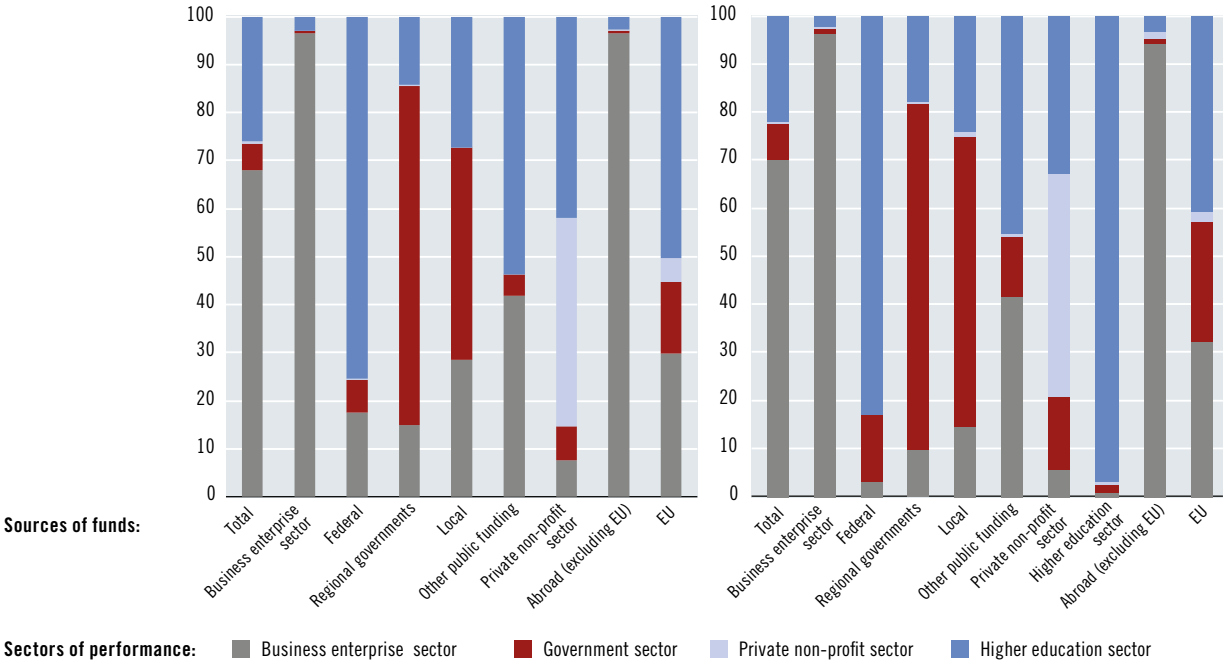
Fig. 2-5: R&D performance and funding, 2019



Note: The figure shows the funding flows between the sectors, e.g. the business enterprise sector funds €6,590 million of the research carried out by the business enterprise sector, €228 million flows from the public sector to the business enterprise sector's R&D sub-sector and €93 million to the institutes' sub-sector, the public sector itself carries out R&D in the value of €913 million, etc. For reasons of clarity, the private non-profit sector and flows from the higher education sector are not shown, with the exception of own funding, which is assigned to the public sector in terms of source of funds. "Abroad" includes the EU.

Source: Statistics Austria. Calculations and graphic: WPZ Research.

Fig. 2-6: Distribution of funding by sector of performance (in %), 2009 [left] and 2019 [right]



Note: "Higher education institutions" as a source of funds were subsumed under "Other public funding" in 2009, but shown separately in 2019. Funding through the research premium were subsumed under "Federal government" in 2009 and "Business enterprise sector" in 2019. The "Total" bar in the left-hand diagram indicates that, in 2009, of all R&D expenditure funded, 68.1% was carried out by the business enterprise sector, 5.3% by the government sector, etc. The "Business enterprise sector" bar in the left-hand diagram indicates that, in 2009, of all R&D expenditure funded by the business enterprise sector, 96.3% was carried out by the business enterprise sector, 0.7% by the government sector, etc. The "Federal government" bar in the left-hand diagram indicates that, in 2009, of the R&D expenditure funded by the federal government, 17.5% was carried out by the business enterprise sector, 7.0% by the government sector, etc. All other bars are to be interpreted in the same way, in both the left-hand (2009) and right-hand (2019) diagrams.

Source: Statistics Austria. Calculations and graphic: WPZ Research.

of 49.7%), as well as by other public funding (decrease of 0.4%). The main reason for this is that the research premium was still classified as public funding in 2009, but was assigned to the business enterprise sector in 2019.[37] It therefore does not follow from the decline that public funding has decreased, but rather that the research premium is no longer interpreted as direct, but as indirect promotion. It should also be noted that funding by the higher education sector was assigned to other public funding in 2009.

Furthermore, it can be seen in Fig. 2-6 that the government's share has increased significantly for all funding sources (i.e. the third bar segment from the top is significantly larger in each case in 2019). One reason for this is that Joanneum Research and the Austrian Institute of Technology (AIT) are no longer counted as business enterprises in 2019 due to their low proportion of performance-based funding, but as government institutions, which has a noticeable quantitative impact due to their sizes alone. The Austrian Academy of Sciences (OeAW) was counted as part of the higher education sector in 2009 but was assigned to the government in 2019, which is also reflected in the parallel decline in the higher education sector.

Table 2-2 shows how the funding of the respective sector of performance by the respective sources of funds changed from 2009 to 2019, in terms of volumes (not percentages). This shows which funding sources have become more important for which sector of performance, and which have become less important. The effect of the new interpretation of the research premium is noticeable in the first row; as a

Table 2-2: Growth in R&D funding by sector of performance and source of funds, 2009–2019

	Growth in funding by source of funds in %								
Sector of performance	Total	Business enterprise sector	Federal government	Regional governments	Local governments	Other public-sector Funding	Private non-profit sector	Abroad (excl. EU)	EU
Business enterprise sector	71.8	94.3	-78.2	13.3	-58.9	14.9	-43.6	58.8	141.5
Government sector	128.8	243.6	150	73.3	12.8	230	73.9	506	276.5
Private non-profit sector	87.7	360.9	-39.1	120	733.3	108.6	-13.8	396.3	-21.5
Higher education sector	38.9	33.9	41.9	111.3	-27.7	-2.3	-37.5	93.7	80.5
All	66.3	93.9	28.4	69.9	-18.2	15.3	-19.9	62.8	122.5

	Growth in funding by source of funds in € millions								
Sector of performance	Total	Business enterprise sector	Federal government	Regional governments	Local governments	Other public-sector Funding	Private non-profit sector	Abroad (excl. EU)	EU
Business enterprise sector	3656.2	3198.8	-267.5	5.4	-1.5	26.1	-1.4	649.3	47.1
Government sector	514.2	58	204.7	141.8	0.5	42.2	2.2	19.3	45.6
Private non-profit sector	31.5	12.5	-0.5	0.8	0	1.1	-2.5	21.2	-1.2
Higher education sector	759.6	34.4	621	43	-0.7	-5.2	-6.7	28.5	45.1
All	4961.5	3303.8	557.6	191	-1.6	64.2	-8.4	718.3	136.5

Note: The research premium as a source of funding was subsumed under "Federal government" in 2009 and "Business enterprise sector" in 2019. The "Total" column in the upper part of the table indicates that, between 2009 and 2019, the volume of R&D performance in the business enterprise sector increased by 71.8%, in the government sector by 128.8%, etc. The "All" row of the same column therefore corresponds to the percentage increase in total R&D between 2009 and 2019. The "Business enterprise sector" column in the upper part of the table indicates that the volume of R&D funded and performed by the business enterprise sector increased by 94.3%, the volume of R&D funded by the business enterprise sector and performed by the government sector increased by 243.6%, etc. The "All" row of the same column therefore corresponds to the percentage increase in R&D funded by the business enterprise sector between 2009 and 2019 (excl. research premium for 2009, but including research premium for 2019). The figures in the lower part of the table refer to the increase in € millions and are to be interpreted in the same way.

Source: Statistics Austria. Calculations: WPZ Research.

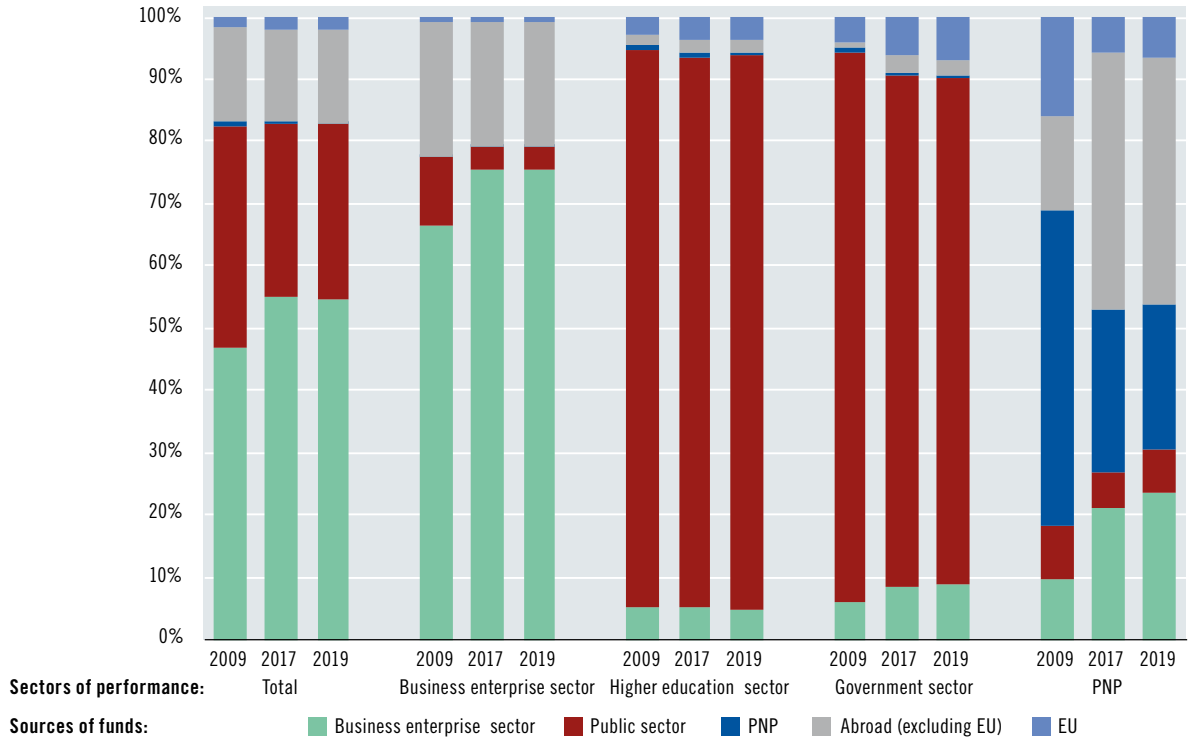
37 For details on the classification of the research premium, see the Austrian Research and Technology Report 2020, p. 18.

result, funding from the federal government has significantly decreased, while funding from companies has significantly increased. The increase in R&D expenditure in the government sector from 2009 to 2019 is also due to the reclassification of the OeAW, the AIT and Joanneum Research. Their R&D expenditures have been allocated to the government sector in 2019, whereas in 2009 they were still part of the business enterprise sector (AIT, Joanneum Research) or the higher education sector (OeAW). Finally, although the share of R&D in Austria funded from abroad and excluding the EU is quite high on the one hand, on the other hand it has increased somewhat less than the total volume since 2009.

Fig. 2-7 shows the funding structures within the research activity sectors for 2009, 2017 and 2019. With regard to the high government share in entrepreneurial research in 2009, the research premium is also noticeable here. Other developments should be seen in the context of the overall trends: The proportion of EU-funded research at higher education institutions has increased, while the share of higher education research itself has decreased.

Fig. 2-8 shows which sectors carry out R&D according to which categories: almost half (48.6%) is accounted for by experimental development, of which the very largest share (94.2%) again is performed by the business enterprise sector. Applied research is also dominated by the business enterprise sector, but to a lesser extent: 65.8% is carried out by the business enterprise sector, 25.2% by the higher education sector, and the remainder by the

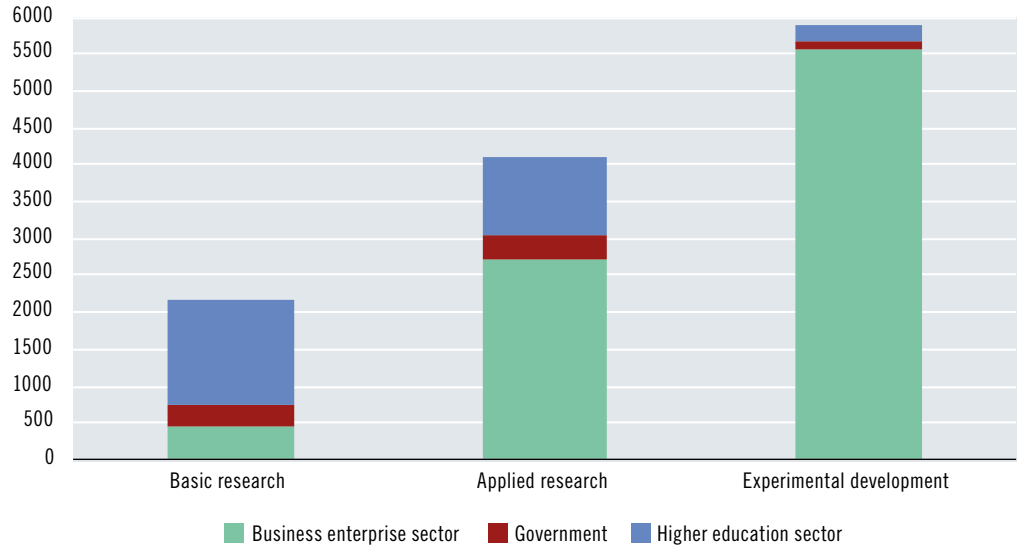
Fig. 2-7: R&D expenditure by source of funds, 2009, 2017 and 2019



Note: The research premium as a source of funding was subsumed under "Public sector" in 2009 and "Business enterprise sector" in 2017 and 2019. The "Total" bar for 2009 indicates that, of all R&D expenditure, 47.1% was funded by the business enterprise sector, 35.6% by the public sector, etc. The "Business enterprise sector" bar for 2009 indicates that, of the R&D performed by the business enterprise sector, 66.6% was funded by the business enterprise sector, 11.0% by the public sector, etc. The "Higher education sector" bar for 2009 indicates that 5.2% of the R&D performed by higher education institutions was funded by the business enterprise sector, 89.5% by the public sector, etc. All other bars and years are to be interpreted in the same way. PNP = private non-profit sector.

Source: Statistics Austria. Calculations and graphic: WPZ Research.

Fig. 2-8: Expenditure on different types of research by sector of performance (in € millions), 2019



Note: The private non-profit sector is not represented on account of its minimal share.

Source: Statistics Austria. Calculations and graphic: WPZ Research.

government (7.8%) and the private non-profit sector (1.3%). Basic research is carried out predominantly (65.9%) at higher education institutions.

In terms of the types of expenditure indicated in Table 2-3, only minor shifts can be seen over time, despite the considerable increase in total volume. About half of this is accounted for by staff expenditure, more than two-fifths by current costs, and the remainder is distributed between expenditure on plants and equipment as well as buildings and land. Taking a closer look at R&D at higher education institutions and its distribution among fields of science in Table 2-4, major differences are noticeable. The largest proportion is accounted for by natural sciences, engineering sciences and human medicine and health sciences (in aggregate 71.9%). In the case of funding, however, by far the largest share – at least two-thirds in each case – is accounted for by the federal government. The business enterprise sector primarily finances engineering sciences as well as human medicine and health sciences.

There are naturally large differences by industries, as Table 2-5 shows. The assignment to the categories of high technology, medium-high technology, medium-low technology and low technology is based on the international sector-specific R&D intensity in relation to gross value added ("R&D as a percentage of GVA"), i.e. it is quite conceivable that industries allocated to high technology in a given country conduct comparatively little research (but primarily pro-

Table 2-3: Types of expenditure, 2009, 2017 and 2019

Type of expenditure	2009		2017		2019	
	in € millions	in %	in € millions	in %	in € millions	in %
Staff costs	3,800.5	50.8	5,622.2	49.8	6,358.7	51.1
Current costs	3,084.2	41.2	4,887.2	43.3	5,196.1	41.8
Expenditure on facilities and equipment	461.9	6.2	665.3	5.9	690.1	5.5
Expenditure on buildings and land	133.2	1.8	115.1	1	196.4	1.6
Total	**7,479.7**	**100**	**11,289.8**	**100**	**12,441.2**	**100**

Source: Statistics Austria. Calculations: WPZ Research.

Table 2-4: Funding R&D expenditure in the higher education sector by field of science, 2019

				Public sector								
	Entities performing R&D	Total	Business enterprise sector	Federal government	Regional governments	Local governments	Other	Combined	PNP	Higher education sector	Abroad (excl. EU)	EU
Fields of science	**Number**	**in € millions**	**in %**	**in %**	**in %**	**in %**	**in %**	**in %**	**in %**	**in %**	**in %**	**in %**
1.0 to 6.0 combined	1,327	2,711	5	73.3	3	0.1	8.1	84.5	0.4	4.2	2.2	3.7
1.0 to 4.0 combined	774	2,035	6.1	69.9	3.4	0.1	8.8	82.1	0.4	4.7	2.6	4.2
1.0 Natural sciences	248	741	2.7	71.3	2.9	0.1	13.3	87.6	0.3	1.7	1.8	5.9
2.0 Engineering sciences	231	575	10.1	67.6	4.8	0.1	5.9	78.3	0.2	4.1	2.4	4.8
3.0 Human medicine, health sciences	232	633	6.8	68.6	2.7	0	6.3	77.7	0.5	9.3	3.7	2
4.0 Agricultural sciences, veterinary medicine	63	86	2.5	83.1	2.1	0	7.6	92.9	0.5	0.7	1.9	1.4
5.0 and 6.0 combined	553	676	1.9	83.6	2	0.1	5.8	91.5	0.6	2.7	1	2.4
5.0 Social sciences	360	438	2.5	83.6	1.8	0.1	4.2	89.7	0.4	3.5	1.1	2.8
6.0 Humanities	193	238	0.7	83.4	2.4	0.1	8.9	94.8	0.8	1.4	0.9	1.5

Note: PNP = private non-profit sector.

Source: Statistics Austria. Calculations: WPZ Research.

Table 2-5: R&D investments and employees in the business enterprise sector by economic sub-sector and knowledge intensity, 2009 and 2019

	2009				2019			
	Employees in R&D, full time equivalents	R&D expenditure	Gross value added (GVA)	R&D as a percentage of GVA	Employees in R&D, full time equivalents	R&D expenditure	Gross value added (GVA)	R&D as a percentage of GVA
	Proportion of all sectors in %			in %	Proportion of all sectors in %			in %
Agriculture, forestry and fishing	0	0	1.3	0	0	0.1	1.2	0.1
Mining	0	0.1	0.4	0.4	0.1	0.2	0.3	1.5
Manufacturing	47	77.3	18.4	7.3	62.9	66.2	18.5	8.8
Types of technology								
High technology	8.8	16.2	1.6	17.9	12.3	14.9	1.9	19.4
Medium-high technology	26.8	45.4	6.3	12.5	37.5	38.8	6.6	14.5
Medium-low technology	7.4	10.5	5.2	3.5	9.7	9.7	5.2	4.6
Low technology	3.5	4.7	4.4	1.8	3.2	2.6	3.9	1.7
Cannot be allocated	0.4	0.5	0.9	1	0.3	0.2	0.9	0.5
Energy and water supply	0.7	0.2	3.4	0.1	0.2	0.4	2.8	0.3
Building	1.5	0.4	6.8	0.1	0.5	0.5	6.5	0.2
Services	50.7	21.9	69.8	0.5	36.3	32.7	70.7	1.1
Knowledge intensity								
High-technology, knowledge-intensive	31.5	12.8	4.5	4.9	22	18.5	6.1	7.5
Other services	19.2	9.1	65.2	0.2	14.3	14.1	64.6	0.5

Note: Economic sub-sectors as per ÖNACE 2008. The calculation is based on two-digit numerical ÖNACE classification and may therefore differ slightly from other calculations. Types of technology as per Eurostat: high technology (industries 21, 26), medium-high technology (industries 20, 27–30), medium-low technology (industries 19, 22–25, 33), low technology (10–18, 31–32); industries 12, 14 and 19 are included in the category "Cannot be allocated" due to data not being published. Knowledge intensity as per Eurostat: "high-technology, knowledge-intensive" includes industries 59–63 and 72 as well as industry 58 on account of aggregated data. Other services: the remainder. FTE = full time equivalents, GVA = gross value added.

Source: Statistics Austria. Calculations: WPZ Research.

Table 2-6: Employees in R&D by sector of performance, 2009 and 2019

	Employees in R&D						R&D expenditure in € millions			R&D expenditure per full time equivalents in € thousands		
	Headcount			Full time equivalents								
	2009	2019	Growth	2009	2019	Growth	2009	2019	Growth	2009	2019	Growth
Higher education sector	39,084	52,663	35%	15,059	18,971	26%	1,952	2,711	39%	129.62	142.92	10%
Government	6,008	10,952	82%	2,679	5,472	104%	399	913	129%	148.95	166.89	12%
business enterprises	50,668	79,274	56%	38,303	58,592	53%	5,093	8,749	72%	132.96	149.32	12%
PNP	742	1,228	65%	397	625	58%	36	67	88%	90.49	107.81	19%
Total	96,502	144,117	49%	56,438	83,660	48%	7,480	12,441	66%	132.53	148.71	12%

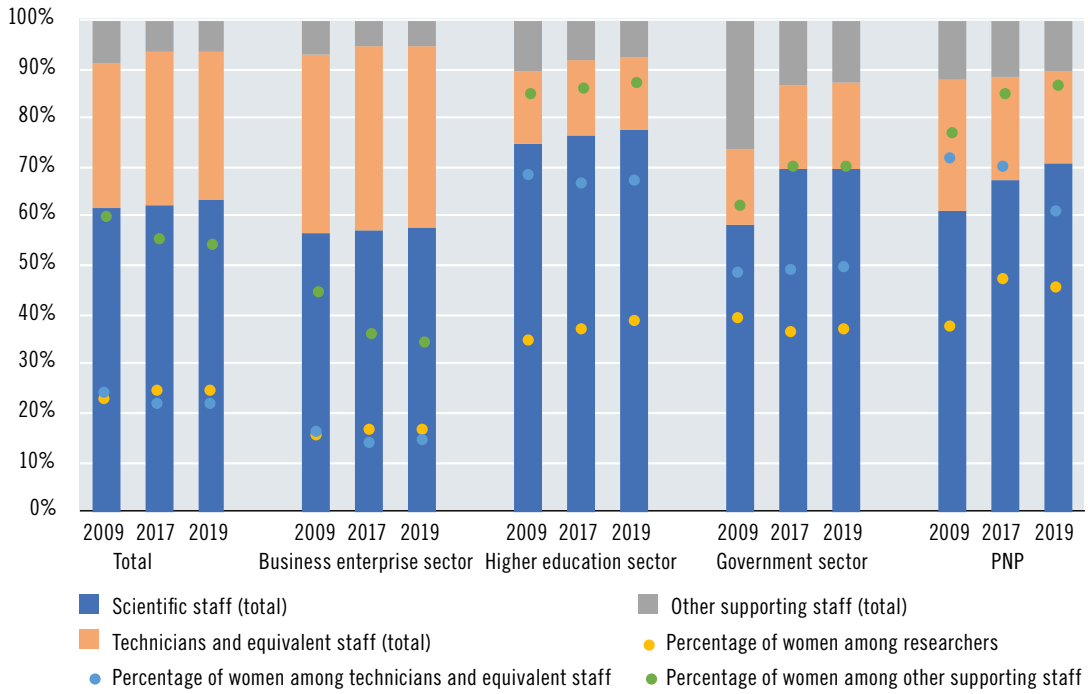
Note: FTE = full time equivalents, PNP = private non-profit sector.

Source: Statistics Austria. Calculations: WPZ Research.

duce). In fact, Table 2-5 shows that the difference between high technology and medium-high technology in Austria is relatively small, and not only that: the industry-specific R&D intensity rose faster in medium-high technology in Austria than in high technology in 2009–2019 (16.1% compared to 8.3%), and fastest in medium-low technology (31.8%), while it fell in low technology (by 9.9%). This corresponds to the picture according to which the strengths of the Austrian industry lie primarily in the medium-tech sector (this includes the metal technology industry).

Table 2-6 shows significant growth in the number of employees in R&D since 2009, both in terms of headcount and full time equivalents, as well as in total nominal R&D expenditure and nominal R&D expenditure per full time equivalent. As the volume of R&D employment grows, so does the number of women employed: As Fig. 2-9 shows, the percentage

Fig. 2-9: Employment structure of R&D staff in FTE, 2009, 2017, 2019



Note: FTE = full time equivalents, PNP = private non-profit sector.

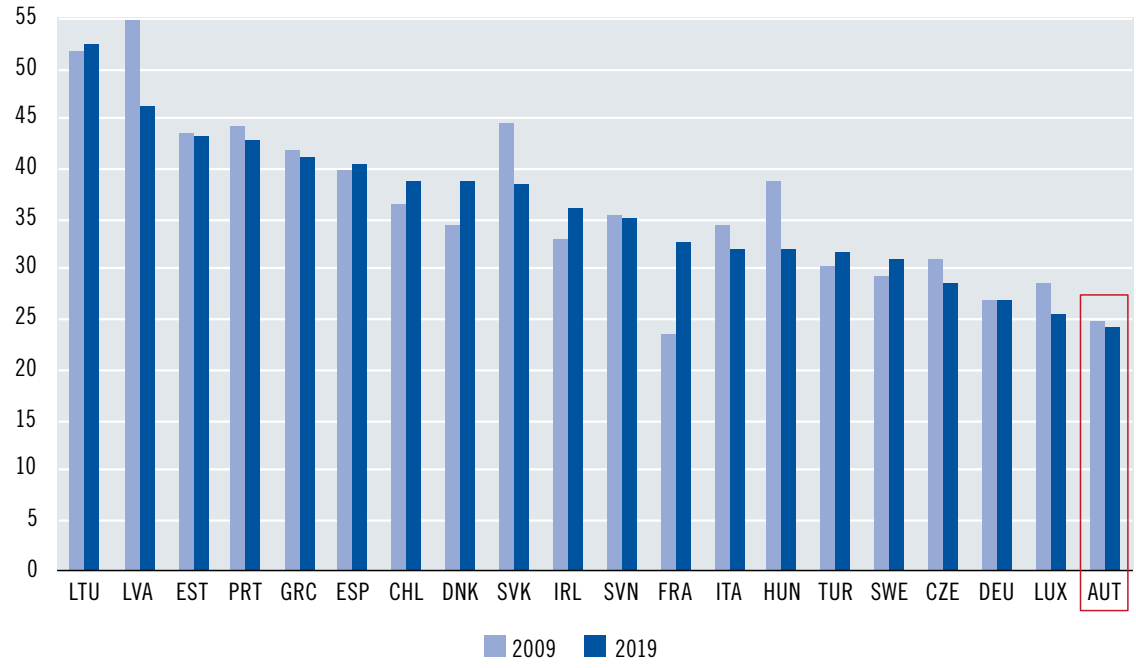
Source: Statistics Austria. Calculations: WPZ Research.

of women among researchers is increasing in all sectors except the government. In the government sector, however, full time equivalent staff of both genders more than doubled between 2009 and 2019: by 152.3% for men and 132.8% for women. The overall percentage of female researchers in full time equivalents was 23.8% in 2019, by sector: business enterprise sector 16.1%, higher education sector 37.8%, government 36.6%, private non-profit sector 44.8%. However, the overall percentage of women among technicians and equivalent staff and other supporting staff decreased in 2009–2019 (from 23.4% to 20.9% and from 47.3% to 42.9%, respectively).

The percentage of women among R&D staff in full time equivalents vary greatly across the OECD, as Fig. 2-10 shows, although the data are fragmentary. The highest values are found in the Baltic countries and the southern European countries Portugal, Greece and Spain; Austria has the lowest value. The reason why the percentage of women in Austria has increased in Fig. 2-9 for researchers, but decreased in Fig. 2-10, is due to the fact that Fig. 2-10 shows the entire R&D staff (i.e., according to the categories of Fig. 2-9, to "researchers" + "higher-qualified non-scientific staff" + "other supporting staff").

One of the socio-economic phenomena of the industrial age is the spatial concentration of economic activities already discussed by Marshall (1890), which also extends to cover the knowledge intensity of production. In Austria, too, R&D activities are distributed very differently in the federal states in 2019. As Table 2-7 shows, four federal states have a share of R&D expenditure that exceeds their share of GDP. Traditionally, Styria ranks highest and the ratio is lowest in Burgenland. The shares naturally have a lot to do with the economic structure as well as the locations of research-intensive facilities, such as higher education institutions or research institutes. For this reason, Vienna's share of business R&D, for example, is comparatively low, while it remains relatively high in the industrialised federal states of Upper Austria and Styria.

Fig. 2-10: Percentage of female researchers in full time equivalents in OECD countries, 2009 and 2019, in percent



Note: Arranged by values for 2019. No data are available on the countries omitted. Chile, Latvia and Lithuania 2018 instead of 2019, France 2010 instead of 2009 and 2017 instead of 2019, Greece 2011 instead of 2009, Ireland und Sweden 2017 instead of 2019.

Source: OECD. Calculations and graphic: WPZ Research.

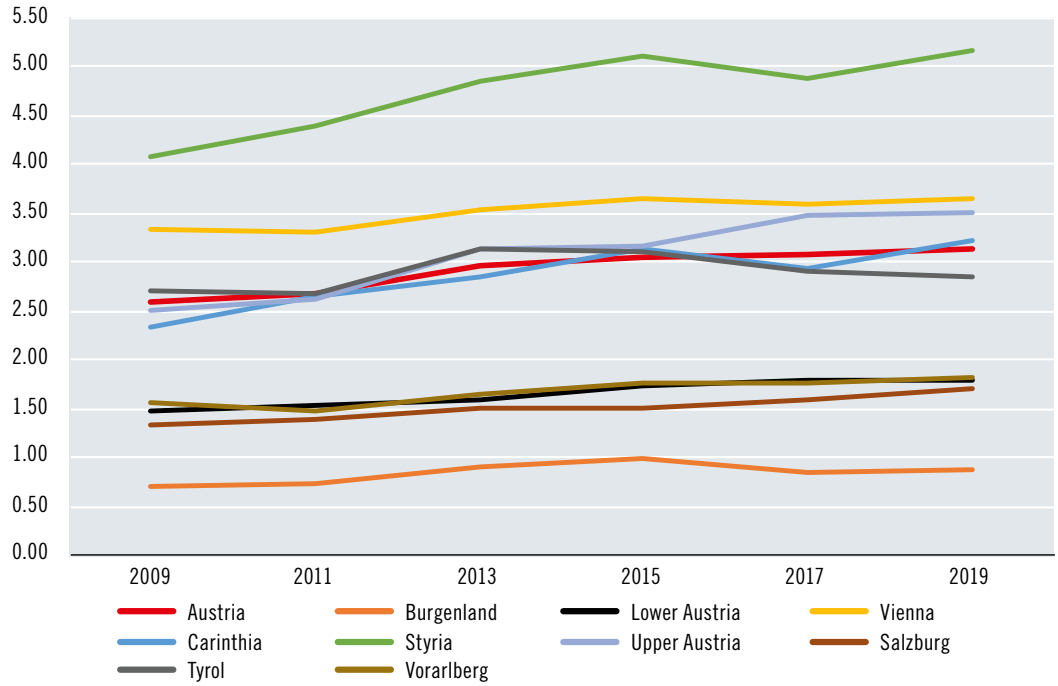
Table 2-7: Shares of the federal states in Austria's R&D and GDP as well as regional R&D intensity, in %

	Share in Austria's R&D expenditure, 2019	Share in GDP, 2019	Regional R&D intensity, 2019	Increase in the regional R&D intensity 2009–2019
Styria	21.0	12.8	5.15	26.85
Vienna	29.4	25.2	3.65	9.28
Upper Austria	19.2	17.1	3.51	40.96
Carinthia	5.6	5.4	3.22	37.61
Tyrol	8.2	9.1	2.83	4.43
Vorarlberg	2.8	4.8	1.82	16.67
Lower Austria	9.1	15.8	1.80	22.45
Salzburg	4.1	7.5	1.70	28.79
Burgenland	0.6	2.3	0.87	26.09

Note: Arranged in descending order by regional R&D intensity 2019; regional allocation according to the R&D location(s) of the survey units
Source: Statistics Austria. Calculations: WPZ Research.

Finally, Fig. 2-11 shows the R&D intensity of the federal states 2009–2019. Styria consistently has the highest research ratio and Vienna the second highest. Behind them, Upper Austria has risen from fourth to third place, Carinthia from fifth to fourth, while Tyrol has dropped from third to fifth place. Lower Austria and Vorarlberg alternate in sixth and seventh place, eighth place is always occupied by Salzburg, ninth place by Burgenland. There is only a direct correlation with regional GDP (gross regional product, GRP) insofar as it naturally reduces the R&D intensity in the denominator; nevertheless, the correlation between the regional R&D intensity and GRP is positive; the correlation coefficient for 2019 is 0.2009. R&D intensities have risen in all federal states – the most in Upper Austria (40.96%) and

Fig. 2-11: R&D intensity of the federal states, 2009–2019



Source: Statistics Austria. Graphic and calculations: WPZ Research.

Carinthia (37.61%), least in Vienna (9.28%) and Tyrol (4.43%). The interregional differences have decreased slightly – the variance of the logarithmically calculated R&D intensities has decreased from 0.2731 to 0.2647.

2.1.3 Recovery and Resilience Plan 2020–2026

With the establishment of the NextGenerationEU (NGEU) fund, the European Union has created a means of cushioning the economic impact of the COVID-19 crisis and coordinated management of a common recovery from the crisis towards sustainability, digitalisation and resilient societies. The largest share of the €750 billion[38] NGEU is earmarked for the Recovery and Resilience Facility (RRF), which is intended to help Member States fund investments with future relevance and reforms by providing them with €360 billion in low-interest loans and €312.5 billion in non-repayable funding grants.[39] Member States have the opportunity to draw upon funds from the RRF by submitting a corresponding Recovery and Resilience Plan (RRP) for the period 2020–2026, which sets out the planned projects, as well as their costs and relevance to the core themes of the green transition and digitalisation, social justice and resilience. The European Semester for the coordination of economic policies provides the central framework for selecting the reform priorities of Member States and monitoring their implementation at Union level.[40]

In April 2021, Austria submitted to the European Commission its national Recovery and Resilience Plan for the years 2020–2026, whose measures are in line with the National Reform Programme (NRP).[41] The RRP was adopted by the Council on 13 July 2021, making Austria one of 13 Member States already part of the first tranche of recovery plans to be supported.

The Austrian RRP contains measures with a total volume of €4.5 billion for the period 2020–2026, whereby Austria is expected to receive €3.46 billion[42] from the RRF, and with the remaining funds being provided from the national budget. The RRF funds will be disbursed in the form of an advance disbursement grant amounting to 13% of the total approved funds (€0.45 billion) and in six tranches in the period from 2021–2026, with disbursement linked in each case to the achievement of the objectives and milestones set out in the RRP. Two thirds of the measures outlined in the RRP are new investments[43] and were not included in Austria's previous budget planning. This can occur either through entirely new investment lines as well as through a budgetary topping up of existing programmes. One third of the RRP measures were already included in the 2021 federal budget appropriation and will remain included in the Federal Expenditure Framework Act until 2024. Although the investment premium generally has neither the requirements of an ecology and environmental support scheme nor those of research promotion, this general measure has, nevertheless, made a sustainable contribution to pushing investments, especially in the areas of ecologisation, digitalisation and health/life science during the COVID-19 pandemic.

The European Commission assessed the Austrian RRP positively across the board and highlighted in particular the high share of funds for climate protection and digitalisation. With a share of the funds provided by the RRF (compared with the €3.5 billion),

38 Based on 2018 prices.

39 European Commission (2022b).

40 European Union (2021).

41 See Federal Ministry of Finance (BMF) (2021, 12).

42 See Council of the European Union (2021). As the allocation of part of the RRF funds is based on the economic development of all EU countries in the period 2019–2021, there are currently only preliminary estimates of the volume of support for Austria. Based on the European Commission's Autumn 2020 Forecast, Austria is entitled to grants of €3.46 billion. The final allocation will be determined in June 2022, as soon as the final Eurostat statistics on the economic development 2019–2021 become available.

43 See Federal Ministry of Finance (BMF) (2021, 7).

59% benefit the achievement of climate protection goals and 53% support the digital transformation. The minimum values of 37% for climate protection and 20% for digitalisation required for the receipt of RRF funds are thus far exceeded, whereby Austria sets a good example and is clearly committed to the EU's priority areas.[44]

Four components of the RRP

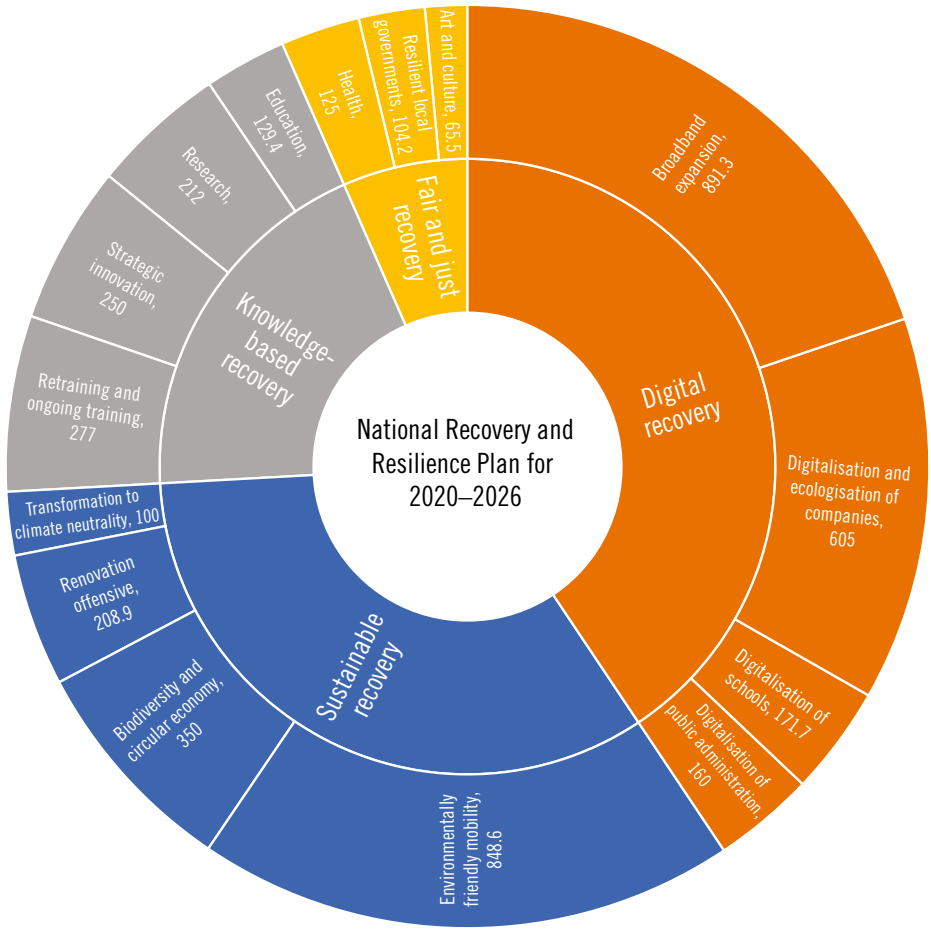
The RRP is structured along four components: sustainable recovery (€1,508 million), digital recovery (€1,828 million), knowledge-based recovery (€868 million) and fair and just recovery (€296 million). The following list (Fig. 2-12) provides an overview of the individual components and initiatives.

The RRP is composed of 34 investments and 25 reforms, the latter including, for example, the eco-social tax reform, the Mobility Master Plan 2030 and the RTI Strategy 2030, but also the KlimaTicket (climate ticket). In the following, the projects of the four components are presented in an overview.

Component 1: Sustainable recovery

During the COVID-19 pandemic, CO_2 emissions in Austria have been reduced. Nevertheless, to achieve the target defined in the Green Deal to reduce net

Fig. 2-12: Measures of the national Recovery and Resilience Plan split into the four components, financial weighting (€ million)



Source: Data: BMF (2021). Graphic: Technopolis.

44 https://ec.europa.eu/commission/presscorner/detail/de/ip_21_3052

Table 2-8: Measures and funding volume of the RRP, component 1: Sustainable recovery

Subcomponents	Renovation offensive	Environmentally friendly mobility	Biodiversity and circular economy	Transformation to climate neutrality
Reforms	• Renewable Energies Heat Act	• Mobility Master Plan 2030 • Introduction of the 123 KlimaTicket	• General legal framework for increasing collection rates for plastic beverage packaging and increasing the supply of reusable containers in the food retail sector	• Renewable Energy Expansion Act
investments	• Promoting the replacement of oil and gas heating systems • Combatting energy poverty	• Promoting zero-emission buses and infrastructure • Promoting zero-emission commercial vehicles and infrastructure • Constructing new railway lines and electrifying regional railways	• Biodiversity funds • Investments in reverse vending systems and measures for increasing reuse quotas for beverage containers • Constructing and retrofitting sorting plants • Promoting the repair of electrical and electronic devices (repair bonus) • Biodiversity and circular economy	• Transforming the industry to climate neutrality
budget	€208.9 million	€848.6 million	€350 million	€100 million

Source: Federal Ministry of Finance (BMF) (2021).

greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels, both structural reforms and substantial investments are necessary. The RRP takes this into account and focuses on the areas of heating transition (renovation offensive, conversion of fossil oil and gas heating systems to heating and hot water systems based on renewable energy sources), mobility (transition to an emission-free bus fleet, infrastructure for electric vehicles, upgrade of the rail network), circular economy and biodiversity, as well as transformation to climate neutrality, especially in industry.

The estimated costs between the measures vary significantly, and for some investments exceed the costs submitted in the RRP.[45] This concerns in particular the construction of new railway lines and the electrification of regional railways (costs: €1,366 million, RRP: €543 million) as well as the promotion of the replacement of oil and gas heating systems (costs: €400 million, RRP: €159 million).

Component 2: Digital recovery

The COVID-19 pandemic has highlighted the importance of digital connectivity; indeed, it is crucial for a dynamic, flexible economy and social exchange, especially in times of crisis and transformation. With the aim of increasing Austria's competitiveness and promoting an inclusive society, above all the **broadband expansion** is therefore considered essential for the nationwide provision of fast internet – this is to be supported and secured by a platform for the coordination of stakeholders and an amendment to the

Table 2-9: Measures and funding volume of the RRP, component 2: Digital recovery

Subcomponents	Broadband expansion	Digitalisation of schools	Digitalisation of public administration	Digitalisation and ecologisation of companies
Reforms	• Creating the platform "Internet Infrastructure Austria 2030" (PIA 2030)	• Ensuring that all secondary level I pupils have fair and equal access to basic digital skills	• "Only Once" bill to amend the Business Service Portal Act	
investments	• Gigabit-capable access networks and symmetrical gigabit connections in areas with particular socio-economic priorities	• Providing pupils with digital devices	• Public administration digitalisation funds	• Digitalisation of SMEs • Digital investments in companies • Environmental investments in companies
budget	€891.3 million	€171.7 million	€160 million	€605 million

Source: Federal Ministry of Finance (BMF) (2021).

45 See Feichtinger et al. (2021, 529).

Telecommunications Act. Furthermore, the **provision of digital end-user devices in education and public administration** should contribute to more equity and increased efficiency.

Complementary to the component digital recovery, reference should be made to Austria's participation in the IPCEI on microelectronics and on connectivity (see Component 3), which also contributes to the digital transformation.

Component 3: Knowledge-based recovery

The pandemic has shown that the funding of science and research along with support services for the labour market and the education system are of extraordinary importance. Additionally, the RTI Strategy 2030 provides strategic direction for the further development of research institutions and infrastructures for the coming years by formulating overarching goals.

With a volume of just under €462 million, approximately 10% of the RRP flows into measures in the area of research and innovation, about half of which goes to universities, according to calculations by the AIT. The only sub-area of the knowledge-based recovery is the so-called Important Projects of Common European Interest (IPCEI), a State aid instrument of European RTI and industrial policy for the promotion of cross-border innovations (see also Chapter 2.3.3). Participation in the IPCEI on microelectronics, on connectivity and on hydrogen is coordinated and prepared jointly by the two Austrian ministries BMK and BMAW (formerly BMDW). They also provide ongoing support to participating and interested companies. These IPCEIs aim, on the one hand, to secure strategic autonomy in the field of semiconductor production and strengthen the business location in the field of future technologies and, on the other hand, to make a significant contribution to the reduction of CO_2 and greenhouse gas emissions through the development and application of innovative technologies in the field of renewable hydrogen. In principle, the funding of the IPCEI flows into the budget chapter (*Untergliederung* – UG) 33 of the Federal Ministry of Labour and Economy (BMAW, formerly BMDW) and UG 34 of the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) and benefits the companies that have submitted an IPCEI application. The call for proposals must take place via a competitive procedure. The IPCEIs on microelectronics, connectivity and hydrogen, which together have a volume of €250 million, are thus also the largest measures of the RRP. Other large projects are "Quantum Austria", a research programme endowed with €107 million, whose strategic goal is to intensify basic research for quantum technologies and to advance the utilisation and market introduction of highly innovative products and services. In this way, competitiveness and European cooperation in this strategic key technology are expected to be further strengthened and a contribution to be made to European technological sovereignty in this area. To this end, the Austrian Science Fund (FWF) and the Austrian Research Promotion Agency (FFG) work closely together on be-

Table 2-10: Measures and funding volume of the RRP, component 3: Knowledge-based recovery

Subcomponents	Research	Retraining and continuing education	Education	Strategic innovation
Reforms	• RTI strategy 2030	• Education bonus	• Improving access to education	
investments	• Quantum Austria – promoting quantum sciences • Austrian Institute of Precision Medicine • (Digital) research infrastructures for the sustainable development of universities in the context of digitalisation	• Funding retraining and continuing education measures	• Package of support hours • Expanding early childhood education	• IPCEI on microelectronics and connectivity • IPCEI Hydrogen
budget	€212 million	€277 million	€129.4 million	€250 million

Source: Federal Ministry of Finance (BMF) (2021).

half of the Federal Ministry of Education, Science and Research (BMBWF) to award funding (see also Chapter 2.4.1). Another major project is the construction of the "Austrian Institute of Precision Medicine" (€75 million), and an additional €30 million are expected to flow into the digital research infrastructure at universities.

Within the four components, knowledge-based recovery accounts for about 19% (approx. €868 million) of the total volume of the Austrian Recovery and Resilience Facility. To this end, the Austrian government supports the projects specified in the following Table 2-10 in its Resilience Facility.

The "European University Association"[46] emphasises the importance of the RRP for the university sector. In the RRP, especially the third component: knowledge-based recovery for higher education institutions, is relevant – about 2.4% of the RRP is exclusively reserved for the university sector, 14.2% addresses research, innovation and education in a broad sense.

Component 4: Fair and just recovery

The changing population structures are prompting an increased focus on social cohesion. For example, there is an increasing need for measures in the areas of health, care, resilient communities and childcare. The area of "fair and just recovery" is cross-sectoral and requires taking different fields into account, such as the arts, climate protection and tax law. The breadth of accountability requires that the measures to be taken are not only well targeted but also diverse.

Within the four components, fair and just recovery accounts for about 7% (about €296 million) of the total volume of the Recovery and Resilience Facility. According to the Resilience Plan, the Austrian government invests in the four sub-areas specified in Table 2-11 below. A special feature of the Austrian RRP is that it includes a reform of the tax system – with the aim of contributing to a better climate (climate neutrality) and to more social justice.[47] The eco-social tax reform was adopted by the National Council in January 2022.

If one looks at the allocation of funds for R&I in comparison with Sweden and Finland[48], it becomes apparent that, similar to Finland, a particularly high proportion of funds is allocated via the Austrian Research Promotion Agency (FFG) (in Finland via "Business Finland"), while in Sweden the agencies are responsible for a very small proportion of the funds. In contrast, in Austria only few funds flow via the ministries, such as the funds for infrastructures or those for the establishment of the Institute for Precision Medicine. In Finland, however, the Ministry of Economic Affairs and Employment is clearly more involved in the allocation of funding.

Projected economic effects of the RRP

According to first estimates[49] great effects can be expected: the Austrian RRP will increase both public and private investment, which will lead to substantial GDP growth in the short and medium term. Private investment will be strengthened in particular through promotions and subsidies, with positive effects on private demand, which is of central importance for the recovery from the COVID-19 crisis. Long-term effects are mainly attributable to investment in research and development.[50] The study authors further emphasise the crucial importance of information technologies for the development of new ideas, products and services: "However, profiting from the digital transformation requires big investments into infrastructure, human capital and organization. The necessary infrastructure is, amongst other things, the technical access to high-

46 See Pruvot and Estermann (2021).
47 Ibid, 528.
48 See Schwaag Serger et al. (2022).
49 See Reiter et al. (2021).
50 Ibid, 4.

Table 2-11: Measures and funding volume of the RRP, component 4: Sustainable recovery

Subcomponents	Health	Resilient communities	Art and culture	Resilience through reform (indeterminate costs)
Reforms	• Making primary care more attractive	• Soil protection strategy • Reform for the further development of the provision of care	• Developing a building culture programme • Creating a national digitalisation strategy for cultural heritage	• Spending review with a focus on "green" and "digital" transformation • Raising the actual age of retirement • Pension splitting • Legal basis and governance in the field of climate protection • Eco-social tax reform • Green finance (agenda) • National financial education strategy • Basic package • Strengthening equity capital • Labour market: one-stop shop for jobseekers and expanding activating aid • Liberalising general conditions under trade law
investments	• Promoting PVE projects • Developing the electronic mother and baby book platform, including the interfaces to the "Early help" networks • National roll-out of "Early help" for socially disadvantaged pregnant women, their young children and families	• Climate-fit town centres • Investing in the implementation of community nursing	• Refurbishing the Austrian Museum of Folk Life and Folk Art and the Prateratelliers • Cultural heritage digitalisation initiative • Klimafitte Kulturbetriebe (Climate-fit cultural institutions) investment funds	
budget	€125 million	€104.2 million	€66.5 million	

Source: Federal Ministry of Finance (BMF) (2021).

speed internet, measured by the broadband penetration rate. Investment into human capital includes the training in digital skills, starting in school, but also involving a large part of the active work force. The digital transformation in private business and in public administration needs substantial organisational effort. The RRP includes measures along all these dimensions. These efforts are complementary, and the long-run growth impact that can be attributed to the digital transformation is the joint outcome of these measures."[51]

Specifically, according to the estimate, in the second year of the resilience plan (2022) GDP will be 0.41% higher (compared to the baseline year without the measures referred to), in the fifth year (2025) it will be 0.91% higher and in year 20 (2040) it will be 1.21% higher. The estimated impact on GDP in 2040 is about €6.5 billion (expressed in euros). Employment is expected to increase by 0.29% in year 2, 0.54% in year 5 and 0.61% in year 20. Assuming there is no change in tax rates, the increase in economic activity will lead to a positive budgetary balance for the Austrian government of 0.20% of GDP in year 2, 0.34% in year 5 and 0.56% in year 20.

The transformative content of the recovery measures

The RRP should not be viewed in isolation. In fact, it enabled the inclusion of strategic projects of the government which – as in other countries in Europe – not only experienced acceleration and reinforcement[52] as a result, but also a stronger commitment, especially since payments are linked to concrete milestones in the implementation of the measures.[53] The framework conditions of the European RRF had to be observed, in particular the regulation that the

51 Ibid, 11.
52 See Dachs and Weber (2022, 19).
53 Ibid, 28.

benefits of the measures must be achieved while avoiding negative environmental effects, as well as the requirement that at least 20% of the measures address digitalisation and 37% green transformation. Austria clearly exceeds these thresholds, with 53% and 59% respectively – otherwise only the RRPs of Denmark and Luxembourg have similarly high shares for the sustainability goals, as does Germany for digitalisation goals. A comparison of the priorities in terms of content in the recovery and resilience plans shows that investments in networks, public transport, renewable energies and the circular economy are prominently higher in Austria than in other countries, and thus represent specific priorities also in an international comparison.[54] An in-depth comparison of the transformation approaches of Austria, Sweden and Finland[55] indicates that Austria prioritises realigning existing markets and actors (such as railway and broadband) to achieve rapid improvements; to achieve system transformation via new markets or actor constellations, more efforts will be needed in the future.

2.2 Austria's position in international comparisons

Technological innovations and developments in recent years have led to ever greater (intelligent) networking of people, machines and products. Innovations in the field of artificial intelligence (AI), quantum technology or the "Internet of Things" (IoT) are changing workplaces, companies and the way societies function. The industrial and societal transformation set in motion by "Industry 4.0" has been further accelerated by the COVID-19 pandemic. Fourth Industrial Revolution technologies became an integral part of everyday (work) life, providing efficient and effective ways to manage the scale and impact of the pandemic.[56] Furthermore, they represent important future fields of research and innovation and are an essential factor in addressing post-pandemic as well as socio-ecological challenges such as climate change. Concerning the social, ecological and economic challenges, the Agenda 2030 with its 17 Sustainable Development Goals (SDGs) should be taken into account as a general framework.

In the coming years, it will be important for national economies to increase the acceptance of and willingness to use future technologies in business enterprises and among the population. This requires an efficient and well-functioning national innovation system that enables the development, diffusion and establishment of new technological processes and innovative industries, thereby increasing a country's competitiveness at the same time.[57]

In the following chapter, Austria's position in research, technology and innovation is presented in international comparison. In particular, three central aspects will be addressed. Section 2.2.1 focuses on Austria's performance in research and development on the basis of key input and output indicators. The status of Austria's digitalisation in international comparison is presented in section 2.2.2. In contrast to the Research and Technology Report 2021[58], only the key findings of the Digital Economy and Society Index (DESI)[59] will be discussed; the detailed examination of the individual indicators of the DESI is not the focus. Instead, a comparative country analysis will be carried out in international comparison in the area of future technologies. In particular, the findings of the Readiness for Frontier Technologies Index[60] and the future technologies of artificial intelligence, quantum technology and the Internet of Things will be dis-

54 Ibid, 23.
55 See Schwaag Serger et al. (2022).
56 See United Nations (2020).
57 See Abramov and Sokolov (2017).
58 See Federal Ministry of Education, Science and Research (BMBWF) et al. (2021).
59 See European Commission (2021a).
60 See United Nations (2021).

cussed. Finally, section 2.2.3 uses a number of indicators to present a country comparison of innovation and transformation capacity. The focus here is on indicators in the area of the circular economy, amongst other things, as well as Austria's resilience capacities and vulnerabilities in international comparison.

In each section, relevant indicators from different sources for the 27 EU countries are compared. The EU average value shown in each case is calculated from the EU countries with available data.[61] Depending on data availability, a comparison is made with Switzerland as an important science and innovation nation, as well as with the most important national economies of the respective continents: USA, China, Brazil, South Africa and Australia.

The key findings of important indicators are highlighted at the beginning of the respective sections. The indices used for the empirical analysis are based on different formats and are described in more detail in the respective sections. The data sources used are listed in Annex I. Furthermore, the indicators discussed in the sections are compared with the respective target from the RTI Strategy 2030.[62]

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

RTI indicators

- **In terms of R&D expenditure, Austria ranks third in the EU top group in 2020, and fourth in terms of the share of R&D employees.**
- **The country shows a need to catch up in venture capital investment (20th place).**
- **Patent intensity: Austria falls out of the top five and occupies the seventh place.**

To show Austria's position with regard to R&D performance and capacity, key input and output indicators have been analysed. Input indicators are expenditure on research and development, the volume of venture capital investments and the staff employed in research and development. Output factors include the number of triadic patents, the quantity and quality of citable scientific publications, the raising of European funds (such as ERC grants) and the number of outstanding universities in the country (measured by the Times Higher Education World University Ranking[63]). Furthermore, Austria's position in global innovation rankings such as the Global Innovation Index[64] and European Innovation Scoreboard[65] is addressed.

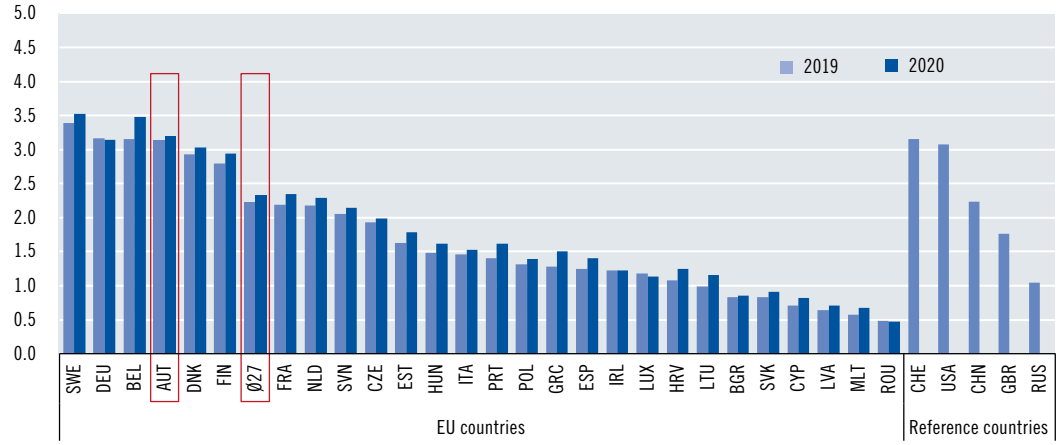
R&D expenditure

An established input indicator in the technology policy discussion is the R&D intensity. This is the percentage of a national economy's gross domestic product (GDP) spent on research and development. Investment in research and development is a basic prerequisite for a country's capability to innovate and to secure its long-term competitiveness.

Fig. 2-13 shows the R&D intensity for European countries and selected reference countries based on Eurostat data[66] for the years 2019 and 2020. Based on the current data, it can be seen that Austria was able to increase its R&D intensity from 3.13% in 2019 to 3.2% in 2020. In 2020, Austria's 3.2% ranks it third in the European leading group behind Sweden (3.53%) and Belgium (3.48%) . In 2019, Austria was still ranked fourth with an R&D intensity of 3.13%. Eurostat provides preliminary figures for 2020. Accordingly, the country ranking could still change, especially since it is unclear what impact the COVID-19 pandemic will have on data quality.

61 For some indicators, values for individual countries are missing from the data sets. As the indicators come from different sources, the year of the currently available data differs in some cases.
62 See Federal Government of the Republic of Austria (2020b).
63 See Times Higher Education (2022a); Times Higher Education (2022b).
64 See World Intellectual Property Organization (WIPO) (2021).
65 See European Commission (2021a); European Commission (2021b).
66 See Eurostat (2021a).

Fig. 2-13: R&D expenditure as a percentage of gross domestic product (in %), 2019 and 2020



Note: No current data are available for Brazil, Australia and South Africa. No data are available for the reference countries for 2020. The data for 2020 are preliminary figures from Eurostat.

Source: Eurostat (2021a). Graphic: iit.

Objective 2 defined in the RTI Strategy 2030 strives, amongst other things, for a ranking among the top 5 in international comparison with regard to the R&D intensity. Limited to the EU countries, this goal has already been achieved with the third place in 2020 and fourth place in 2019. In a global country comparison, however, there is still catching up to do.[67]

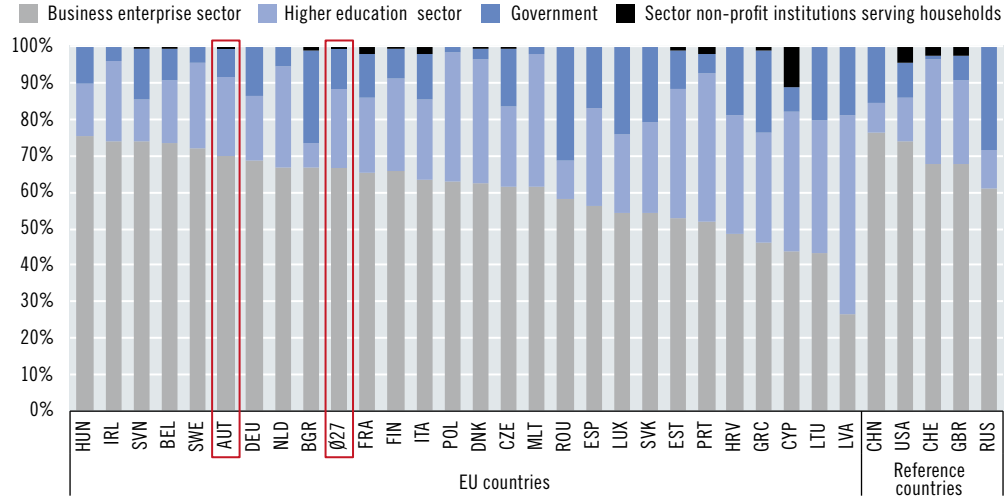
Looking at R&D expenditure in an international comparison raises the question of which sector contributes significantly to a country's innovation capability. Figs. 2-14 and 2-15 show the composition of Austria's R&D expenditure for the years 2019 and 2020 by sector of performance in a cross-country comparison, broken down by R&D expenditure in the business enterprise sector, the higher education sector, the government sector and private non-profit organisations. For better comparability of the importance of sectors across the single countries, the percentage shares of R&D expenditure by sector are presented as a stacked bar chart. The total expenditure for each country consequently adds up to a total of 100%. It is clear that the business enterprise sector accounts for the largest share of R&D expenditure in the years 2019 and 2020 in all EU and non-EU countries except Latvia. In second place comes the higher education sector, which in most EU countries (24 out of 27) plays a more important role in R&D expenditure than the government sector. In terms of R&D expenditure in the business enterprise sector, Austria is in a leading position (sixth place) in the EU country comparison in 2019 with 70.3%, just behind Sweden with 71.9% and ahead of other industrialised nations such as Germany, the UK or the Netherlands. A comparable picture is emerging for 2020. Austria is in sixth place with a slightly lower share of the business enterprise sector (69.3%).

Another goal defined in the RTI Strategy 2030 is to increase the share of venture capital investments in the gross domestic product from 0.02% to 0.1%.[68] Venture capital volume is an indicator of the relative dynamics of an economy. In particular, young companies that use and develop new (and thus inevitably risky) technologies often finance themselves pre-

67 Austria ranks ninth in the OECD ranking for 2019 behind Israel, South Korea, Taiwan, Sweden, Japan, Germany, Switzerland and Belgium (See OECD 2021c). The latest available data for Switzerland is from 2017. The OECD data for 2020 is still incomplete, so no ranking can be prepared for that year yet.

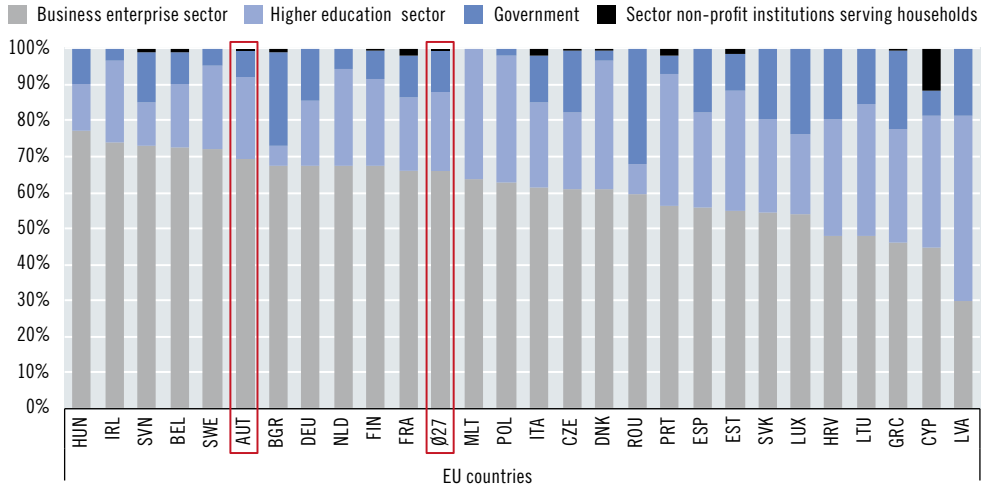
68 See Federal Government of the Republic of Austria (2020b, 7).

Fig. 2-14: R&D expenditure by sector of performance in international comparison, 2019



Note: No current data are available for Brazil, Australia and South Africa.
Source: Eurostat (2021a). Graphic: iit.

Fig. 2-15: R&D expenditure by sector of performance in international comparison, 2020



Note: No current data are available for the reference countries. The data for 2020 are preliminary figures from Eurostat.
Source: Eurostat (2021a). Graphic: iit.

dominantly through venture capital. According to the European Innovation Scoreboard 2021[69], Austria's venture capital investments in the three-year average 2018–2020 were 0.05% of GDP, including growth capital, which does not correspond to the scientific definition, as it can also be invested in established companies. Invest Europe, the organisation on whose data the information in the European Innovation Scoreboard is also based, estimates the share of venture capital investments in GDP for the years 2018–2020 at 0.02% as referred to in the RTI Strategy 2030. Traditionally higher shares than Austria are shown by comparable countries with regard to size and GDP, such as Denmark, Finland, Sweden and

69 See European Commission (2021b).

Switzerland, which are usually ahead of Austria in other technology rankings.[70]

R&D employees

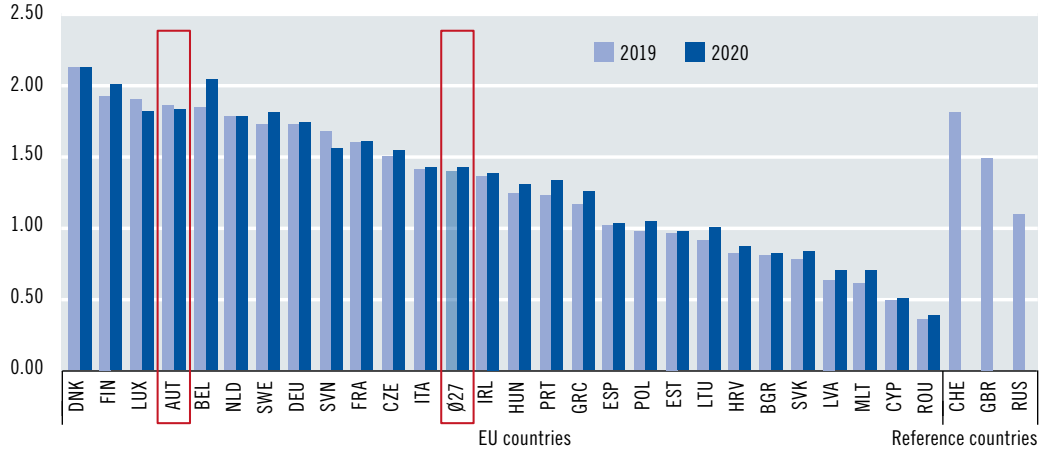
In addition to financial resources, employees in research and development represent a significant input factor for innovation capability. The field of activity of R&D employees includes conceiving or creating new knowledge, products, procedures, methods and systems as well as managing those (research) projects. Fig. 2-16 shows the percentage of R&D employees of the total working population for the years 2019 and 2020. The calculation is based on full-time equivalents (FTE). In 2019, 1.87% of people in gainful employment in Austria were employed in research and development. This places Austria in the EU leading group just behind the second and third ranked countries Finland (1.93%) and Luxembourg (1.90%) and well above the EU average of 1.40%.[71] The data for 2020 are preliminary figures from Eurostat. Austria is also among the top EU leaders in 2020 and can defend its fourth place. Compared to 2019, Luxembourg could be overtaken. It should be emphasised, however, that Belgium records the highest increase in R&D staff between 2019 and 2020, thereby overtaking Austria in 2020. If Belgium's preliminary figure is revised downwards, Austria would very likely move up to third place.

Triadic patent applications

The OECD defines triadic patents as a "family" of patents filed simultaneously with the three major patent offices in Europe (European Patent Office, EPO), Japan (Japanese Patent Office, JPO) and the United States (United States Patent and Trademark Office, USPTO) to protect the same invention in these key markets.[72] Triadic patents can therefore be seen as an indicator of high quality inventions, reflecting a nation's innovation capability and potential to develop far-reaching innovations.

Fig. 2-17 shows the number of triadic patents filed per 1,000 R&D employees in international comparison. Austria, with a value of 4.58 patents in 2019, is in seventh place and slips out of the top group compared to 2018 (fifth place). Luxembourg (6.5) and Denmark (5.34) were able to increase their triadic patent intensity, thereby overtaking Austria. In total, the number of patent applications per 1,000 R&D

Fig. 2-16: R&D staff as a percentage of the working population, 2019 and 2020



Note: The information for Russia is from 2012. No current data are available for Australia, Brazil, China, USA and South Africa. No data are available for the reference countries for 2020. The data for 2020 are preliminary figures from Eurostat.

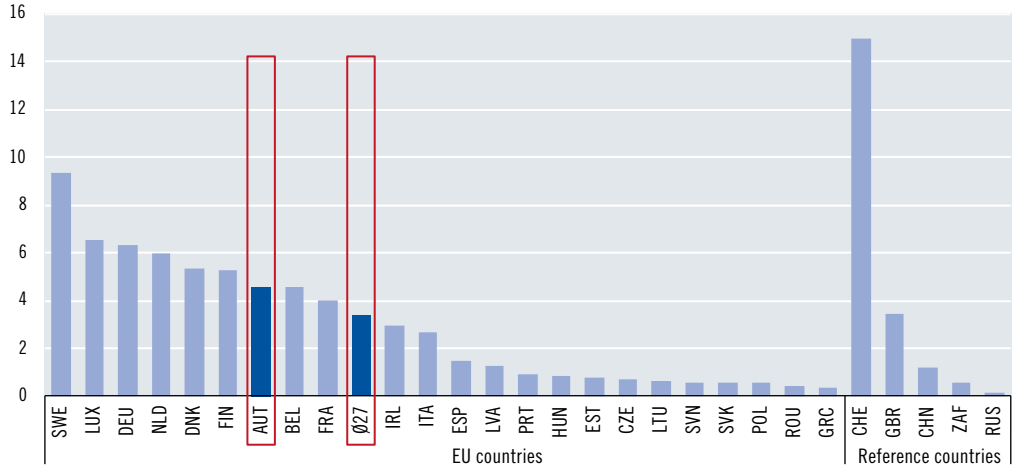
Source: Eurostat (2021a). Graphic: iit.

70 See Keuschnigg and Sardadvar (2019).

71 See Eurostat (2021a).

72 See OECD (2021d).

Fig. 2-17: Patent intensity (triadic patents) per 1,000 R&D employees, 2019



Note: No data are available for Bulgaria, Malta, Croatia, Cyprus, Australia, Brazil and the United States. R&D expenditure for Switzerland and South Africa are from 2017 and for Estonia from 2018.

Source: OECD (2021b). Graphic: iit.

employees in the EU fell from an average of 3.56 in 2018 to 3.40 in 2019. Austria is also subject to this EU-27 trend and even reduced its patent intensity slightly more than the EU average by 0.70 percentage points to 4.58. The leader remains Sweden (9.35) followed by Luxembourg (6.50) and Germany (6.29).

Austria's international position with regard to science

Science

- **Austria remains in the upper midfield in eighth place in terms of scientific publications.**
- **The country's h-index is above the EU average.**
- **ERC grants were successfully acquired, and Austria ranks second here.**
- **No Austrian university is represented in the top 100 of the Times Higher Education World University Ranking.**

The indicators (i) quantity and quality of citable scientific publications, (ii) raising of competitive funds and (iii) international university rankings provide information about the scientific performance of a country.

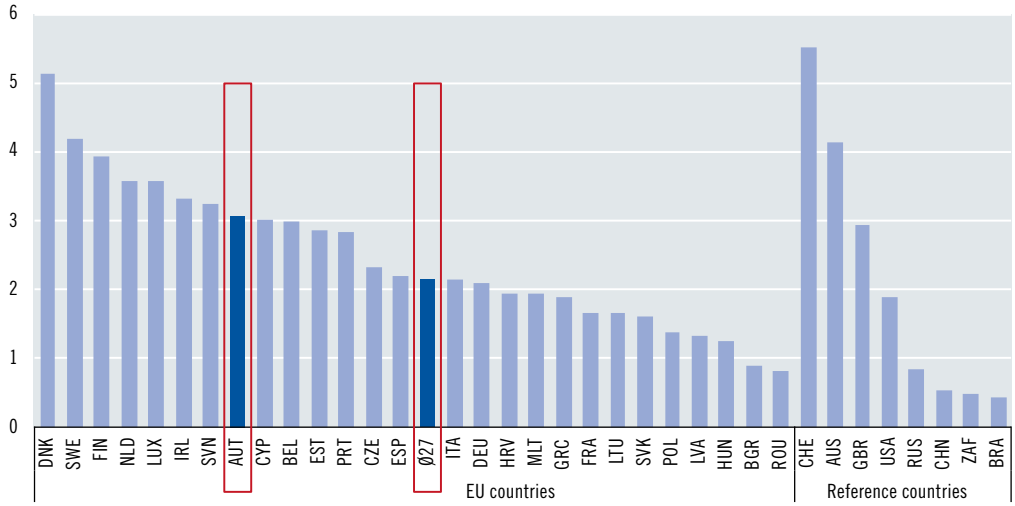
Citable scientific publications

The number of citable scientific publications in a country is a quantitative measure of scientific performance. These include, amongst other things, scientific articles, reviews and books. Fig. 2-18 shows the result of a bibliometric analysis for the year 2020, which was carried out on the basis of the publication database of Scimago[73]. The number of articles was standardised with the country population. Austria was able to maintain its eighth place from the previous year and to increase its level from 2.86 to 3.06 citable publications per 1,000 inhabitants. Denmark (5.41), Sweden (4.18), Finland (3.94), the Netherlands (3.58), Luxembourg (3.57), Ireland (3.32) and Slovenia (3.24) were again ahead of Austria. These countries were also able to increase their scores compared to the previous year. Only the Netherlands and Luxembourg swapped places in their ranking.

A different picture emerges when a quality measure is used instead of a quantity measure. The qual-

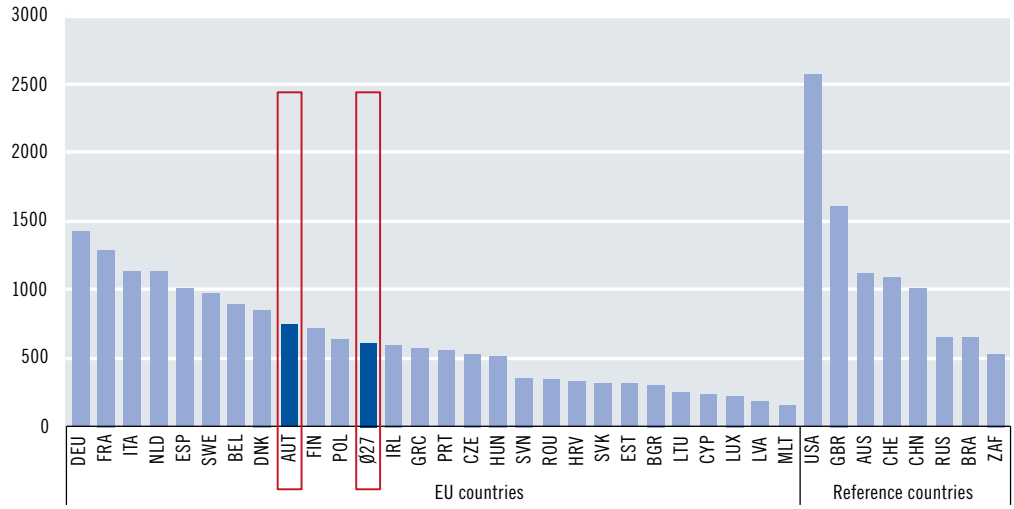
73 See Scimago Journal & Country Rank (2021).

Fig. 2-18: Number of scientific (citable) articles in all disciplines, standardised by country population, 2020



Source: Scimago Journal & Country Rank (2021). Graphic: iit.

Fig. 2-19: Quality of the scientific articles in all disciplines, as measured by the h-index, 2020



Source: Scimago Journal & Country Rank (2021). Graphic: iit.

ity of scientifically citable articles can be measured with the help of the h-index[74]. The h-index is a measure based on the analysis of publication data that uses scientific publications and citations to quantify both the scientific productivity of journals and the scientific impact of individual publications. One advantage of the h-index is that it can also be applied to researchers as well as to individual countries. Fig. 2-19 shows the result of a bibliometric analysis based on the publication database of Scimago[75] and compares the h-index across countries.

With an h-index of 740, Austria takes ninth place in the EU-27 comparison and thus performs similarly well as when examining the quantitative measure. For other countries, however, major differences between the two measures are apparent. Countries

74 See Hirsch (2005).

75 See Scimago Journal & Country Rank (2021).

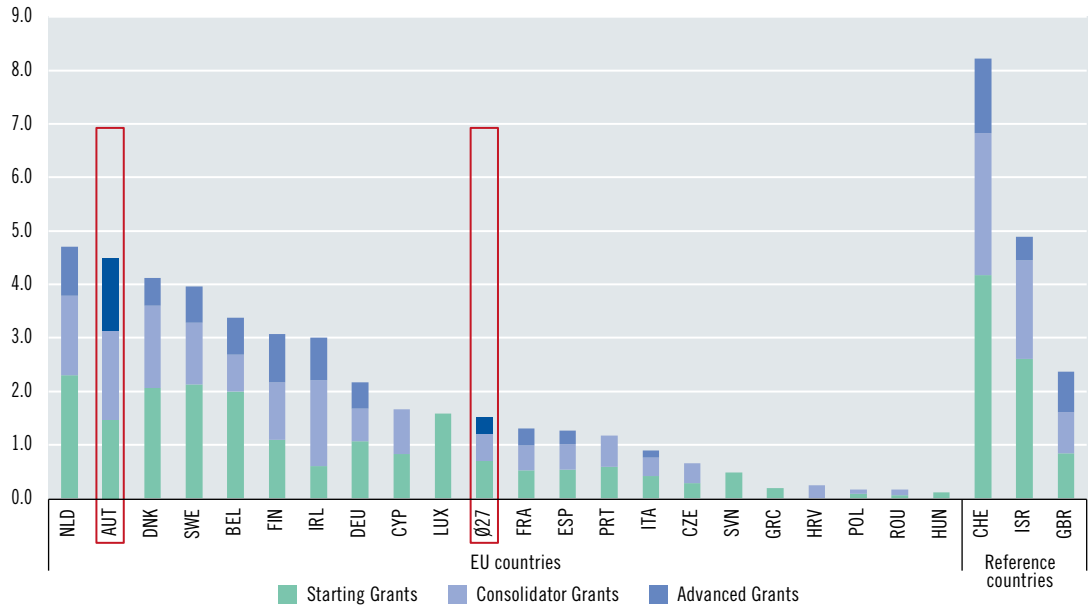
such as Denmark or Sweden, in comparison, which are leaders in the quantitative measure, perform significantly worse in the h-index. The leader Denmark lands one place ahead of Austria in eighth place in the h-index (EU-27), while Sweden loses four places. On the other hand, Germany and France lead the h-index ranking despite their below-average number of scientific citable publications per 1,000 inhabitants (Germany 15th, France 19th). In a global comparison of countries, the USA is by far the leader in terms of the h-index, followed by the UK. These two countries are also home to a large number of the world's most renowned universities and are most strongly represented in the Times Higher Education World University Ranking[76].

European Research Council (ERC) grants

The funds of the European Research Council (ERC) are among the most prestigious European science awards and are part of the Excellent Science pillar of the Horizon Europe programme. The ERC grants are intended to support cutting-edge research in all fields of research; they are aimed at researchers of all nationalities. The central ERC grant categories are the ERC Starting Grant, the ERC Consolidator Grant, the ERC Advanced Grant, the ERC Synergy Grant and the ERC Proof of Concept.[77] The ERC Starting Grant is aimed at researchers whose PhD is 2-7 years old and the ERC Consolidator Grant at researchers whose PhD is 7-12 years old. The ERC Advanced Grant promotes researchers who have made significant research achievements in the last ten years. The ERC Synergy Grant aims to foster interdisciplinary cooperation and supports two to a maximum of four researchers and their teams with different skills and resources to jointly solve ambitious research problems. The ERC Proof of Concept supports researchers who have already received an ERC grant and now want to explore the commercial or societal potential of the funded project.

Fig. 2-20 shows the number of ERC Starting Grants, ERC Consolidator Grants and ERC Advanced

Fig. 2-20: Number of European science awards (ERC grants) in Horizon 2020 per 1 million inhabitants, 2020



Note: Bulgaria, Estonia, Latvia, Lithuania, Malta and Slovakia did not apply for any ERC grants in 2020.

Source: European Commission (2021b). Graphic: iit.

76 See Times Higher Education (2021a).

77 See European Commission (2021a).

Grants raised per million inhabitants in 2020.[78] In the overall assessment of ERC grants, i.e. in the cumulative number across all three ERC grant categories, Austria is in second place behind the Netherlands and ahead of large countries such as Germany (8th place) or the UK. The objective defined in the RTI Strategy 2030 of ranking among the top ten is thus already being met.[79] Austria is also consistently in the top 10 in the differentiated analysis of the individual ERC grants. Austria is the EU leader in raising ERC Consolidator and ERC Advanced Grants.[80] Austria does comparatively less well in ERC Starting Grants (sixth place), but is still in the top third in both categories. In a global comparison of countries, Switzerland occupies the lead position by far.

Universities

As central players in Austria's knowledge and innovation system, higher education institutions contribute to knowledge creation, provide training and qualifications for predominantly younger adults, and drive forward technological developments, and thereby support the country's economic development and social-ecological transformation. These institutions have to compete not only on a national level but also internationally. The Times Higher Education World University Ranking[81] (THE Ranking) uses in total 13 performance indicators to compare universities in terms of their teaching, research, knowledge transfer and international outlook. So far, including in the 2022 THE Ranking, no Austrian university has yet been placed amongst the 100 best universities worldwide. The objective stated in the RTI Strategy 2030, for at least two universities to be placed in the Times Higher Education World University Ranking within the next few years, therefore remains an unfulfilled ambition so far. The top countries in the THE Ranking are the USA, well ahead with a total of 38 listed universities, followed by the United Kingdom (11), Germany (7) and the Netherlands (7). Amongst the top 200 universities listed in the THE Ranking 2022 are the University of Vienna at rank 137, and this year for the first time also the Medical University of Graz, at rank 196. It is worth noting that the University of Vienna shows a positive trend, with steady improvement in recent years (2019: rank 143; 2017: rank 161).

Amongst the young universities, i.e. those which are no more than 50 years old, Austria's performance is significantly better. In fact there are four Austrian universities listed amongst the top 50 in the Times Higher Education Young University Ranking 2021[82]: the Medical University of Innsbruck (19th place), Medical University of Graz (21st place), Medical University of Vienna (24th place) and the University of Klagenfurt (48th place). This places Austria ninth in the global comparison of countries, and fourth amongst the EU-27 states.

Austria's position from the perspective of global innovation rankings

Global innovation rankings: GII & EIS

- **GII: Up one place to rank 18**
  - **Greatest improvement in the Infrastructure input indicator (+13 places)**
  - **Improvement still needed in the Innovation Output Sub-Index (ranked 24th)**
- **EIS: Consistent on rank eight**
  - **Top 5 rankings in Intellectual assets and Finance and support**
  - **Improvement needed in Use of information technologies (ranked 14th)**

78 The raised ERC grants being considered are from the year 2020, and not from the entire Horizon 2020 period. The ERC Proof of Concepts are not included due to the comparatively low funding volume. Similarly, the ERC Synergy Grants are not shown in a country comparison, as one ERC Synergy Grant funds two to four researchers partly from different countries.

79 See Federal Government of the Republic of Austria (2020b, 7).

80 Austria ranks second for ERC Synergy Grants and seventh for ERC Proof of Concept.

81 See Times Higher Education (2022a).

82 See Times Higher Education (2022b).

Two important international overall indices that can be used to compare the innovation capability and performance of different countries are the Global Innovation Index (GII)[83] and the European Innovation Scoreboard (EIS)[84]. The significance of these indices is also reflected in the Austrian federal government's RTI Strategy 2030. This sets the objective of improving Austria's ranking in the GII from the top 19 to top 10, and targeting an improvement of at least three ranks (from top eight to top five) in the EIS.[85]

The Global Innovation Index 2021 (GII) is made up of two equally weighted sub-indices and provides a measure of the innovation capability and performance of each country. The Innovation Input Sub-Index is made up of five input pillars which capture elements of the economy that enable and facilitate innovative activities (e.g. institutional environments, human capital or information and communication technologies). The Innovation Output Sub-Index is includes two output pillars and measures the output of innovative activities in the economy (e.g. knowledge creation, knowledge diffusion, or creative goods and services).

In 2021 Austria continued the positive trend of the previous year, and improved its position from 19th to 18th place (out of 132 countries in total). This places Austria amongst the top 15% of countries in this worldwide comparison (see Table 2-12). In addition to this improvement in the rankings, it is worth noting that the absolute index value also rose from 50.13 in 2020 to 50.90 in 2021. The improvement in ranking recognised in the 2021 Austrian Research and Technology Report (from 21st place in 2019 to 19th place in 2020) was achieved despite a decrease in the index value from 50.94 in 2019 to 50.13 in 2020.[86] The index value for 2021 has recovered to the 2019 level, while Austria's ranking has improved by three places.

As in the last two years the leading country is Switzerland (65.5), followed by Sweden (63.1) and the USA (61.3). In the EU-27 comparison Austria is in the top ten once again, at rank eight, which is one place better than in the previous year (ninth place). The objective defined in the RTI Strategy 2030 of becoming one of the ten best countries has thus been achieved in terms of the EU-27 comparison, but not yet in the global comparison.[87]

Analysis of the GII 2021 sub-indices shows that on the input side Austria could further develop its skills in the input dimension, and could improve its ranking by two places to reach 16th place. There have been noteworthy improvements in the input indicators for Infrastructure. Here, Austria has moved up 13 places and now ranks seventh. Another area of strength on the input dimension is once again "human capital" (seventh place as in the previous year). In contrast, Austria still shows room for improvement in the Innovation Output Sub-Index. This actually shows a slight decline in comparison to last year, dropping by one position to rank 24, largely due to the negative trend in the indicators for "creative goods" (27th place).[88]

Table 2-12: Austria's international position in GII and EIS, 2021

Index	Austria's position				EU-27 comparison
	Value 2020	Ranking 2020	Value 2021	Ranking 2021	
Global Innovation Index 2021	50.13 (Scale of 0 to 100)	19 (out of 132)	50.90 (Scale of 0 to 100)	18 (out of 132)	8 (out of 27)
European Innovation Scoreboard 2021	131.7 (Scale of 0 to 180)	7 (out of 27)	133.6 (Scale of 0 to 180)	8 (out of 27)	8 (out of 27)

Source: WIPO (2021); European Commission (2021c). Graphic: iit.

83 See World Intellectual Property Organization (WIPO) (2021).
84 See European Commission (2021d).
85 See Federal Government of the Republic of Austria (2020b, 7).
86 Austria has overtaken Iceland and Norway in the rankings, as these countries reported an even greater decline in their index scores. Looking at the overall picture, the median GII score declined from 33.86 in 2019 to 30.94 in 2020.
87 See Federal Government of the Republic of Austria (2020b, 7).
88 See World Intellectual Property Organization (WIPO) (2021).

The European Innovation Scoreboard (EIS) is another index that is used to assess the research and innovation performance of EU Member States, and the relative strengths and weaknesses of their research and innovation systems. The EIS is compiled using four dimensions, namely: i) framework conditions, ii) investments, iii) innovation activities and iv) impacts. The four dimensions each consist of three sub-dimensions, which in turn are each based on either two or three indicators.

The overall performance of each country's innovation system is then expressed in a combined index, the Summary Innovation Index. Here Austria ranks eighth in the EU-27 for 2021 (see Table 2-12). The objective of aiming to be recognised amongst the five leading states in the European Innovation Scoreboard (EIS), as defined in the RTI Strategy 2030, has therefore not yet been met. (For 2021 the top five are Sweden, Finland, Denmark, Belgium and the Netherlands).[89] Comparing the EIS 2021 with the EIS 2020, the first three places were once again taken by the Scandinavian countries listed above; Belgium has improved its position, moving up from sixth to fourth within the year.

It is important to note that Austria's ranking remains steady, at eighth, as described in the 2021 Austrian Research and Technology Report. This could be interpreted as indicating that there has been neither improvement nor deterioration. However, the EIS rankings for 2020 and 2021 cannot be compared directly with each other, as new indicators have been introduced for the 2021 EIS, and existing indicators have been adjusted. If the new and adjusted indicators of the EIS 2021 were applied to the EIS 2020 values, then Austria would be in seventh place in the EIS 2020, and thus one position higher than in the original calculation of the EIS 2020. This would indicate that Austria's position has actually declined over the year, compared to other countries, from seventh position (EIS 2020) to eighth (EIS 2021).

An innovation leader is defined as an EU member state whose overall index score is more than 125% of the EU average. According to the EIS 2021, Austria's score is 118.7% of the EU average, while the figure for 2020 was 119.9%. In comparison to the targeted level of 125%, which would be needed to qualify as an innovation leader, Austria has fallen back in the new EIS, although the score is higher than that reported in the 2020 EIS using the old method (117.5%). This is due to retroactive revisions of data and the introduction of new indicators. Therefore, it is not possible to identify conclusively whether Austria has improved or declined in comparison to 2020.

In total, Austria is showing ongoing improvement – as are most EU Member States – and this results in varying interpretations, depending whether the change is compared to its own standardised score for the previous year, or – as in the EIS 2021 – the score of seven years previously. The European Commission[90] interprets Austria's performance as having declined in comparison with the EU. In digitalisation, for example, although Austria is above the EU score and has improved clearly since 2020, the country has fallen behind since 2014 compared to the EU as a whole: while in 2014, Austria was 20.3% above the EU, this figure is now only 6.2%. So in this area, Austria has lost its lead; this example illustrates how much the interpretation depends on the frame of reference.

The following examines the EIS scores for 2020 and 2021, using the EIS 2021 indicators to analyse the EIS score for 2020. This allows the actual change in Austria's EIS score to be identified. Austria's score in the Summary Innovation Index shows a positive development from 2020 to 2021, increasing from 131.7 to 133.6.[91] However, Austria is one place lower in the comparison of EU countries, because Germany has

89 See Federal Government of the Republic of Austria (2020b, 7).
90 European Commission (2021c, 59).
91 Both scores are based on the indicators used in the EIS 2021.

recorded a larger increase than Austria's (from 131.2 to 137.9). Looking at the individual sub-indices, Austria achieves a top-five ranking in the areas of Intellectual assets[92] (fourth place) and Finance and support[93] (fifth place). Improvement is needed particularly in Use of information technologies[94] (14th position).

2.2.2 Austria's position in terms of digitalisation

Digitalisation (DESI) and future technologies (Readiness for Frontier Technologies Index)

- **DESI: Up one place to number ten**
  - **All four dimensions of DESI are above the EU average.**
- ***Readiness for Frontier Technologies Index:*** **Austria is in a strong mid-range position at 11th place.**

The digital transformation of science and business has been underway for several years and was significantly accelerated by the COVID-19 pandemic, when most of the world shifted many activities to online formats, and countries' internet use increased by up to 60%[95,96]. Digital distance learning, working from home and mobile applications to monitor the progression of the pandemic were all introduced, and researchers worked successfully to find a vaccine. The growth of digital business and social activities makes it clear that connectivity and the use of digital technologies should be priority goals for a modern knowledge economy like Austria. Even if online activities may reduce slightly after the COVID-19 pandemic, in many fields the pandemic is a catalyst for digitalisation. Fundamental processes in research, technology and innovation are also affected by this shift towards digitalisation and are being dynamically advanced by the use of digital systems and services.[97] In the coming years it will therefore be important to expand and further develop digital skills in order to create innovations that are internationally competitive.

The current status of digitalisation in Austria can be described using the indicators of the EU country comparison. The following focuses particularly on Austria's performance in the European Commission's[98] Digital Economy and Society Index (DESI) and the Readiness for Frontier Technologies Index published by the United Nations (UN)[99]. The latter index evaluates countries' readiness to use future technologies such as artificial intelligence (AI), quantum technologies and the Internet of Things (IoT).

Digital Economy and Society Index (DESI)

The Digital Economy and Society Index is published annually by the European Commission and reports on indicators of Europe's digital performance. In 2021 the DESI was adjusted to take account of the latest technological and political developments and to better reflect changes in the framework conditions, including the two major political initiatives which will affect the digital transformation in the European Union in the years ahead, namely the Recovery and Resilience Facility, and the Digital Decade Compass.[100] The indicators used for the Index are structured around the four areas in the Digital Compass. These are: i) connectivity, ii) human capital, iii) integration of digital technology and iv) digital public services.[101]

92 Intellectual assets combines the indicators of Patent and Trademark applications, and Design applications.
93 Finance and support includes the indicators for R&D expenditures in universities and government research organisations, Venture capital investments, Direct government funding and governmental tax support for business R&D.
94 Use of information technologies covers the proportion of Employed ICT specialists and the percentage of Enterprises providing ICT training (for their personnel).
95 See OECD (2020a).
96 See OECD (2020b).
97 See OECD (2020c).
98 See European Commission (2021e).
99 See United Nations (2021).
100 See European Commission (2021f).
101 Ibid.

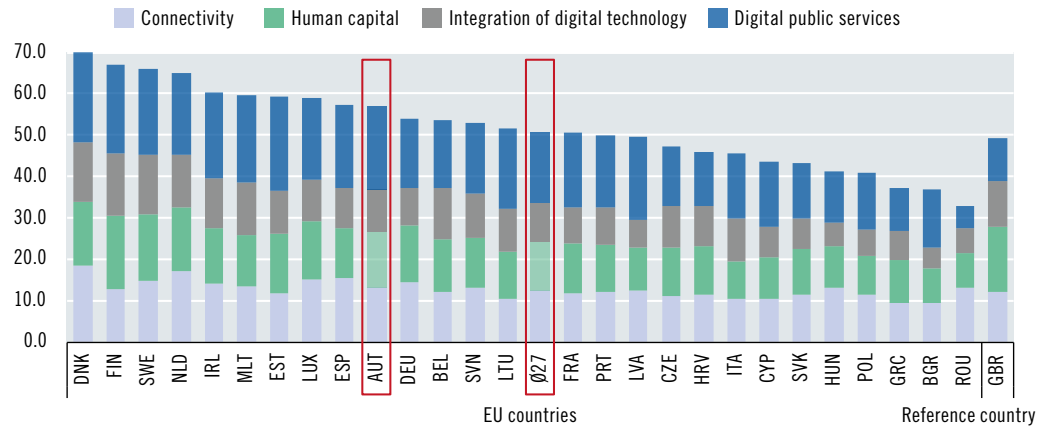
Fig. 2-21 shows the structure of the composite DESI index in terms of international rankings, i.e. using the combined scores of EU countries in all four dimensions. With 56.9 points, Austria is slightly above the EU-27 average (50.7) and ahead of major countries such as Germany (54.1), France (50.6) and the United Kingdom (49.4). As the year before, the Scandinavian countries remain at the top of the DESI ranking (with scores between 70.1 and 66.1). Austria's position is one place higher than in the prior year, ranking tenth[102], which means it is closer to the objective defined in the RTI Strategy 2030, of becoming one of the top five.[103] In fact Austria is above the respective EU average in all four areas of the DESI index. Here an improvement is evident compared to the previous year, particularly in the areas of connectivity and the integration of digital technologies, where previously Austria's score was below average. A particular highlight is the improvement in connectivity. Where Austria was in 24th position a year ago, it has improved in 2021 to reach 11th place.[104]

Ability to apply technologies of the future (Readiness for Frontier Technologies Index)

Frontier technologies, which are preceded by a high level of basic and application-oriented R&D, are regarded as having enormous market potential. The United Nations for example expects an increase in market growth from 16 billion dollars in 2017 to 191 billion dollars in 2024 in the area of artificial intelligence.[105] Amongst the most important frontier technologies are artificial intelligence, the Internet of Things, big data, blockchain, 5G, 3D printing, robot technology, drone technologies, genome editing, nanotechnologies and photovoltaics.[106]

To evaluate the capacity of a country to develop frontier technologies, to adopt, use and adapt them, the following makes reference to the Readiness for Frontier Technologies Index 2021[107]. This index covers five building blocks: i) ICT deployment, ii) skills, iii) R&D activity, iv) industry activity and v) access to finance; each of these building blocks is made up of two indicators. The building block "access to finance"

Fig. 2-21: Digital Economy and Society Index, 2021



Source: European Commission (2021e). Graphic: iit.

102 The improvement by one place is valid despite the change in method used to calculate the DESI.
103 See Federal Government of the Republic of Austria (2020b, 7).
104 See European Commission (2021g).
105 See United Nations (2021).
106 See Austrian Academy of Sciences (OeAW), Institute of Technology Assessment (ITA) and the Austrian Institute of Technology (AIT) (2021) for a technology assessment of Austria's position in these future-oriented areas.
107 See United Nations (2021).

is the exception here, and includes only one indicator. The indicators used for the five building blocks are described in more detail below:

ICT deployment: Using, adopting and adapting frontier technologies requires sufficiently developed ICT infrastructure, especially since the Internet of Things, big data and blockchain are internet-based technologies. This sub-index reflects the level of ICT infrastructure. Two aspects of ICT infrastructure need to be considered in particular: the prevalence of ICT to ensure that everyone has access to the infrastructure; and the quality of ICT infrastructure that allows for more advanced and efficient use. For these purposes the two indicators used are internet users (as a percentage of the population) and the mean download speed.

Skills: Using, adopting and adapting frontier technologies requires people equipped with relevant skills. Two types of skills need to be considered: skills acquired through education, and skills acquired in the workplace through practical training or "learning by doing". The overall educational attainment of the population is measured through expected years of schooling, while the skill level in the labour market is measured by the extent of highly qualified employees.

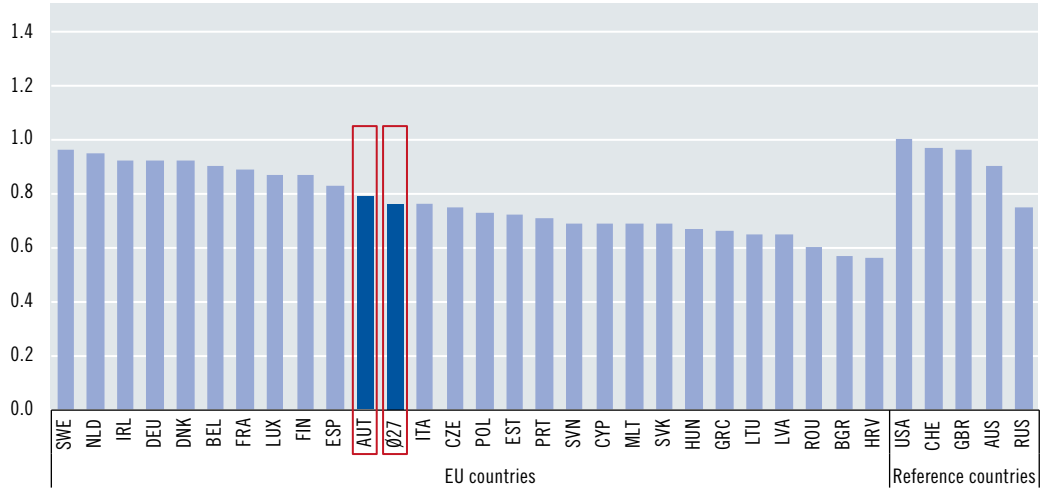
R&D activity: R&D activity is needed not only for the production of frontier technologies, but also for their adoption and adaptation, as these technologies often require adjustment and modification for local use. R&D activity is measured using the number of scientific publications and registered patents filed in the field of frontier technologies.

Industry activity: This building block captures ongoing activities in an industry related to the use, adoption and adaptation of frontier technologies. It considers three sectors that are early adopters: manufacturing, with high-tech manufacturing as the front-runner; finance; and ICT, which generally tends to interact with other technologies. The indicators used are export data on high-technology manufactures as well as on digitally deliverable services.

Access to finance: This building block assesses the availability of finance to the private sector. Better access to finance can accelerate the use, adoption and adaptation of frontier technologies. For this purpose, domestic credit to the private sector as a percentage of GDP is recorded. This indicator measures resources provided by financial corporations such as finance and leasing companies, money lenders, insurance companies, pension funds and foreign exchange companies.

In the overall assessment of the Readiness for Frontier Technologies Index 2021 (Fig. 2-22), Austria ranks in the upper midfield in the EU coun-

Fig. 2-22: Readiness for Frontier Technologies Index, 2021



Source: United Nations (2021). Graphic: iit.

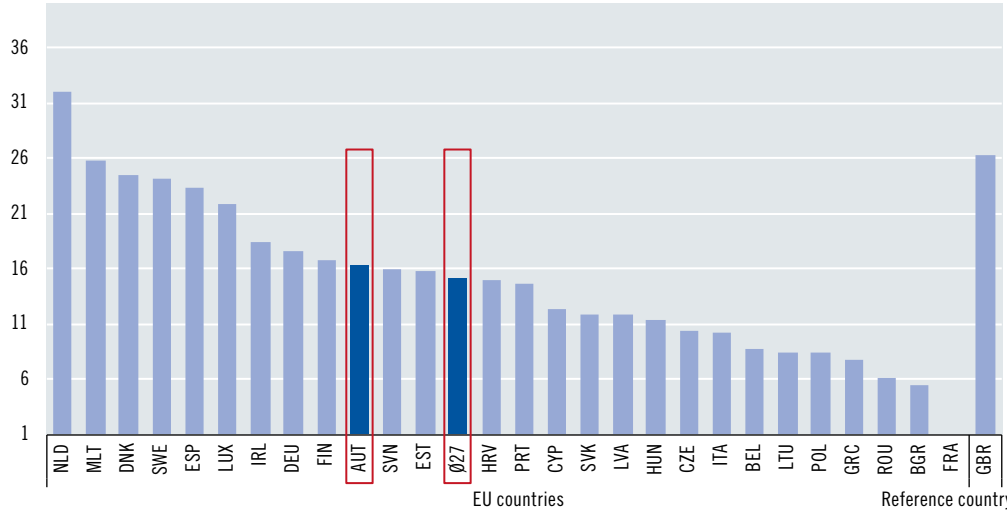
try comparison, at the 11th place. The leading EU countries are (here again) Sweden, the Netherlands and Ireland. In the global country comparison, Austria ranks in the leading group, at position 22 (out of 158 countries). The front runners are the USA, Switzerland, the United Kingdom and Sweden. A differentiated examination of four indices shows that Austria performs best in R&D activity (9th place) and access to finance (12th place). There is room for improvement in ICT deployment (16th place) and skills (17th place).

Internet of Things (IoT)

After the convergence of landline and mobile phone networks and of telecommunications and radio, the Internet of Things represents the next step in the alignment process between ICT, the economy and society. This convergence has the potential to support further important innovations and to contribute to economic growth and social prosperity. The United Nations expects market growth for this economic sector from 130 billion dollars in 2018 to 1.5 trillion dollars in 2025.[108]

The extent to which the IoT is used by the wider population is shown in the country comparison in Fig. 2-23. This shows the average percentage of the population using IoT items in everyday life across the following six areas[109]: (i) internet-connected thermostats, electricity meters, lights, power sockets or other internet-connected systems for home energy management, (ii) internet-connected burglar alarm systems, smoke alarms, security cameras, door locks or other internet-connected home security systems, (iii) internet-connected household devices such as robot vacuum cleaners, fridges, ovens, coffee machines, (iv) virtual assistants in the form of a smart

Fig. 2-23: Use of Internet of Things in the population, 2020



Note: No data are available for France.

Source: Eurostat (2021a). Graphic: iit.

108 United Nations (2021); for Europe, Germany and Austria statista anticipates a market volume in 2027 of 6.70 billion, 1.776 billion and 0.166 billion euros respectively: https://de.statista.com/outlook/tmo/internet-der-dinge/europa; https://de.statista.com/outlook/tmo/internet-der-dinge/deutschland; https://de.statista.com/outlook/tmo/internet-der-dinge/oesterreich

109 In addition to the six areas mentioned in the text, survey respondents were also asked about the use of IoT in the following areas: internet-connected home audio systems and smart speakers; use of the internet on a smart TV, games console, home audio system or smart speaker; use of a smart watch, fitness armband, security tracker, internet-connected smart glasses or headphones, accessories, clothing or shoes; internet-connected devices for monitoring blood pressure, blood sugar, body weight or other internet-connected devices for health monitoring and care; internet-connected toys, e.g. robot toys (including educational toys) or smart dolls; use of a car with built-in wireless internet link.

speaker or app, (v) internet content via internet-enabled TV at home for private purposes, (vi) internet via a games console with internet connection.[110] For each area Eurostat gives the percentage of the population that uses the respective segment of the IoT. The values in Fig. 2-23 are the arithmetic mean of all six percentages.

Overall, it is clear that the Internet of Things has not yet arrived nationwide for the end consumers. The EU average figure of approximately 15.2% clearly illustrates the potential for market growth in Europe. In the country comparison, the leaders are the Netherlands (32%), the United Kingdom (26.3%) and Malta (25.8%). Austria is in the upper mid-range with 16.3% (tenth place in the EU-27), just above the EU average. In Austria there is so far little use of the IoT in the areas of home energy management, home security systems and internet-connected household devices (between 4–5%). The highest figures are for internet-enabled television sets (46%) and games consoles (21%).

The reasons for this low diffusion of IoT in Austria are partly security concerns and the perceived minimal advantage of IoT products. 53% of the population in Austria see no need to use IoT devices or systems, and 31% have concerns with regard to privacy and the protection of personal data that are collected when using these devices or systems.[111]

Artificial intelligence (AI)

Artificial intelligence:
- **The proportion of companies with at least one form of AI is below the EU-27 average (22nd place).**
- **Scientific output (publications) in the field of AI is in the upper mid-range (eighth place).**

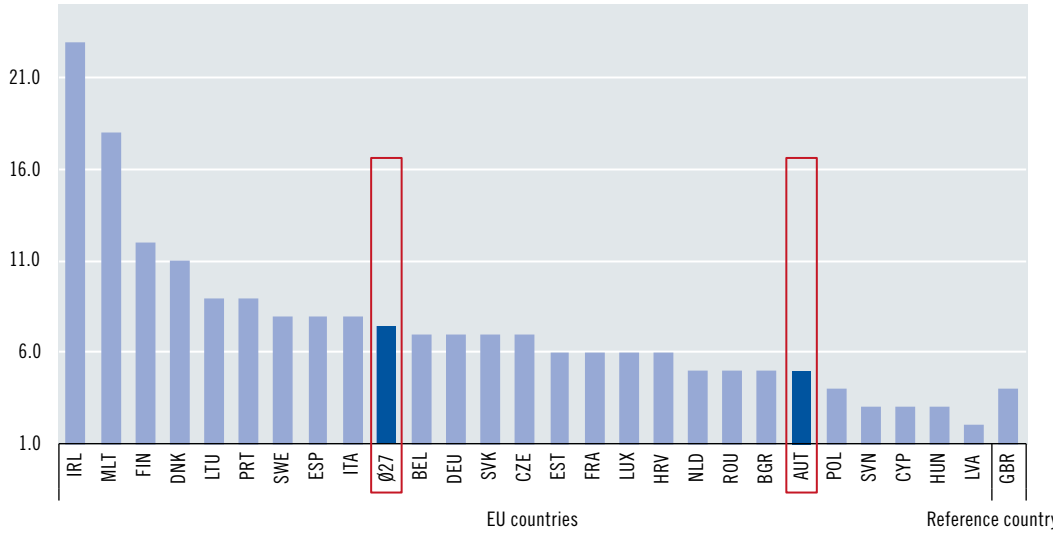
The term artificial intelligence (AI) describes machines that are able to carry out human-like cognitive processes such as learning, understanding, interacting and reasoning. AI is regarded as an important driver for increasing productivity and economic growth, as tasks are completed with greater efficiency, and decision-making processes are significantly improved by analysing large volumes of data. AI also has the potential to generate new markets and industries through the development of new products and services.[112] In recent years AI has been a leading factor in setting new trends in technology, and this is expected to be the case in the coming years too.[113] The use of AI in the business enterprise sector, and innovation capability in this area, can therefore be referenced as indicators for the future performance and competitiveness of a country.

Fig. 2-24 shows the proportion of companies using at least one of the following AI applications in 2020: (i) chat services which use a chatbot or virtual agent to respond to customers, (ii) internal analysis of big data using machine learning (e.g. deep learning), (iii) internal analysis of big data using natural language processing, natural language production or speech recognition, and (iv) use of service robots (e.g. for monitoring, cleaning, transport). The figures represent all companies (without the finance sector) with ten or more employees. Altogether, the proportion of companies using at least one form of AI is still very low for the whole EU, with an average of 7.6%. In Austria only about 5% of firms use at least one form of AI. This places Austria below the EU-27 average, in 22nd place. Ireland is well ahead of the rest of the EU-27, with a percentage over four times that of Austria, followed by Malta (18%), Finland (12%) and Denmark (11%).

Scientific citable publications are an indicator of a country's research activities in the field of AI.

110 See Eurostat (2021b).
111 See Eurostat (2021c).
112 See Szczepanski (2019).
113 See World Economic Forum (WEF) (2019).

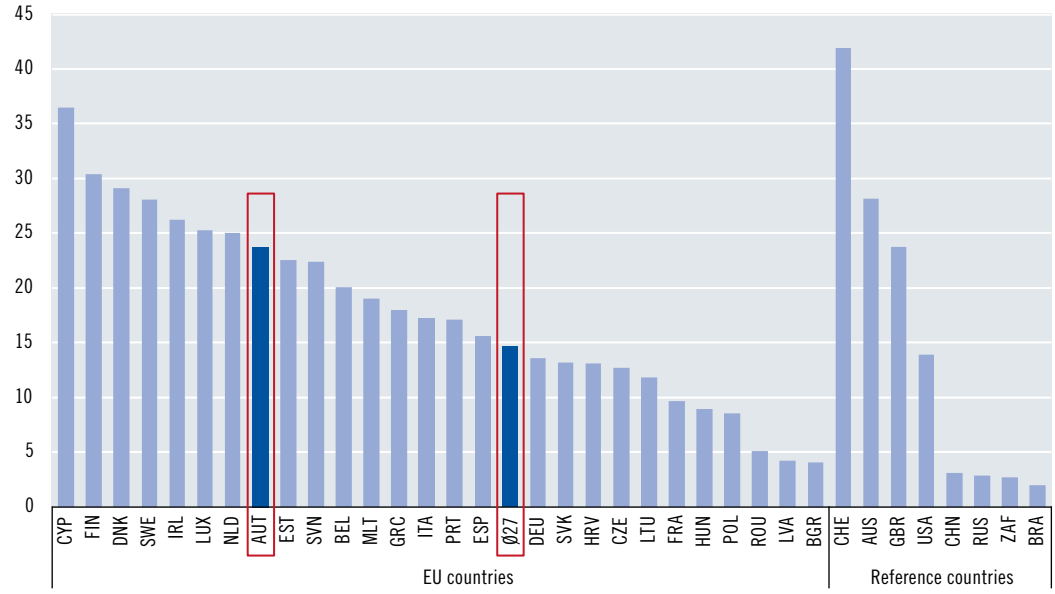
Fig. 2-24: Percentage of companies with at least one form of AI in use, 2021



Note: No data are available for Greece.

Source: Eurostat (2021a). Graphic: iit.

Fig. 2-25: Number of scientific publications in the field of AI per 1 million inhabitants, 2020



Source: Scopus (2021). Graphic: iit.

Fig. 2-25 shows the results of a bibliometric analysis based on the Scopus[114] publications database.

A Scopus search identified all publications in the year 2020 with the keywords AI and artificial intelligence that were released as an academic article, review, book, book chapter, note, short survey or letter. The results show that Austria's position amongst EU countries is better with regard to AI research than for the use of AI in everyday business activities. With around 24 publications per one million inhabitants,

114 See Scopus (2021).

Austria ranks eighth, in the upper mid-range, ahead of recognised research countries like Germany, the United Kingdom or the USA. The leading country is Cyprus, followed by the Scandinavian countries. In the global country comparison, Switzerland is in the lead by far, with around 42 publications per one million inhabitants.[115]

Quantum technology

Quantum technology
Austria is one of the leaders in
- **patent registrations (second place) and**
- **scientific publications (third place)**

The field of quantum technology has so far been characterised as being the preserve of academic research. In the last five to ten years, however, there has been a growing number of endeavours and initiatives to advance quantum technology to the point where it can be used to help develop new products and thus to contribute to economic growth.[116] For this purpose, in 2018 the European Commission launched the Quantum Flagship programme, with a funding volume of 1 billion euros and a ten-year duration.[117] One of the best-known developments of quantum research is quantum computers, which are capable of carrying out quantum calculations. Quantum calculations are one of the most wide-ranging and demanding quantum technologies. Using quantum bits (which can accept the conditions zero and one simultaneously) and instantaneous correlations throughout the entire quantum computer, a large number of calculations can be carried out simultaneously; this grows exponentially with the number of quantum bits. This enables problems to be solved which today's most powerful high performance supercomputers would never be able to manage.[118] In addition to this, developments and innovation in the field of quantum technology may provide a boost for innovations in other frontier technologies, such as AI or autonomous driving.

The innovation capability and performance of a country in the area of quantum technology is quantified by analysing patents and bibliometric data. For the patent analysis, Cooperative Patent Classification Codes (CPC codes) and keywords are used to filter the patents registered with the European Patent Office[119]. For these analyses, CPC codes and keywords from four different areas of quantum research are used[120]: Quantum Computing, Quantum Key Distribution, Entanglement and Cold Atom Interferometry.[121]

Fig. 2-26 shows the number of patents across all four areas of quantum research per 10,000 R&D employees (measured as full time equivalents, or FTE). Since patent applications are generally published 18 months after the date of application to the European Patent Office, the year 2019 was used for the patents analysis. Austria is one of the leaders here, with a score almost three times the EU-27 average, behind Ireland and ahead of the United Kingdom. In the international ranking, Austria is behind Ireland, China and Switzerland.[122]

115 Cyprus leads the rankings here because the country has a small number of inhabitants, combined with the fact that the University of Nicosia has specialised heavily in research into future technologies. Amongst other things, it has established the Institute for the Future (Iff) which focuses on three major areas of research and study: extended and virtual reality, artificial intelligence and blockchain/cryptocurrency technologies (see https://www.timeshighereducation.com/cn/world-university-rankings/university-nicosia).

116 See Travagnin (2019).

117 See European Commission (2021h).

118 See European Commission (2021h).

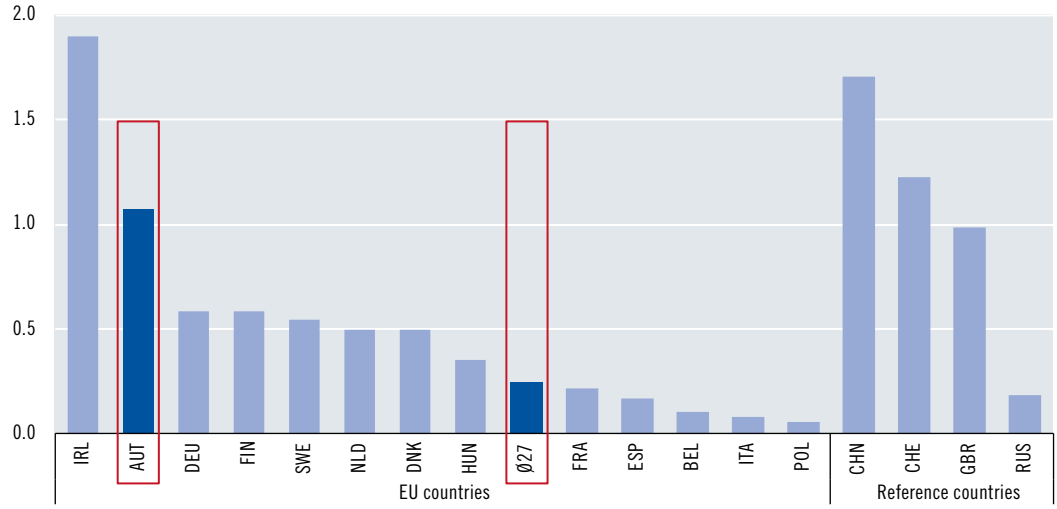
119 See European Patent Office (2021).

120 The CPC codes used for the patents analysis and the keywords used for the bibliometric analysis are based on the analysis carried out by the Joint Research Center (see Travagnin, 2019).

121 See European Commission (2021h).

122 With 488 patents, the USA has the second-highest absolute score, behind China. However, as there are no data available on the number of R&D employees in the USA, no standardisation was possible.

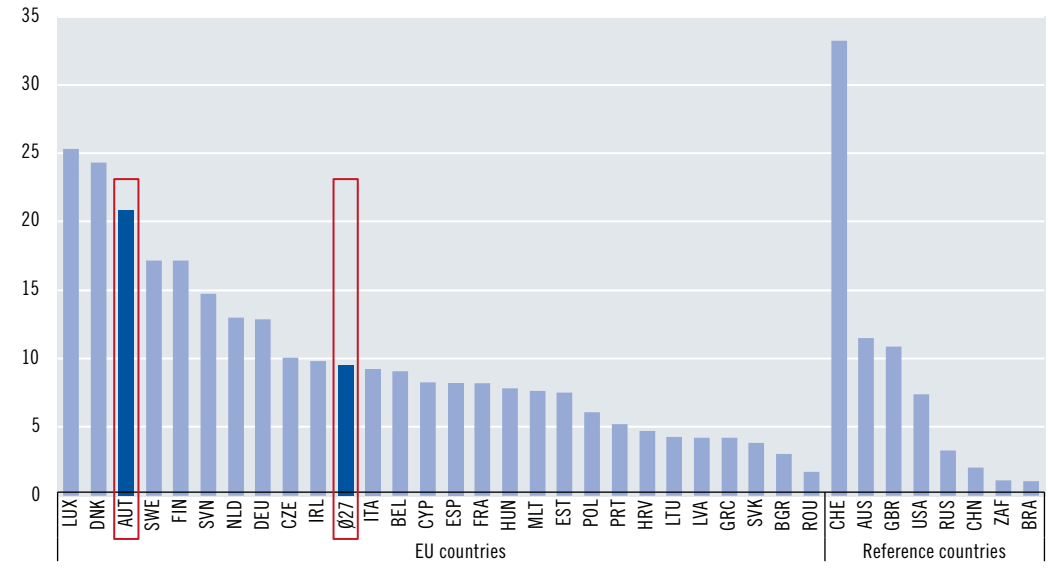
Fig. 2-26: Patents in the field of quantum technology per 10,000 R&D employees, 2019



Note: Bulgaria, Malta, Croatia, Cyprus, Greece, Romania, Luxembourg, Slovakia, Slovenia, Lithuania, Czechia, Estonia, Portugal, Latvia, Brazil and South Africa did not submit any patents in 2019. The value of patents for the United States and Australia could not be standardised due to a lack of R&D staff figures.

Source: European Patent Office (2021). Graphic: iit.

Fig. 2-27: Number of scientific publications in the field of quantum research per 1 million inhabitants, 2020



Source: Scopus (2021). Graphic: iit.

Another area where Austria plays a leading role is in the number of scientific publications in the field of quantum research. Fig. 2-27 shows the results of a bibliometric analysis for 2020, carried out with help of the publications database Scopus. It includes publications that were issued as scientific article, review, book, book chapter, note, short survey or letter.[123] Here Austria ranks third, with approximately

123 See Scopus (2021). The keywords used were: qbit; qbits; qubit; qubits; quantum computer; quantum computers; quantum computation; quantum computations; quantum memory; quantum memories; quantum error correction; quantum simulation; quantum simulations; quantum key distribution; qkd; quantum cryptography; photon; photons; photonic; entangled; or entanglement; entangling; entangle; cold atom; atom; atoms; atomic; interferometer; interferometry.

20 publications per one million inhabitants, behind Luxembourg and Denmark. This score is more than twice the EU average. In the global country comparison, Switzerland is the only other country to score higher than Austria, which means Austria is still ahead of major research nations such as the USA.

2.2.3 Austria's innovation capability

The basic prerequisite for the development of new innovative products and services is a country's innovation capability. To assess it, the methodology of the Innovation Capability Indicator of the Institute for Innovation and Technology (iit) is used.[124] In contrast to the global innovation indices GII and EIS presented above, the iit indicator isolates innovation capability from innovation performance (e.g. patents). The iit Innovation Capability Indicator defines the capability for innovation as the ability to generate new content and to translate it into products, processes and services which can compete on the market. Both existing knowledge (human capital) and the ability to combine different types of knowledge capital are taken into account in the indicator. The iit Innovation Capability Indicator covers four subject areas or pillars:

- **Human capital:** The knowledge of individuals, particularly working people
- **Complexity capital:** The diversity of useful knowledge which makes it possible to produce complex products
- **Structural capital:** The ability to consolidate knowledge within a business enterprise
- **Relationship capital:** The ability to consolidate knowledge beyond organisational borders

In contrast to the Austrian Research and Technology Report 2021, structural capital is not addressed this year, as the data from the European Work Condition Survey (EWCS)[125] originally planned for 2020 is not available due to COVID-19. The EWCS is surveyed every five years and enables an EU comparison of structural capital by analysing learning and creativity of work structures in companies and administrations. In the Research and Technology Report 2021, two indicators from the WEF's Executive Opinion Survey were temporarily used. Since no new data is available for these indicators either, they are not taken into account here.

Human capital

Talents

- ***IMD World Talent Ranking*: Fourth place in EU comparison (no change)**
- **The share of 25-64 year olds with a tertiary education is below the EU average.**
- **Second highest share of STEM graduates in the EU**
- **Above average share of 25-64 year olds with participation in training (ninth place)**

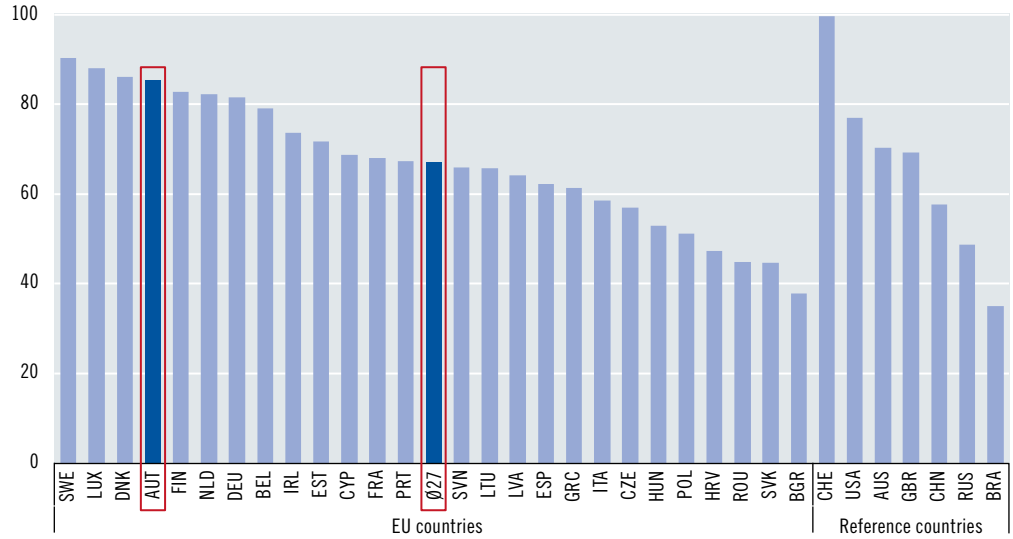
A country's human capital is closely linked to its research performance and innovation capability, i.e. the more human capital there is, the greater the potential to create relevant research and far-reaching innovations. Human capital is defined as the total stock of knowledge and skills in the population that can be used in the value creation process. This includes formal educational and training qualifications as well as informal knowledge and skills.

The state of Austria's human capital in the EU country comparison is considered on the basis of four indicators: i) the IMD World Talent Ranking (WTR), ii) the percentage of 25-64 year olds with a tertiary degree, iii) the percentage of graduates in STEM subjects and iv) the percentage of 25-64 year olds with participation in training.

Fig. 2-28 presents the IMD World Talent Ranking (WTR) for the year 2021.[126] The WTR quantifies the status and development of the competencies neces-

124 See Hartmann et al. (2014).
125 See Eurofound (2021).
126 See IMD World Competitiveness Center (2021).

Fig. 2-28: IMD World Talent Ranking, 2021



Note: No data are available for Malta.

Source: IMD World Competitiveness Center (2021). Graphic: iit.

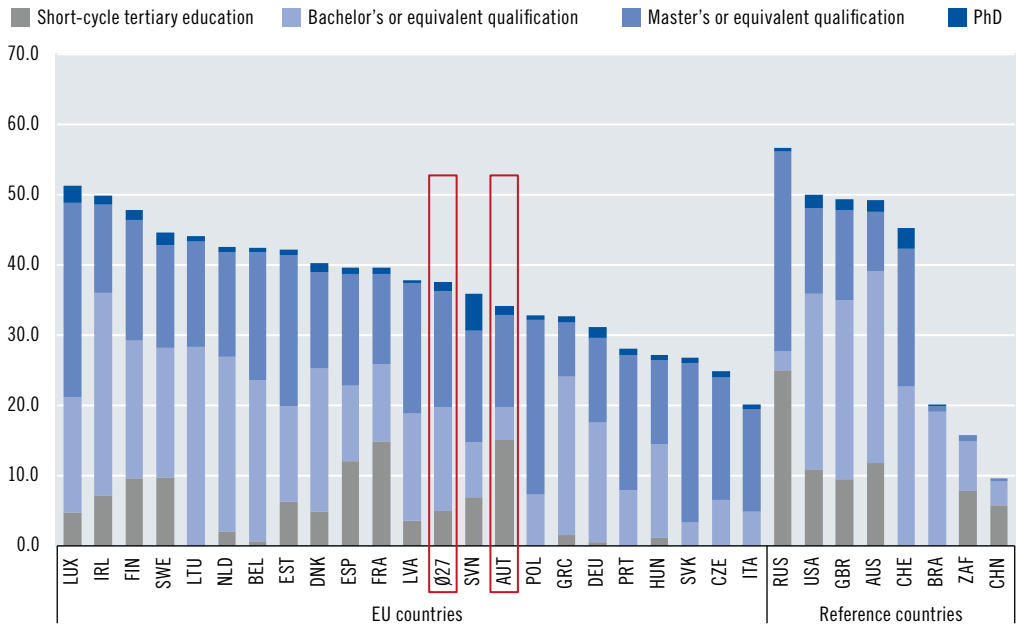
sary for enterprises and the economy to achieve long-term value creation. For this, indicators from three main factors[127] are used to measure the development, retention and recruitment of highly skilled workers at home and abroad. The special characteristic of the WTR is that not only "hard" data (e.g. public expenditure on education) but also "soft" factors play a role, which analyse the perceived quality of education investments (e.g. management training). Austria ranks fourth in the IMD World Talent Ranking in an EU comparison and thus just misses the goal of being among the best top three in the RTI Strategy 2030.[128] This year, Sweden was able to take the top spot in the EU ranking, followed by Luxembourg and Denmark. In a global comparison, Switzerland continues to lead, and Austria remains in sixth place.

The second human capital indicator shows that the overall participation in tertiary education in Austria could be increased from 33.8% in 2019 to 34.2% in 2020. This increase results from a higher share of bachelor's and master's degrees. The share of PhDs remains unchanged at 1.2% and the share of short-term tertiary education decreased by 0.3 percentage points. Despite the increase in tertiary degrees, Austria was overtaken by Slovenia in the EU-27 country comparison (Fig. 2-29) and ranks 14th, below the EU average (EU-27: 37.6%). However, the comparison of Austria with other EU countries is only meaningful to a limited extent, as structural differences in the education system contribute to the fact that a comparatively low share of the population has a tertiary degree. In Austria, as in Germany and Switzerland, dual education systems play a central role in training skilled workers, and this takes place outside the academic system. In comparison with these two countries, Austria is three percentage points ahead of Germany, but clearly behind Switzerland (45.3%). Differentiated by degrees, there are major distinctions between Austria and Germany. While the share of PhDs and the share of master's degrees are still comparable, Austria records a high share of short-cycle tertiary education (15.2%). This share is almost zero in Germany (0.6%). Consequently, the share of

127 Investment in and development of domestic talent, attractiveness for foreign talent and availability of skills and competences in the talent pool.

128 See Federal Government of the Republic of Austria (2020b, 7).

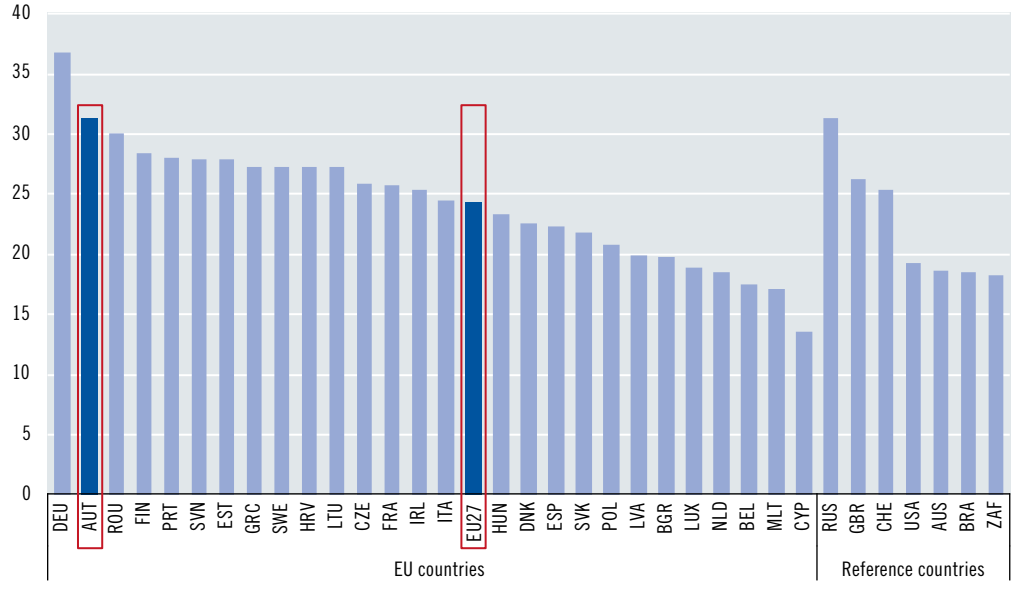
Fig. 2-29: Percentage of 25-64 year-olds with tertiary education, 2020



Note: The most recent figures available were used for Denmark (2019), Brazil (2018), Russia (2018) and China (2010). No data are available for Bulgaria, Cyprus, Croatia, Malta and Romania.

Source: OECD (2021a). Graphic: iit.

Fig. 2-30: Proportion of graduates in STEM subjects, 2019



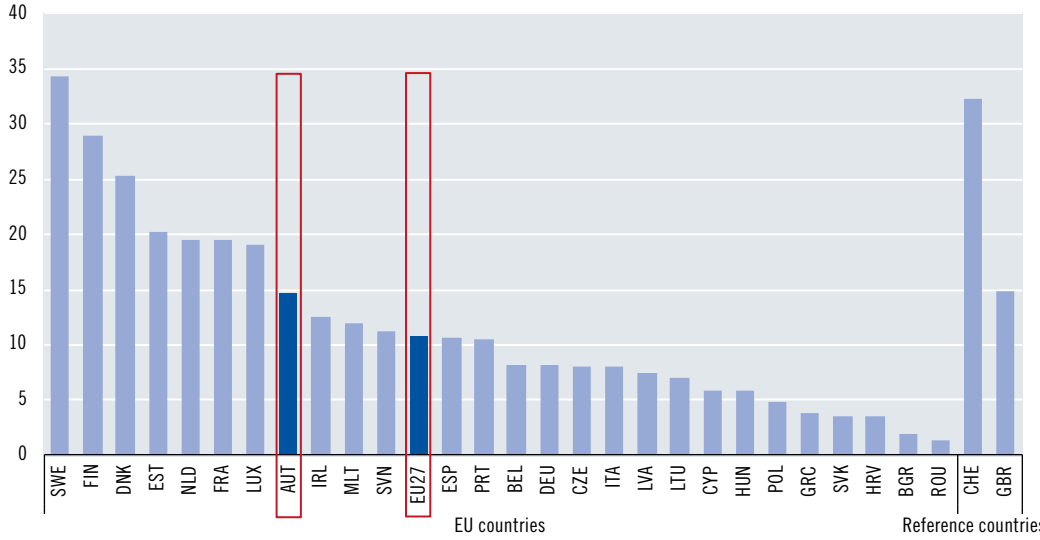
Note: The values for Spain are from 2018. No data are available for China.

Source: UNESCO (2021). Graphic: iit.

bachelor's degrees in Austria is distinctly lower than that of Germany (4.5% vs. 17.0%).

A different picture emerges for graduates in STEM subjects. In the course of the ongoing digital transformation in all areas of the economy and society, this indicator is of importance, based on the assumption that a high value is associated with a high technology-based innovation potential. As Fig. 2-30 illus-

Fig. 2-31: Percentage of 25–64 year-olds taking part in training in 2021



Note: No data are available for Brazil, China, Russia, the USA, Australia and South Africa.
Source: European Commission (2021i). Graphic: iit.

trates, Austria ranks second behind Germany (36.8%) with 31.4% STEM graduates. In fact, this high value promises sustained positive prospects for the country's future innovation capability. Objective 3 of the RTI Strategy 2030 states that the share of STEM graduates should be increased by 20%.[129] Austria was already able to achieve a slight increase in the share of STEM graduates between the years 2018 (31.03%) and 2019 (31.40%), so the development seems to be going in the right direction.

Another indicator of human capital is the percentage of 25-64 year olds participating in training (Fig. 2-31). In view of the digital transformation in the economy and society already mentioned above and also the trend towards longer employment biographies, the willingness to engage in lifelong learning is becoming increasingly important. Consequently, the importance of formal, non-formal and informal training is also growing. Here, Austria is above the EU average in the top 10 and ahead of large nations such as Germany. The leading countries here are again the Scandinavian countries Sweden, Finland and Denmark, which, with values between 34.3% and 25.3%, are clearly above the Austrian value (14.7%).

Complexity capital

Complexity capital

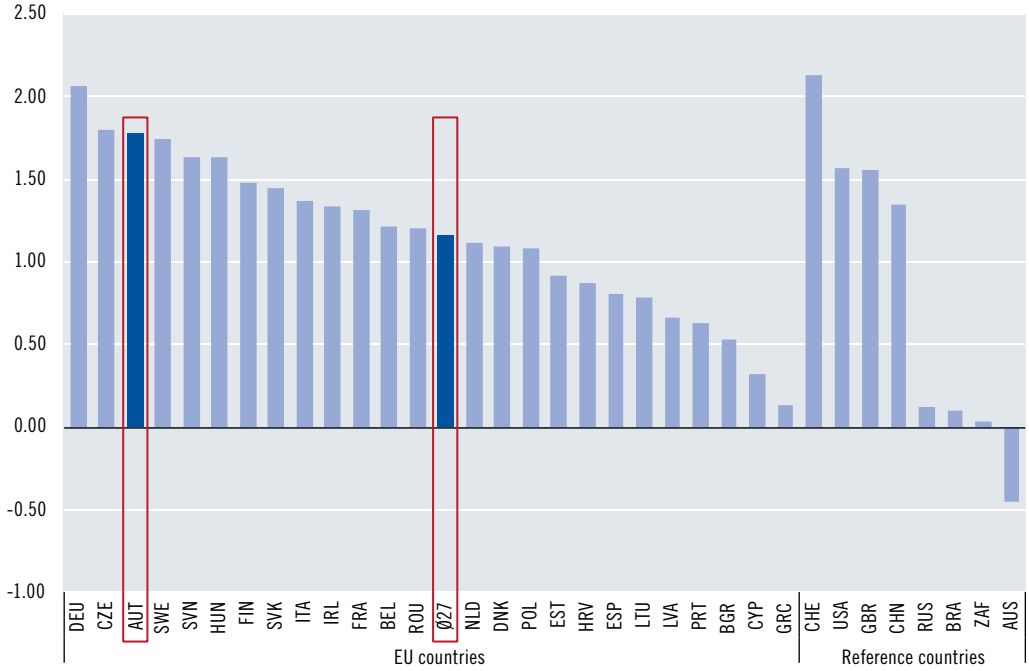
- **The economy in Austria is characterised by a very high level of complexity (rank three).**
- **Slight deterioration by one position compared to the previous year in the Economic Complexity Index (ECI)**

Countries with high complexity have a range of highly developed, specialised skills at their disposal and are therefore in a position to produce a highly diversified set of complex products. Alongside human capital, complexity capital is thus another indicator of a country's innovation capability.

Complexity capital is subsequently measured by the Economic Complexity Index (ECI).[130] By means of this index, not only the absolute number of prod-

129 See Federal Government of the Republic of Austria (2020b, 7).
130 See The Growth Lab at Harvard University (2021).

Fig. 2-32: Economic complexity, 2019



Note: No data available for Luxembourg or Malta.

Source: The Growth Lab at Harvard University (2021). Graphic: iit.

ucts manufactured in and exported by the country is considered, but also in particular how complex and diverse these products are. If the number of complex products in the total export volume of a country increases, the value of economic complexity also increases. On the other hand, the value decreases if the number of countries that also export this product increases. The ECI analysis is based on export data and is standardised to values between -2.5 and +2.5.

Fig. 2-32 shows the economic complexity in a country comparison for the year 2019. As in previous years, the economy in Austria is characterised by a very high level of complexity.[131] In the EU country comparison, Austria ranks third behind Germany and Czechia. Austria lost the second rank from the previous year to Czechia, as its index value fell from 1.80 to 1.77, while Czechia was able to keep its index value almost constant (-0.0005). Germany, the leader, also has a lower value than in the previous year, although the loss is not as severe as for Austria (2018: 2.09 and 2019: 2.07). In a global country comparison, Austria is behind Switzerland (2.13), but ahead of the large national economies USA (1.57) and China (1.35).

131 Mechanical engineering products – including machinery for processing rubber and plastics as well as calendering and other rolling machinery –, measuring instruments, serums and vaccines as well as automobiles and vehicle parts, are products with a high degree of complexity that account for a relatively high share in Austria's exported goods in 2019. In the export of composite materials made of ceramics and metals (cermets), products with a particularly high complexity value but not very high trade volumes, Austria holds a very high market share (second rank behind Germany). See https://atlas.cid.harvard.edu, https://comtrade.un.org.

Relationship capital

Relationship capital

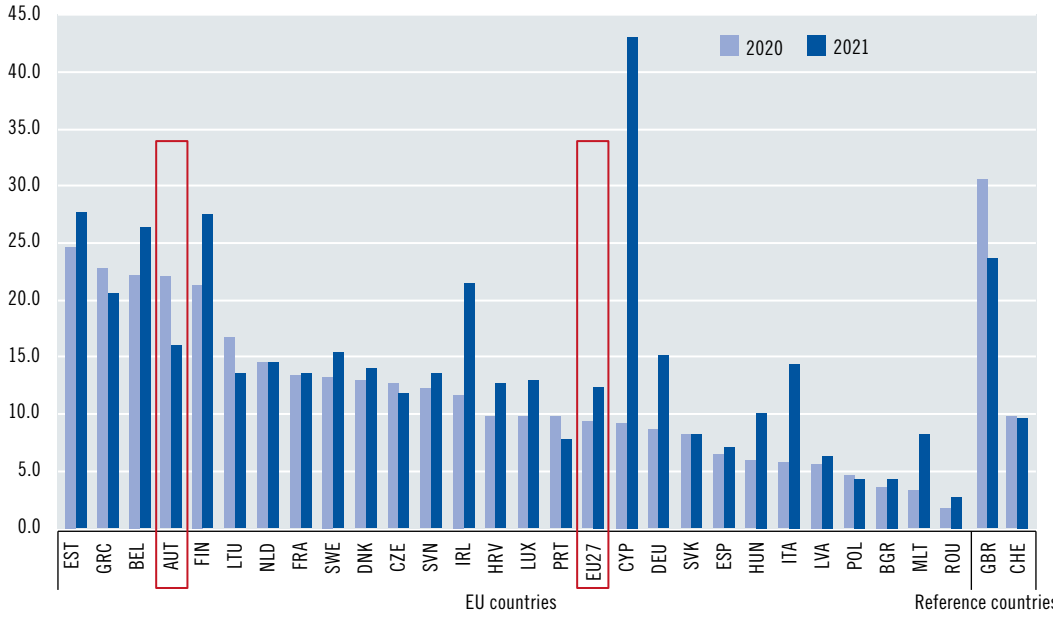
- **High number of collaborations between SMEs and other companies; Austria ranks fourth.**
- **Very good ranking in joint publications by public and private partners; Austria is ranked third.**
- **Average amount of job mobility of employees in science and technology**

Exchange and cooperation with external partners are decisive factors in the innovation process. A good network of business enterprises with other companies or higher education institutions and other research institutions can increase research efficiency and accelerate the development time of new or improved products (technologies).

In order to map Austria's relationship capital and to be able to compare it with the relationship capital of other EU countries, the following indicators are discussed in more detail: i) the number of small and medium-sized enterprises (SMEs) with cooperative relationships via innovation activities with other companies or institutions, ii) the number of cooperative public-private research publications with domestic and foreign participation, and iii) the job mobility of employees in science and technology.

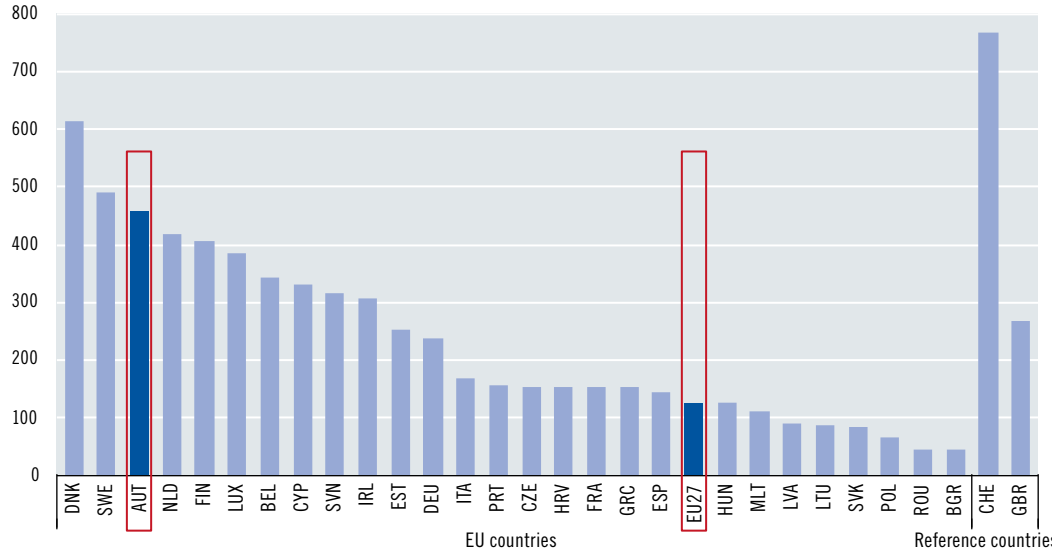
Fig. 2-33 shows the answers to the question to what extent innovating small and medium-sized enterprises collaborate with other partners in the innovation process. This indicator measures the extent to which SMEs are involved in innovation cooperation. Complex innovations, especially in the ICT sector, often depend on the ability to draw on various sources of information and knowledge and to collaborate in the development of an innovation. This indicator measures the flow of knowledge between public research institutions and enterprises as well as be-

Fig. 2-33: Collaboration by SMEs with partners in the innovation process, 2020 and 2021



Note: No data are available for Brazil, China, Russia, the USA, Australia and South Africa.
Source: European Commission (2021c). Graphic: iit.

Fig. 2-34: Joint publications by public and private partners per 1 million inhabitants, 2021



Note: No data are available for Brazil, China, Russia, the USA, Australia and South Africa.
Source: European Commission (2021c). Graphic: iit.

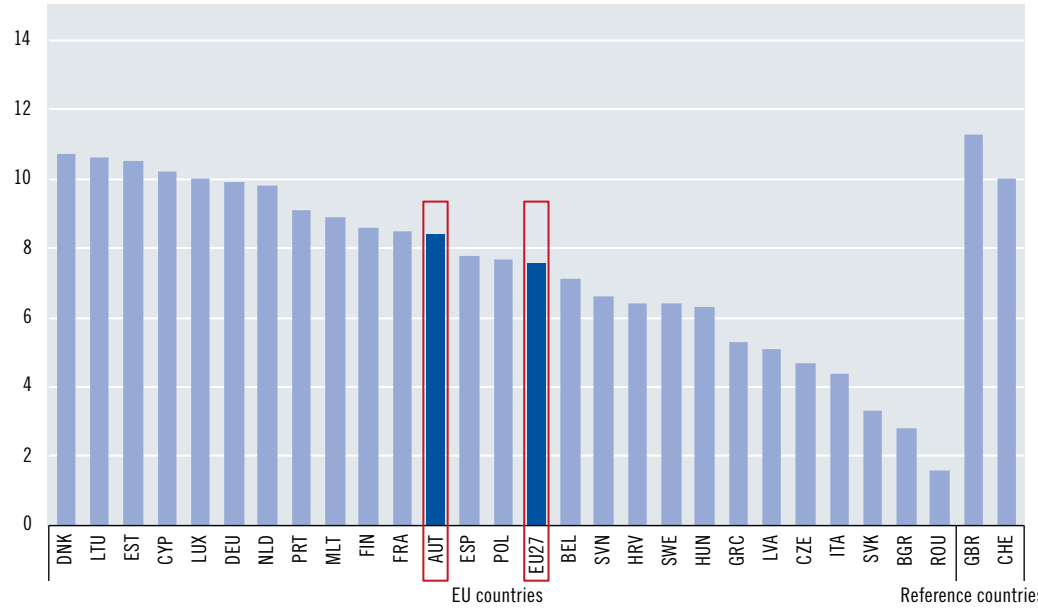
tween enterprises. The indicator is limited to SMEs, as almost all large enterprises are already involved in innovation collaboration.[132] Austria ranks fourth in 2020, ahead of large nations such as Germany and France and above the EU average.[133] If the data for 2021 are used as a basis, Austria takes seventh place. In some cases, there are considerable changes between 2020 and 2021 in the values for individual countries (e.g. Cyprus). It is unclear to what extent these differences are caused by changes in the Community Innovation Survey, on which this indicator is based, and what impact the COVID-19 pandemic has had on data quality.

The number of joint publications by public and private partners is shown in Fig. 2-34 and is standardised with the country population (per million inhabitants). With a value almost twice as high as the EU average, Austria is in third place behind Denmark and Sweden.

The indicator was adapted this year, so that comparability with the values in the Research and Technology Report 2021 is no longer given. Prior to the adaptation of the indicator, the number of public-private research publications was measured, where the publications are attributed to the country/countries in which the companies or other private-sector organisations are located. In the course of adapting the indicator, a broader definition was used and it now also includes those public-private research publications with co-authorship where the publications are attributed to the country/countries in which the public sector organisations are located. Thus, co-publications between domestic public sector organisations and foreign business enterprises are also included.[134] Despite the adaptation of the indicator, Austria was able to maintain its third place as reported in the Research and Technology Report 2021.

132 See European Commission (2021c).
133 This indicator is based on data from the Community Innovation Survey. It is conducted every two years (see https://ec.europa.eu/eurostat/web/microdata/community-innovation-survey). For this reason, the indicator values shown in the EIS are identical for the years 2019 and 2020.
134 See European Commission (2021c).

Fig. 2-35: Job mobility of employees in science and technology, 2021



Note: No data are available for Ireland, Australia, Brazil, China, Russia, USA and South Africa.
Source: European Commission (2021c). Graphic: iit.

Fig. 2-35 compares the job mobility of employees in science and technology in Europe. This indicator measures the movement of people between one job and another from one year to the next.[135] Employees in science and technology include people who either have a tertiary education or are employed in a scientific or technical profession for which a tertiary education is normally required. The quantitative consideration of labour market mobility is based on the assumption that an exchange of knowledge results from people moving from one job to another. Not every change of job creates or disseminates knowledge. However, it can be assumed that higher job mobility goes hand in hand with a higher probability of knowledge creation and dissemination. In this respect, Austria ranks in the mid-range of the EU-27 countries in 12th place, just above the EU average.

Circular economy and resilience

Circular economy and resilience

Circular economy:

- **Average private investment, jobs and gross value added in connection with circular economy sectors**

Resilience:

- **"Medium-high" resilience capacities and "medium-low" resilience vulnerabilities in the social and economic area**
- **"Green resilience": highest resilience capacities in the EU, but also medium-high resilience vulnerabilities**
- **"Medium-high" digital resilience capacities and medium-low digital resilience vulnerabilities**
- **Geopolitical resilience: medium resilience capacity and medium resilience vulnerabilities**

Austria's innovation capability in the circular economy and Austria's resilience capacities and vulnerabil-

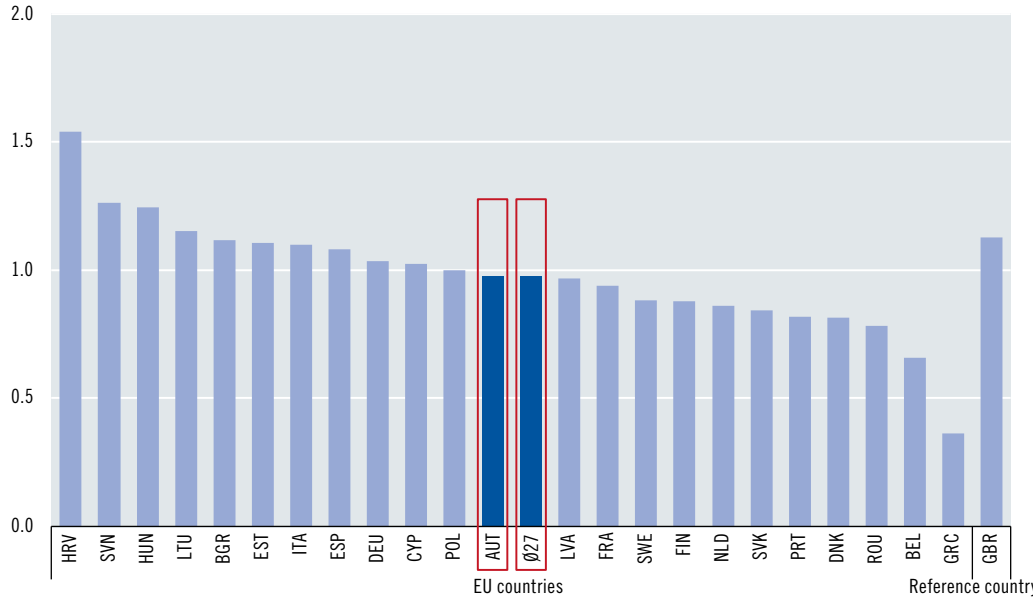
135 Access to the labour market from unemployment or inactivity is not included.

ities are presented below. Innovations in the circular economy are, in fact, positively associated with the turnover and employment growth of companies, and companies with circular economy innovations show a significantly better financial situation than companies without circular economy innovations.[136] Regarding a country's resilience, empirical analyses point to a positive relationship between research and innovation performance and crisis resilience.[137]

Circular economy

In the course of climate change and the effort to reduce CO_2 emissions, the predominantly prevailing linear economic model is increasingly being critically discussed. In the context of the European Green Deal[138], the European Commission is therefore striving for a transformation from a linear to a circular economy with the "Circular Economy Action Plan". By 2050, a carbon-neutral, environmentally sustainable, toxin-free and fully circular economy is to be achieved, including stricter recycling rules and binding targets for the use and consumption of materials.[139] Consequently, for the successful transition to a full circular economy, new innovative business models need to be developed and new technologies introduced in almost all areas. In this context, we must work in particular towards fulfilling Sustainable Development Goals (SDG) 9, "Industry, Innovation and Infrastructure", and SDG 12, "Responsible Consumption and Production". Austria's prerequisites for establishing a circular economy are presented below using an indicator that includes gross investments in tangible assets, the number of employees and gross value added at factor cost in three circular economy sectors. These are the recycling sector, the repair and reuse sector and the rental and leasing sector. Fig. 2-36 shows that the

Fig. 2-36: Private investment, jobs and gross value added in connection with circular economy sectors, standardised with the GDP, 2018



Note: The data for Estonia are from 2016 and for Finland from 2017. No data are available for the Czechia, Luxembourg, Ireland, Malta, Australia, Brazil, China, Russia, USA, Switzerland and South Africa.

Source: Eurostat (2021a). Graphic: iit.

136 See Horbach and Rammer (2020).
137 See Frisenbichler et al. (2020).
138 See European Commission (2021j).
139 See European Parliament (2021).

value of the indicator for Austria in the year 2018 is in line with the EU average, but at the same time also highlights the country's need to make up leeway in this area.

Resilience

The European Commission uses "strategic foresight" in its concepts in order to be able to react better to transformation, such as climate change, digital technologies and geopolitics. For this purpose, the Strategic Foresight Report (SFR) has also been published since 2020.[140] The central theme of the first SFR was resilience in Europe, "as resilience becomes a new compass for EU policymaking".[141] The Joint Research Center of the European Commission accordingly developed a dashboard[142] that measures resilience in four dimensions, namely i) the social and economic dimension, ii) the green dimension, iii) the digital dimension and iv) the geopolitical dimension.

For each dimension, an index of resilience capacities as well as resilience vulnerabilities is produced. The index of resilience capacities quantifies the structural characteristics of a country that help it to manage transitions and cope with future shocks. The index of resilience vulnerabilities measures a country's structural characteristics that can exacerbate the negative impacts of a changing environment (e.g. challenges related to the digital and green transformation of the economy and society). Each indicator shows the relative situation of the respective country in the last available year within the reference distribution, which is composed of the values of the respective indicator for all Member States and all years of the reference period 2007–2017. For example, a high resilience capacity for a country means that the corresponding indicator value is high in a historical comparison across all Member States. When interpreting the indices, it is important to note that they only illustrate the relative and not the overall situation of resilience capacities and vulnerabilities, i.e. countries with the lowest resilience capacity and the highest resilience vulnerabilities may still perform well in absolute terms.[143]

Each index (resilience capacities and resilience vulnerabilities) is composed of 14-17 indicators from various areas. Resilience in the social and economic dimension is the capacity to cope with economic shocks and to achieve long-term structural change in a fair and inclusive way. Indicators in this dimension come from the areas (i) inequalities and social impacts of the transitions, (ii) health, education and work, and (iii) economic and financial stability and sustainability.[144]

Resilience in the green dimension ("green resilience") reflects a country's capabilities to achieve climate neutrality by 2050. The indicators of the index come from the areas (i) climate change mitigation and adaptation, (ii) sustainable use of resources, and (iii) ecosystems, biodiversity and sustainable agriculture.[145]

"Digital resilience" means ensuring that human dignity, freedom, equality, security, democracy and other fundamental European rights and values are preserved and strengthened by the way we live, work, learn, interact and think in this digital age[146]. Indicators of this index come from the four areas (i) digital for personal space, (ii) digital for industry, (iii) digital for public space, and (iv) cybersecurity.[147]

"Geopolitical resilience" finally describes the abili-

140 See European Commission (2021k).
141 See European Commission (2020).
142 See European Commission (2021l).
143 Ibid.
144 Ibid.
145 Ibid.
146 See European Commission (2020, 34).
147 See European Commission (2021l).

ty *for Europe to strengthen its "open strategic autonomy and global leadership role"* [148]. Indicators for this index come from the areas: (i) raw material and energy supply, (ii) value chains and trade, (iii) financial globalisation, and (iv) security and demography.

Figs. 2-37 to 2-40 show resilience capacity and resilience vulnerabilities in the EU country comparison across all four dimensions. A higher value in the capacity index indicates a higher relative resilience capacity, and a higher value in the vulnerability index indicates higher relative resilience vulnerabilities.

For Austria, the social and economic dimensions show high resilience capacities and low resilience vulnerabilities. Together with Germany, Austria ranks sixth in resilience capacities behind the leading Scandinavian countries Sweden, Denmark and Finland. Austria also ranks sixth, together with Czechia and Sweden, in resilience vulnerabilities, ahead of large nations such as Germany and France (first place has the lowest indicator value, i.e. the lowest resilience vulnerabilities).

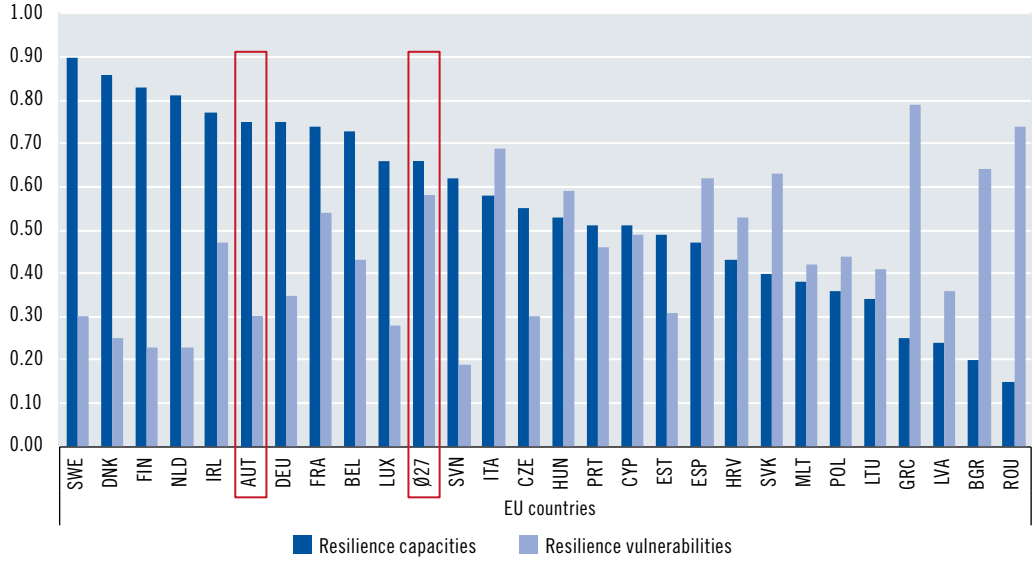
In the green dimension, Austria's position in the EU-27 comparison is very contrasting. On the one hand, the country is the leader in terms of resilience capacities, ahead of Luxembourg, Denmark and Germany. On the other hand, it occupies one of the lowest positions in terms of resilience vulnerabilities (22nd place). This discrepancy in the green dimension is possible because different indicators are used for the two indices. For example, the resilience capacities include the indicators insured losses from climate extremes, CO_2 absorption by forests, energy productivity and national expenditure on environmental protection. The index for resilience vulnerabilities includes, among others, the indicators fatalities from climate extremes, the waste generation rate, fossil fuel subsidies and domestic material consumption per capita.

With regard to resilience in the digital dimension, Austria ranks above the EU-27 average in the indicator for resilience capacities at 13th place (together with Croatia and Portugal). At sixth place (together with Sweden), the country has low resilience vulnerabilities. Finland, Denmark and Estonia occupy top positions in both indicators.

Austria has the greatest need to catch up in the dimension of "geopolitical resilience". Here, the country ranks below the EU-27 average in the midfield for both resilience capacities (11th place) and resilience vulnerabilities (17th place). This index includes several indicators that show how resilient supply chains are in the respective country. These are: supplier concentration in base materials (e.g. iron and aluminium), the concentration of value chain partners, the supplier concentration in energy carriers, the extra-EU import partner concentration (i.e. states outside the EU) and import dependency for energy materials. The importance of resilient supply chains for a national economy has been clearly demonstrated in the last two years by the global supply shortages due to the COVID-19 pandemic. For Austria, the picture of the resilience vulnerabilities of its supply chains is mixed. The resilience vulnerabilities are "medium-low" for the indicators "supplier concentration in base materials" and "concentration of value chain partners", "medium" for the indicators "supplier concentration in energy carriers" and "extra-EU import partner concentration" and "medium-high" for "import dependency for energy materials". For this very reason, initiatives to increase resilience and to (re)locate value chains are of particular concern to the Austrian federal government. Corresponding initiatives – such as the IPCEI, the European Chips Act, the Raw Materials Strategy for Austria, etc. – are actively supported.

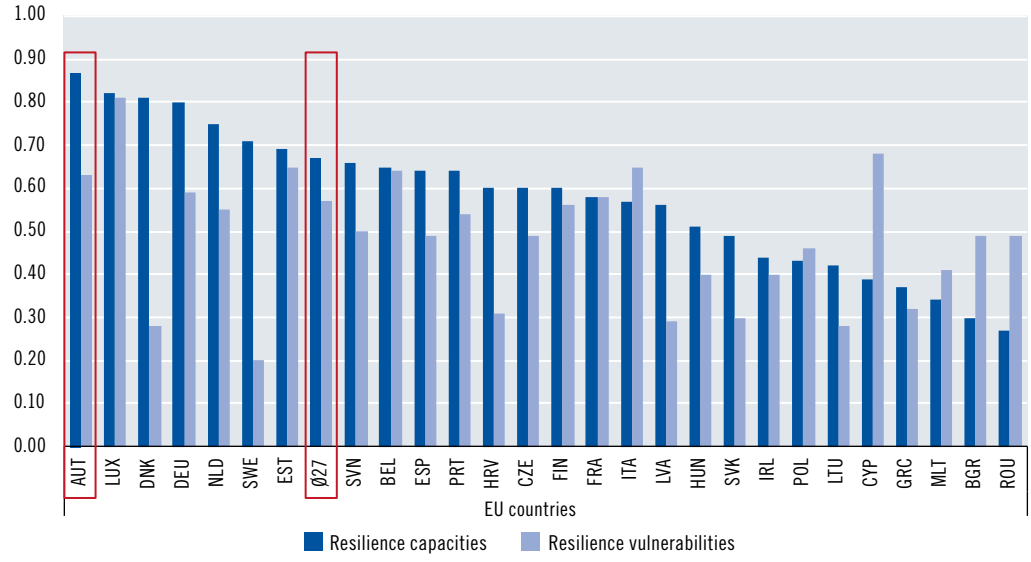
148 See European Commission (2020, 16).

Fig. 2-37: Resilience: social and economic dimension, 2021



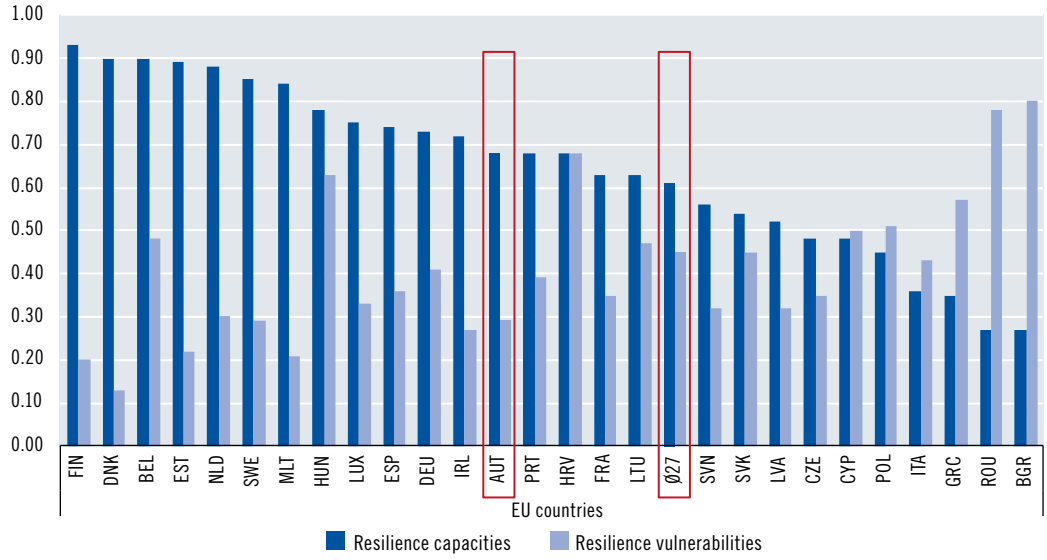
Source: European Commission (2021l). Graphic: iit.

Fig. 2-38: Resilience: green dimension, 2021



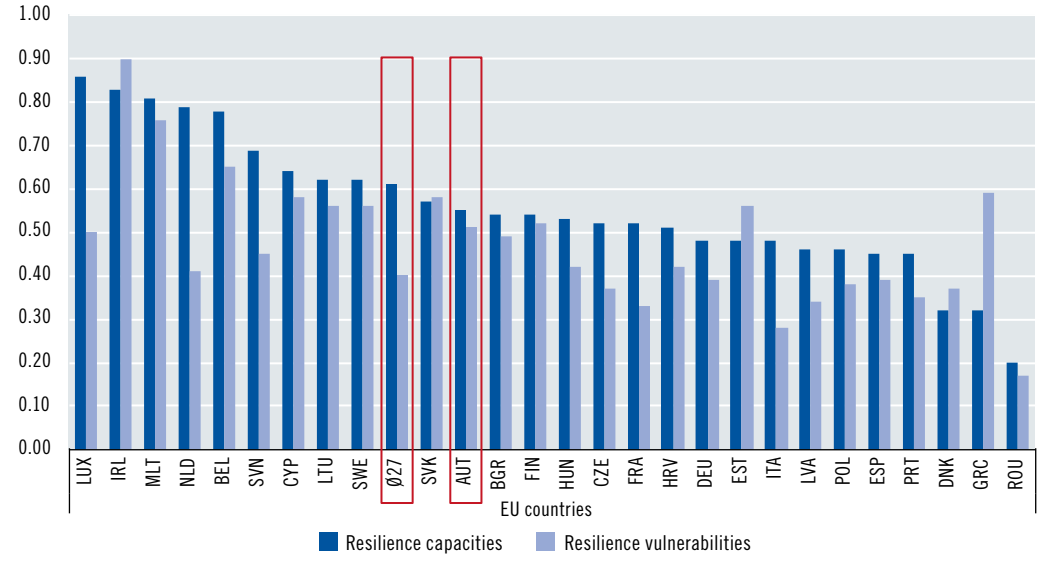
Source: European Commission (2021l). Graphic: iit.

Fig. 2-39: Resilience: digital dimension, 2021



Source: European Commission (2021l). Graphic: iit.

Fig. 2-40: Resilience: geopolitical dimension, 2021



Source: European Commission (2021l). Graphic: iit.

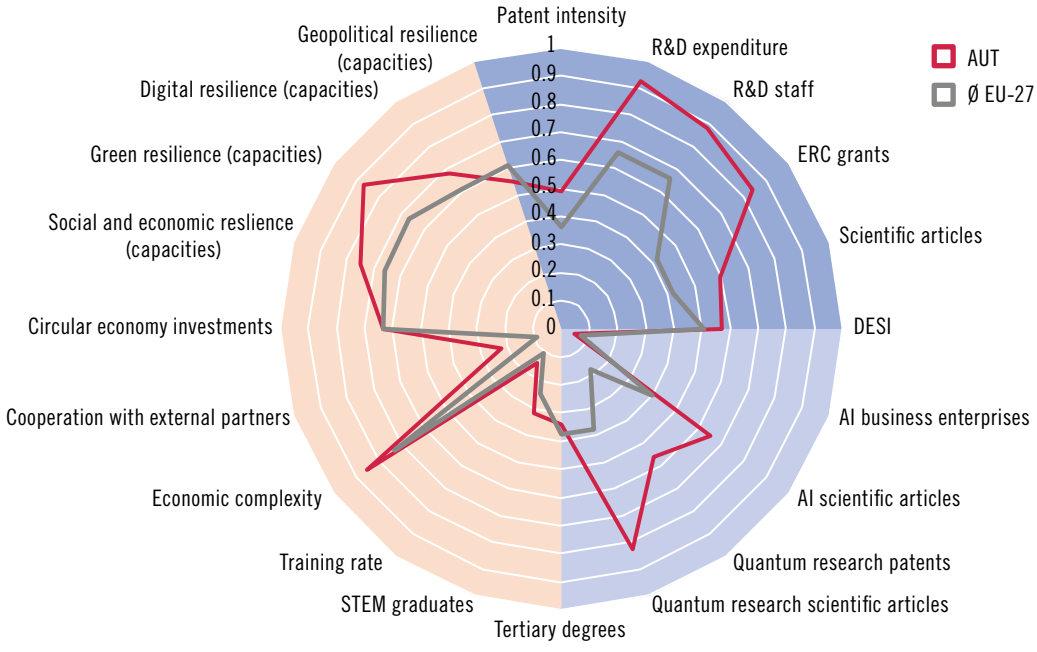
2.2.4 Summary

In this chapter, Austria's performance in research and development, the state of digitalisation and the innovation capability were analysed on the basis of various indicators and Austria's positions in international comparison were presented. Altogether, an above-average position was achieved in many areas. However, in some indicators there is clear potential for catching up. The central results are summarised in Fig. 2-41 as a radar chart. The light orange segment of the figure includes basic indicators of performance in research and development, the blue segment includes indicators of the state of digitalisation, and the light blue segment shows indicators of innovation capability. Austria's respective value (red line) is compared to the EU-27 average value (grey line). The various scales were uniformly standardised to values between 0 and 1.

Austria's picture in the area of performance in research and development is entirely positive. In the basic RTI indicators of patent intensity, R&D expenditure, R&D staff, ERC grants and scientific publications, Austria is consistently, and in some cases clearly, above the EU average. In particular, Austria occupies a front rank in terms of R&D expenditure, R&D staff and acquiring ERC grants.

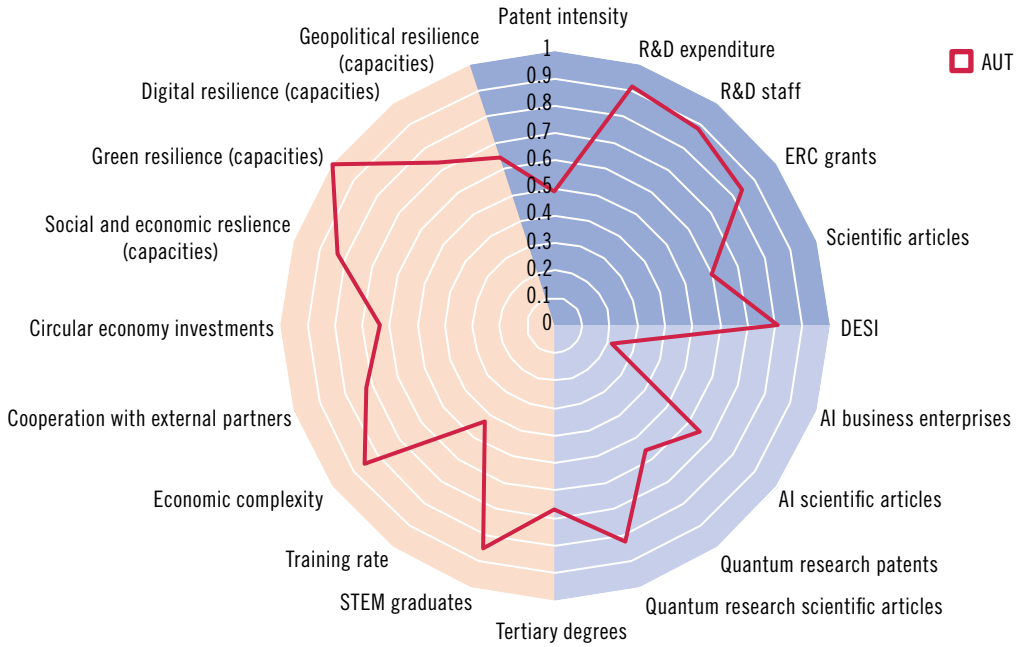
In the area of digitalisation, Austria was able to improve slightly compared to the previous year. All sub-indices of the DESI are now above the EU average and the country occupies a place in the upper midfield in the overall DESI assessment. A differentiated picture of Austria's position in an international comparison can be seen in future technologies. In the Readiness for Frontier Technologies Index and in the application of the Internet of Things in everyday life (neither indicator is listed in Fig. 2-42), the country is rated average, and it ranks below the EU average in the use of artificial intelligence in companies. The country occupies a significantly better position in research on future technologies. In terms of scientific publications in the field of AI and quantum technology as well as the number of patents registered in the field of quantum technology, the country ranks consistently above the EU average and achieves top positions in both indicators of quantum technology.

Fig. 2-41: Summary of Austria's position compared to the EU average



Source: iit.

Fig. 2-42: Summary of Austria's score compared to the leading scores



Source: iit.

A differentiated picture also emerges for the indicators of innovation capability. In terms of human capital, tertiary degrees and the training rate are only slightly above or slightly below the EU average, while a very high share of STEM graduates was achieved (second place in the EU). When interpreting the human capital indicators, it is important to note the Austrian dual vocational education system, which trains a large share of skilled workers outside the tertiary education sector. Training of complexity capital – the ability to produce complex products – is also excellent. Here the country ranks third in the EU. The situation with regard to relationship capital is more differentiated: all values are above the EU average, however the gap to the EU average is particularly large for public-private co-publications and particularly small for job mobility of employees in science and technology (neither indicator is shown in Fig. 2-42). Austria's position is weaker in the indicators concerning the circular economy. Private investment, jobs and gross value added in connection with the circular economy sectors are at the EU average. With regard to resilience capacities, the picture is positive, with values partly noticeably above the EU average. The only exception is geopolitical resilience, for which a weaker value was observed.

Fig. 2-42 offers a different perspective on Austria's strengths and weaknesses in an international comparison by visualising, for each indicator, the gap to the leading nation, i.e. what share Austria's value represents of the highest value in the EU. This clearly shows Austria's excellent position in R&D expenditure, R&D staff, ERC grants, publications on quantum research, STEM graduates, economic complexity and its leading position in green resilience. Austria's DESI score is interesting. While the country was only slightly above the EU average in Fig. 2-41, it now shows that the gap to the leading nation, Denmark, is smaller than assumed. Austria shows the largest gap to the highest value in the EU in the use of AI in companies.

2.3 Austria and European research, technology and innovation policy

Austria and the European RTI policy

- **Austria remains in 10th place among the EU Member States in terms of participation in Horizon 2020.**
- **Austria was able to maintain its top three ranking in the success rate in Horizon 2020 (17.3%) compared to the previous year and the other EU Member States.**
- **The success rate of the business enterprise sector in Horizon 2020 was also 17.3%.**
- **Austria is currently participating in two Important Projects of Common European Interest (IPCEI). It is sounding out four other areas.**

Performance in European programmes is a key indicator of the strength and competitiveness of Austria's knowledge and innovation system. Austria has carved out a strong position over the years. The changed framework conditions and the urgent need to develop solutions for major societal challenges have led to a radical change in European RTI policy. In particular, Horizon Europe, the Framework Programme for Research and Innovation, is to pursue a mission-oriented innovation policy, as well as contribute significantly overall to the digital and ecological transformation as well as to European sovereignty. These approaches are also being taken up at the national level, and it is proving to be quite challenging to shape and further develop scientific and RTI policy in the coming years in such a way that it meets the demands and goals of mission-orientation as well as the other strategic objectives.

Section 2.3.1 first discusses Austria's performance in Horizon 2020 and then, in section 2.3.2, the significance of the European Commission's Strategic Plan for implementing Horizon Europe. Austria's efforts to participate in IPCEI and to support this European initiative, which are explained in Section 2.3.3, can be seen as exemplary for a new, interdisciplinary and transnational approach in RTI policy.

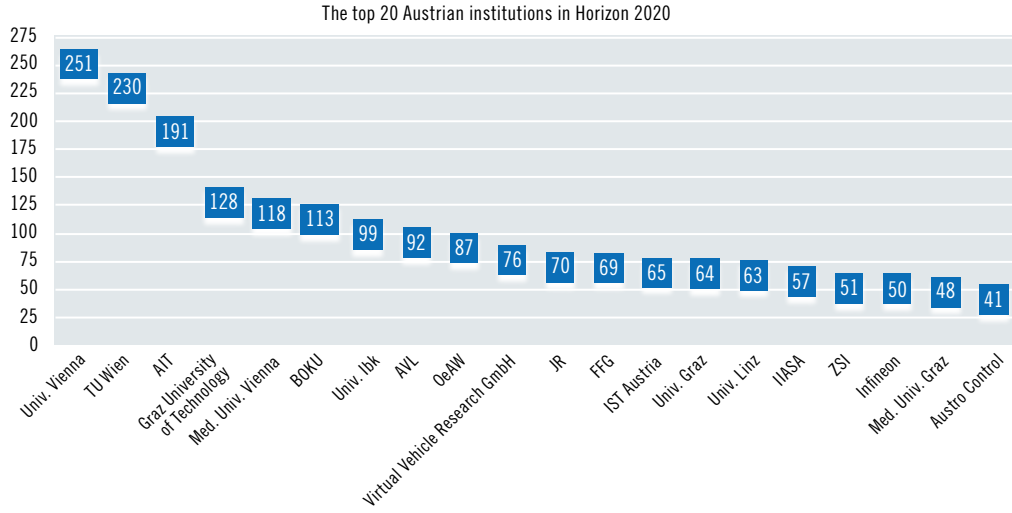
2.3.1 Austria's performance in Horizon 2020

The final calls for proposals in spring 2021 brought the curtain down on the European Commission's eighth Research Framework Programme, Horizon 2020. It has been replaced by its successor programme, Horizon Europe, whose first round of calls for proposals was held in autumn 2021. While it is too early for a statistical consideration of Horizon Europe at this point in time due to the few data points available, a final look at Horizon 2020 can be taken.

The following overview of Austria's performance in Horizon 2020 is based on contract data, i.e. funding agreements between the European Commission and the project consortia. Projects on the reserve list or contracts in preparation were not included in the analysis. The data were provided by the European Commission via the eCORDA monitoring system in January 2022 and prepared by the Austrian Research Promotion Agency (FFG), therefore allowing a preliminary overall assessment of Austria's participation in Horizon 2020.

Overall, the data confirm the positive achievements of Austrian institutions and researchers from industry and science in Horizon 2020. The total amount of funding allocated to Austria was €1.95 billion, approximately 2.9% of the funds distributed by the European Commission. This means that Austria received proportionately more funding from Horizon 2020 than it paid in. Austria's proportion of approved participations, i.e. the participation of Austrian institutions in approved projects, was 2.8%, equal to the funding acquired by Austrian institutions from the Horizon 2020 budget. Out of 178,616 participations in total within funded Horizon 2020 projects, 5,089 were Austrian. With these participations, Austria is placed in tenth position in comparison with other European countries and in eleventh position in international rankings, just behind Switzerland (5,147) and ahead of Denmark (3,987). Naturally enough, the larger European countries have the highest numbers of participations in absolute terms: Germany (20,710), Spain (18,871), Great Britain (17,576), France (17,548)

Fig. 2-43: The top 20 Austrian institutions in Horizon 2020, measured in terms of the number of investments



Source: Data from the FFG *EU-Performance Monitor* on 2 March 2022. Graphic: ZSI.

and Italy (17,197). The percentage of Austrian project coordinators amongst all coordinators was 2.7% (in absolute figures a total of 967). With a success rate of 17.3% in terms of participations, Austria ranks significantly above the average success rate of 15.3% for Horizon 2020, ranking third amongst the Member States of the European Union, after Belgium (19.0%) and France (17.5%), and on a par with the Netherlands.[149]

Each participation in an approved project is counted separately. Thus, the participation of two different Austrian institutions in one approved project counts twice. Similarly, a single Austrian institution can participate several times in a number of approved projects, which means that each individual project participation is counted once and added up over the projects. Fig. 2-43 shows the most successful Austrian institutions with regard to the number of their project participations in Horizon 2020.

The involvement of Austrian participants in the individual pillars of Horizon 2020 and their budget chapters (see Table 2-13) naturally varies greatly, especially at the level of the budget chapters within the three major programme areas ("pillars") of "Excellent Science", "Industrial Leadership" and "Societal Challenges". In this respect, most of the funds were raised by Austrian actors under Pillar III, "Societal Challenges", amounting to €733.3 million. The Austrian share under Pillar III represents 2.8% of all budgeted funding for projects under this pillar. In Pillar I, Excellent Science, €709.1 million was allocated to researchers based in Austria, corresponding to a 2.8% share in this pillar. In Pillar II, "Industrial Leadership", €446.8 million was acquired by Austria: a 3.2% share of the funding, i.e. an above-average success under this pillar for Austria, in contrast to the other two pillars.

With a 2.4% share of participations and a 2.5% share of project coordinations, Austrian participations in the "Excellent Science" pillar are significantly below the averages for Austria under Horizon 2020, which stand at 2.8% (project participations) and 2.7% (coordinations) respectively. The Austrian shares in the other two pillars are higher: "Industrial Leadership" (3.3% and 2.9%) and "Societal Challenges" (2.9% and 3.1%, respectively). Austria's performance in the programme line "Science with and for Society" is significantly above average: here, the proportion of

149 For comparison: the success rate for Swiss participations is 17.5%, and for US participations 18.5%.

Table 2-13: Austria's success in Horizon 2020 according to pillars, project participations, projects, coordinations and budget

	Approved participations (all countries)	Approved Austrian participations	Austria's share (in %)	Approved coordinations (all countries)	Approved coordinations (Austria)	Proportion of projects with Austrian coordinators out of all coordinations (in %)	EU funding (all countries, in € millions)	EU funding (Austria, in € millions)	Austria's share of the EU contribution (in %)
Horizon 2020 total	178,616	5,089	2.80%	35,393	967	2.70%	68,172	1,948	2.90%
Excellent Science	56,696	1,360	2.40%	20,663	523	2.50%	25,015	709	2.80%
of which ERC	10,089	292	2.90%	2,844	234	3.00%	13,461	411	3.10%
Industrial Leadership	39,204	1,285	3.30%	6,579	194	2.90%	13,761	447	3.20%
Societal Challenges	75,262	2,217	2.90%	7,073	220	3.10%	26,288	733	2.80%
Spreading excellence and widening participation	1,623	50	3.10%	493	1	0.20%	1,017	12	1.20%
Science with and for Society	2,614	138	5.30%	261	22	8.40%	493	31	6.30%
Cross-Theme	1,110	19	1.70%	225	4	1.80%	505	8	1.50%
EURATOM	2,107	20	0.90%	99	3	3.00%	1,094	9	0.80%

Source: EC/FFG as of Feb 2022, contract data. Graphic: ZSI.

Austrian coordinations is 8.4%, the proportion of funding raised is 6.3% and the share of all project participations is 5.3%. However, it should be noted that this programme line only has a small amount of budgeted funding (only 0.7% of the total funding is allocated to this programme line). Austrian participation is particularly low in the similarly modest funding areas of "Cross-cutting issues" (1.7% of all participations and 1.8% of all coordinations) and EURATOM (0.9% of all participations and 3.0% of coordinations).

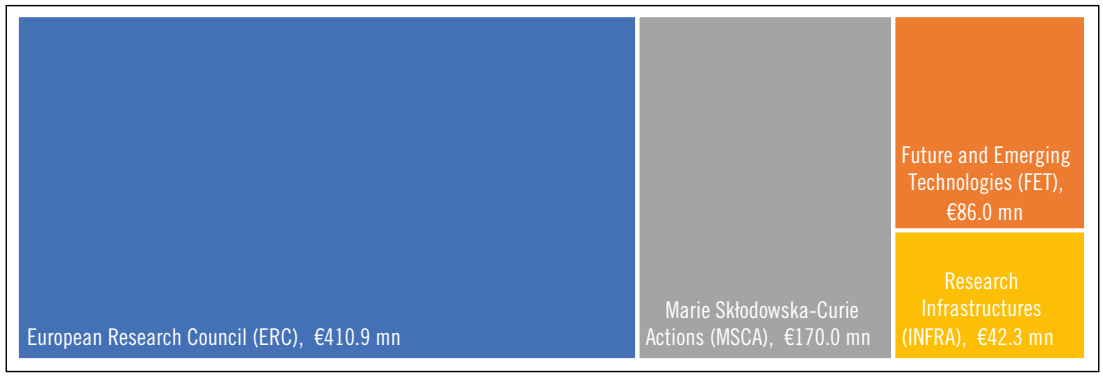
In the "Excellent Science" pillar, Austrian institutions have an above-average proportion (3.3%) of project applicants within the programme area "Future and Emerging Technologies (FET)" (coordinations 4.1%; funding 3.3%), and in applications to the European Research Council (ERC) with 2.9% (coordinations 3.0%; funding: 3.1%). There are comparatively low levels of participation in "Research infrastructures", with 2.0% (coordinations 2.9%; funding 1.7%). In terms of monetary value, the ERC with €410.9 million and the Marie Skłodowska-Curie Actions (MSCA), with €170.0 million, are of particular relevance to Austria, despite relatively low levels of participation in the MCSA, at 2.2% (see Fig. 2-44).

In the "Industrial Leadership" pillar, Austrian institutions have the highest proportion of project participations in particular in the thematic clusters "Materials"[150] with 4.6% (coordinations 2.6%; funding 5.0%), and "ICT" with 3.6% (coordinations 4.1%; funding 3.5%); these industry-related themes are recognised strengths for Austria in Horizon 2020. To a lesser extent this is also true for the "Advanced Manufacturing" cluster, with a participation share of 3.1% (coordinations 6.0%; funding 4.2%), and "Advanced Manufacturing" with 3.0% (coordinations 2.8%; funding 2.8%). In terms of monetary value, especially "ICT" in the pillar "Industrial Leadership" with €245.3 million is of relevance for Austria (see Fig. 2-45).

Under Pillar III, "Societal Challenges", Austrian institutions have the highest levels of project participation in the thematic clusters "Smart, Green and Integrated Transport", with 4.0% in comparison to all participations in this cluster (3.6% of coordinations, and 3.1% of funding); "Inclusive, Innovative and Reflective Societies" with 3.8% (coordinations 3.5%, and funding 4.2%); and "Secure, Clean and Efficient Energy" with 3.3% (coordinations 3.6%; funding 3.3%). These thematic Societal Challenges may be seen as

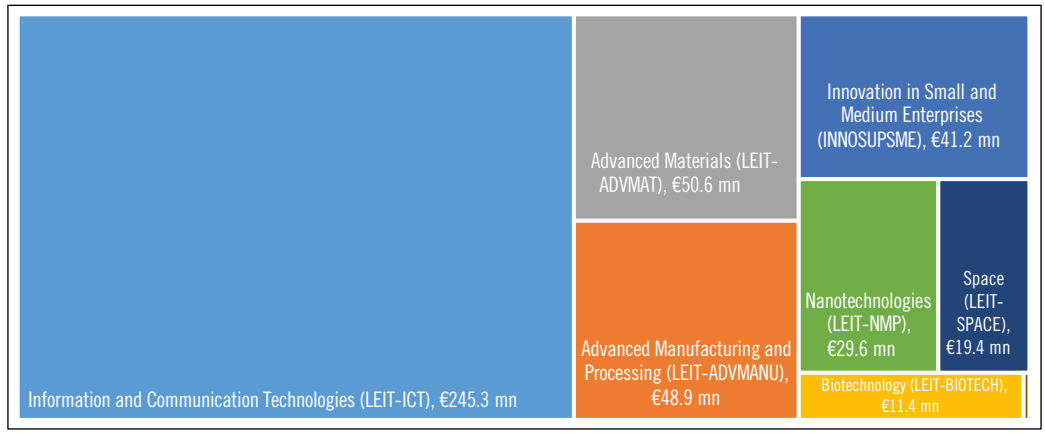
150 Nanotechnologies, Advanced Materials and Production (NMP) programme.

Fig. 2-44: Funds raised by Austrian players in Pillar 1 "Excellent Science" by programme, 2014–2020



Source: Data from the FFG *EU-Performance Monitor* on 2 March 2022. Graphic: ZSI.

Fig. 2-45: Funds raised by Austrian players in Pillar 2 "Industrial Leadership" by programme, 2014–2020



Source: Data from the FFG EU-Performance Monitor on 2 March 2022. Graphic: ZSI.

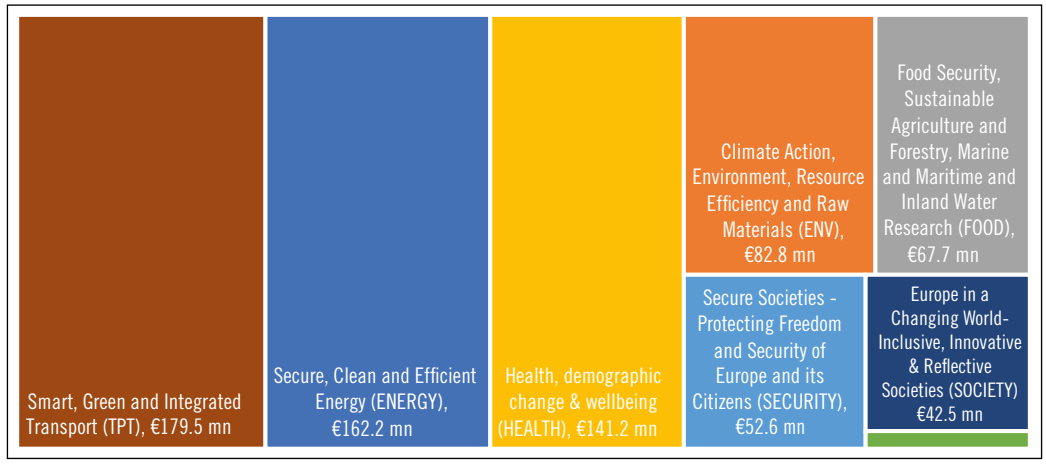
Austrian fields of strength in comparison to the rest of Europe. Below-average level participations occur particularly in the clusters "Food safety and security, sustainable agriculture and forestry, maritime and limnological research and bio-economy" with 2.1% (coordinations 1.8%; budget 1.9%) and "Health, demographic trends and wellbeing" with 2.1% (coordinations 2.8%; funding 2.3%). Considered solely from the perspective of funds raised, the most significant clusters for Austria are "Transport" (€179.5 million), "Energy" (€162.2 million) and "Health" (€141.2 million) within this pillar (see Fig. 2-46).

The largest share of Austrian participations under Horizon 2020 – relative to the total number – come from the business enterprise sector (36.8%), of which approximately 46.1% are in small and medium-sized enterprises (SMEs) – slightly below the European average of 51.0% for SMEs in the business enterprise sector in Horizon 2020[151]. This is followed by the higher education sector (29.3%) and the non-university research sector (23.5%). These three sectors combined make up almost 90% of Austrian participations in Horizon 2020 projects. The rest is attributable to the public sector (3.1%) and the "other" category (7.4%).

In monetary terms, €771.8 million (or 39.6%) is at-

151 Data on the proportion of SMEs amongst business enterprise sector participants in Horizon 2020 was kindly provided by the Austrian Research Promotion Agency (FFG). Funding approvals for Austrian SMEs constituted 45.2% of successful applications from the entire Austrian business enterprise sector. The comparable figure at European level is 52.0%.

Fig. 2-46: Funds raised by Austrian players in Pillar 3 "Societal Challenges" by programme, 2014–2020



Note: Unlabelled area in green (bottom right): cross-cutting issues, €4.9 million.
Source: Data from the FFG EU-Performance Monitor on 2 March 2022. Graphic: ZSI.

tributed to universities and higher education institutions, €584.5 million (or 30.0%) to firms and €482.4 million (or 24.8%) to non-university research institutions.

These different types of institutions are involved to a varying degree in each programme line. In terms of funding raised, the proportion of the Austrian higher education sector under Pillar I "Excellent Science" is 71.1%. This can be attributed – unsurprisingly – to a high proportion of participations in European Research Council (ERC) projects, at 76.7%. The higher education sector's share of funding raised in the programme lines FET and MCSA is very high, at 68.1% and 69.1% respectively. The corresponding proportion for the non-university sector under Pillar I is 17.0%, and for the business enterprise sector, 10.9%.

Within Pillar II "Industrial Leadership" and Pillar III "Societal Challenges" in contrast, the picture – measured in terms of funding raised – is completely different. Under these two pillars the level of participation by the Austrian business enterprise sector is ahead of that by the Austrian non-university sector. The Austrian higher education sector was allocated just 17.2% of the total funding amount in "Industrial Leadership". In terms of funding raised, the proportion for the Austrian business enterprise sector under Pillar II is 51.6%. The corresponding share for the Austrian non-university sector is 27.6%. The rest is attributable to other organisational types (3.6%). Under Pillar III, in terms of funding raised, the proportion for the Austrian business enterprise sector is 36.4%. The corresponding proportion under this pillar for the non-university sector is also comparatively high, at 29.0%. For the higher education sector, the proportion of funding acquired under Pillar III is just 23.6%. 11% is attributable to other organisational types.

In the horizontal programme area "Science with and for society", Austrian participation can be broken down by organisation type and amount of funding raised: Higher education sector: 32.3%, business enterprise sector: 12.1%, and non-university sector: 42.3%, other organisational types: 13.3%. In the programme area "Spreading excellence and widening participation" the proportions are 50.4% (higher education sector) and 41.5% (non-university research).

2.3.2 Strategic plan of Horizon Europe and mission-orientation as a new policy approach

For the duration of Horizon Europe, multi-year "Strategic Plans" are introduced for the first time, which represent the strategic focus points across programmes, which the European Union and the Mem-

ber States are in particular aiming at in the respective multi-year phase, naturally against the background of the current challenges for the Union. In the first Strategic Plan (European Commission, 2021), four "Key Strategic Orientations" were defined for the years 2021 to 2024 of Horizon Europe.
These are:

First, promoting an open strategic autonomy by leading the development of key technologies, sectors and value chains: in particular, the COVID-19 pandemic has made the need for digitalisation in all aspects of society evident. Furthermore, the data economy is at the heart of innovation and is creating many new jobs. The EU's ambition here is to equip Union citizens with digital solutions within the meaning of the European values. Horizon Europe therefore aims to support and shape innovative technologies and solutions for the health sector, cultural heritage, the protection of critical infrastructure, cybersecurity and data protection, and inclusive growth. By investing in digital and other critical supply chains, Europe should become more resilient and independent. The transition to a digital and green economy also presents a unique opportunity to decouple resource consumption from economic development.

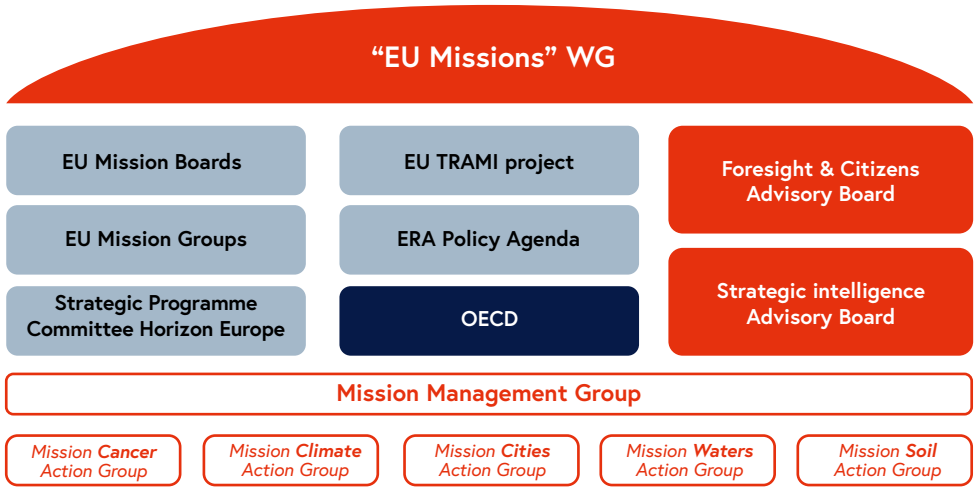
Second, restoring Europe's ecosystems and biodiversity, and managing sustainably of natural resources: agriculture, forestry and fishing, and especially global warming, put pressure on ecosystems. The European Union wants to halt the decline of biodiversity and protect ecosystems. By using natural resources sustainably, food security and a clean and healthy environment should be safeguarded. Horizon Europe therefore aims to increase knowledge in this area and promote innovative technologies for sustainable use. In this area, the investments of Horizon Europe will also be coordinated with the initiatives of the European Green Deal, in particular the Farm to Fork Strategy and the Biodiversity Strategy.

Third, making Europe the first digitally enabled circular, climate-neutral and sustainable economy through the transformation of its mobility, energy, construction and production systems: the European Union's goal is to substantially reduce greenhouse gas emissions by 2030 and become climate-neutral by 2050. The transformation to a climate-neutral, circular and competitive economy requires unprecedented changes in our economic system; these changes are expected to contribute to the post-COVID green recovery. The investments of Horizon Europe are expected to support the different dimensions of the European Green Deal and ultimately make all economic sectors climate-neutral. This should also fix the EU's global leadership in the field of technology for a green transformation, whereby the aspect of digitalisation can make an important contribution to achieving this goal.

Fourth, creating a more resilient, inclusive and democratic European society: social cohesion and healthcare, the rights and the security of the Union's citizens is a key objective of the EU. However, there are a number of threats to wellbeing in connection with demographic developments, globalisation, new threats to security and rapid technological change. The pandemic has shown that research and innovation are central to understanding the risks and developing responses to acute and recurrent problems. This goes hand in hand with the Union's goals of creating good working and living conditions, protecting the rule of law and guaranteeing basic government functions such as healthcare and education, as well as making adequate provision for threats and disasters. The investments of Horizon Europe are intended to expand medical technologies in order to promote the health of the population. In addition, Horizon Europe aims to drive institutional development and innovation, support democratic processes and strengthen trust in democratic institutions. It also aims to link educational opportunities with labour market needs, not least to meet the labour needs of the transition to a green economy.

The Horizon Europe Strategic Plan aims to increase the effectiveness of research and innovation. In this context, the EU Framework Programme for Research and Innovation uses a new policy ap-

Fig. 2-47: Governance structures of the "EU Missions" working group



Source: BMBWF.

proach that is gaining prominence in both the OECD and the EU under the title "mission-oriented innovation policy".

Mission-orientation links research and innovation with societal goals in sectors such as health, environmental or agricultural policy. The contents of missions are developed jointly in a co-creation process by as many relevant RTI and sectoral actors as possible, which is intended to achieve a high degree of engagement, commitment and goal orientation. Missions implement concrete measures for ambitious yet realistic projects whose success depends largely on the contribution of research and innovation. In doing so, missions make use of a broad portfolio of instruments, from thematic research and technology programmes to the promotion of networks and infrastructures to sectoral instruments of legislation. The involvement of the public plays an important role throughout the entire life cycle of missions, as it ensures the accuracy and acceptance of the solutions to be developed.

The mission-orientation of Horizon Europe supports, among others, the Twin Transition, i.e. the transition to a digital and green economy. It also contributes to other EU strategic goals, such as the "European Beating Cancer Plan". The European Commission has defined five missions in Horizon Europe:

- CANCER: Conquering Cancer – Mission Possible
- CLIMATE: Climate Resilient Europe
- CITIES: 100 Climate-neutral Cities by 2030
- OCEANS: Mission Starfish 2030
- SOIL: Caring for Soil is Caring for Life

For each of these missions, the European Commission, advised by the expertise of "Mission Boards", has developed an implementation plan that defines the goals and intervention logic of the missions as well as discusses overlaps with other EU and Member State instruments.

Since societal transformations do not happen in a linear fashion, but are essentially based on systemic, cross-actor and cross-sectoral processes and thus depend on innovation and knowledge creation, the contribution of RTI policy in the coming years is of central importance in order to support transformations in a well targeted manner. In fact, it is up to the effective acting in concert of sectoral and RTI policies to implement the missions and, in the course of this, to proactively involve all relevant actors, to take supporting measures as well as to adapt them on an ongoing basis.[152]

152 See Hekkert et al. (2020), Polt et al. (2019), European Commission (2018), Boon and Edler (2018), Kattel and Mazzucato (2018).

In the general context of mission-oriented innovation policy, Austria has already taken the first steps, such as aligning research funding programmes to support the missions by, for example, setting thematic priorities such as sustainable energy and mobility, promoting impact innovation, addressing the topic of healthy food and nutrition or establishing the *Bündnis Nachhaltige Hochschulen* (alliance of sustainable higher education institutions). The participation in IPCEI is also an essential step towards a new, future-oriented industrial policy.

The implementation of the missions of Horizon Europe in Austria is being prepared by a newly created governance under the umbrella of the RTI Task Force. An "EU Missions" working group was established under the co-leadership of the BMBWF and BMK and with the participation of the other relevant ministries as well as the ten central institutions in accordance with the Austrian Research Financing Act (FoFinaG). The working group "EU Missions" has provided five thematic expertise groups (Mission Action Groups) with the mandate to elaborate concrete Austrian implementation proposals on the basis of the European implementation plans.

Two internationally staffed advisory boards accompany the design phase with advice in terms of methodology on the use of strategic foresight, citizen engagement and the use of strategic intelligence for monitoring and controlling the success and effectiveness of the missions.

The steering and coordination structures established in Austria are closely linked with relevant European and OECD bodies and processes, for example with an EU project on networking mission-oriented agencies of Member States (TRAMI project), which is coordinated under Austrian leadership.

The proposals for mission-oriented measures in each of the five EU missions ought to be incorporated into an "Austrian Implementation Plan", which can form the framework for close cooperation of RTI policy with health, climate, energy, mobility, water and agricultural policy both in Austria and at the European level by 2030.

2.3.3 European initiatives: IPCEI

*I*mportant Projects of Common European Interest (IPCEI) is an EU state aid instrument for providing well targeted promotion of consortium projects in strategically important value chains that are supposed to make a very important contribution to sustainable economic growth, jobs, competitiveness and resilience. Taking part in IPCEIs marks a major step towards a new, future-oriented industry policy. Across borders, IPCEIs should mobilise know-how and capital to enable ground-breaking innovations and infrastructure projects. In this way, it is possible to address societal challenges as well as market and system failures that could not be addressed without transnational cooperation and coordination. In doing so, the benefits of the project must not be limited to the direct participants or the specific sector, but must additionally be transferable to the economy and society through positive spill over effects. In addition, coordinated support in selected industries should strengthen innovation and reduce dependence on intercontinental supply chains. IPCEI thus represent a core element of European industrial policy.

The special feature of IPCEI is that the EU-wide rules on state aid in accordance with the General Block Exemption Regulation (GBER, European Commission 2014) are generally not, or only to a limited extent, applicable to aid measures within the framework of IPCEI. These are checked for compatibility with the internal market by means of a separate catalogue of criteria (point (b) of Article 107(3) of the TFEU and 2021/C 528/02). The criteria allow significantly greater flexibility in the design of project funding. This includes, for example, the selective granting of aid and the promotion of first industrial implementations. The EU Commission notes that company aid in the millions can have a distorting effect on competition, as competing, non-subsidised companies are put at a market disadvantage. It is therefore required to weigh up whether the positive effects of promotion (the contribution to strategic goals) outweigh the negative effects on competition.

This concerns not only horizontal competition (i.e. competition in the same product market), but also effects along the supply chain and potential overcapacities that may arise (European Commission, 2021c). Furthermore, there is a claw-back rule for funding under IPCEI, i.e. in the case of unexpectedly successful projects, the supported companies have to pay back part of the funding as a general rule. This avoids overfunding, which would have an additional negative impact on competition.

General requirements

In order to fall under the special provisions of point (b) of Article 107(3) of the TFEU, IPCEI projects must fulfil certain criteria, which can be found in the related Communication from the European Commission.[153] The revised IPCEI Communication applies from 1 January 2022 and contains a range of targeted adjustments based on the experience gained from the application of the 2014 IPCEI Communication[154]. In particular, the strategy now places a stronger focus on the participation of SMEs and start-ups, emphasises the pan-European character and networking of participants, and takes into account current EU priorities in project goals.[155]

IPCEI projects must thus:

- Make a concrete contribution to Union goals or strategies, such as the Green Deal, Next Generation EU, the digital or data strategy, or the European Health Union. The project must also have a significant impact on sustainable growth.
- Aim to address a serious market or systemic failure that prevents the project from being implemented without aid, or address a societal challenge that could not otherwise be addressed or overcome.
- Be cross-border. As a rule, a project must involve at least four Member States (in exceptional and duly justified cases, the participation of at least two Member States is justified). In addition, Member States notifying a project must inform all Member States about the project in advance and give them sufficient opportunity to participate.
- Lead to benefits that have broad use for the European economy and society through positive spill over effects. Not only participating Member States and business enterprises may benefit, but also other parts of the Union and other industries; upstream or downstream markets must be positively affected.
- Be co-financed by aid recipients (except in exceptional and duly justified cases in specific markets or for SMEs).
- Have no negative environmental effects in accordance with Article 17 of Regulation (EU) 2020/852. Therefore, there must be no significant negative impact on environmental objectives.

Additionally, projects of any kind eligible for aid must be significant both quantitatively and qualitatively – this can mean a large volume, broad scope of application, but also a high financial risk – and they must also be assessed for their compatibility with the internal market. Compatibility exists if aid is necessary and appropriate in terms of amount and, at the same time, does not lead to disproportionate distortions of competition. Moreover, it must be weighed up whether the positive promotion effects outweigh the negative ones.

Eligible projects

In principle, three types of projects can be funded within the scope of the IPCEI, although experience to date shows that RDI and FID projects are in reality treated as a joint IPCEI:

- Research, Development and Innovation (RDI) projects: These must either be of significant innovative nature, or add significant value in the industry concerned in view of the current state of the technology.

153 See European Commission (2021m).
154 See European Commission (2014).
155 See European Commission (2021n).

- First Industrial Deployment (FID) projects: These include projects that are in their post-pilot phase but do not yet comprise mass production or commercial activities, such as the upscaling of pilot plants. These projects must enable the development of a new product/service with high innovation content, or lead to the introduction of an innovative production process. Adaptations of existing facilities without an innovative dimension and the development of new versions of existing products are explicitly excluded here.
- Infrastructure projects in the fields of environment, energy, transport, health or digital must be of particular importance for the respective strategies[156] of the EU or make a significant contribution to the internal market. Projects can be supported until they are fully operational. Non-discriminatory access to the infrastructure created must be guaranteed.

Funding systematics

Aid granted via IPCEIs is financed and administered by the Member States. In Austria, the Austria Wirtschaftsservice (aws), in cooperation with the Austrian Research Promotion Agency (FFG), was commissioned as a "joint funding channel" for the processing of previously approved subsidies. The respective federal ministries, i.e. the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) and Federal Ministry of Labour and Economy (BMAW) up to now, are formally responsible for granting the subsidies.

IPCEI projects can be divided into four phases before their potential implementation[157]:

1. Within the framework of a needs assessment, companies or research institutions express their general interest in participating by submitting a project outline. This is formally verified by the joint funding channel and examined by the responsible ministries. Based on this, a proposal to recommend or not recommend the submission for nomination for phase 2 is forwarded to the responsible federal ministries.
2. Within the framework of a national proposal for expressions of interest, companies develop a project portfolio and an analysis of the funding gap according to the European IPCEI standard, which is evaluated at national level by an independent jury of experts. The project documents must include, amongst other things, a counter-factual scenario as well as demonstrate a high degree of innovation. The joint funding channel subsequently submits a recommendation of the projects to the responsible federal ministry or ministries. The decision on the submission for pre-notification is made at the end of phase 2 based on the recommendations, relevant national strategies as well as budget restrictions set by the responsible federal ministry or ministries.
3. The individual project documents (project portfolio and funding gap analysis) are closely reviewed at European level, with any ambiguities resolved in an iterative process. At the end of phase 3, an approval is granted by the Commission under state aid law if the proposal is successful.
4. The projects approved by the Commission are elaborated in detailed national grant agreements between the companies and the joint funding channel. The funding is paid out in instalments.

Existing projects with Austrian involvement

To promote the production of batteries in the EU, an IPCEI on batteries has been approved, so far with two stages: In the "IPCEI on Batteries" approved in 2019, 17 companies in seven Member States will be supported with a total of €3.2 billion, which is expected to lead to private investment of €5 billion.[158] The second IPCEI European Battery Innovation EuBatIn launched in 2021 includes 41 companies in 12 Member States, which will receive €2.9 billion in

156 See BMDW (2020).
157 See BMK (2021b).
158 See European Commission (2019).

funding and are expected to make private investments of €9 billion.[159] Six Austrian companies (AVL List GmbH, Borealis AG, Miba eMobility GmbH, Rosendahl Nextrom GmbH, Varta Micro Innovation GmbH and Voltlabor GmbH) are participating in the second round of the IPCEI and are receiving funding from the Republic of Austria at a total of up to €45 million. The IPCEI EuBatIn is being managed by the joint funding channel in cooperation with the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK).[160] EuBatIn is divided into four work streams (WSs), each of which also involves at least one of the Austrian companies. WS 1 deals with sustainable mining and further processing of raw materials required for battery production, WS 2 with the development and initial industrial implementation of battery cells, modules and innovative test methods, WS 3 with battery systems including management systems, algorithms and innovative test systems for their operation and WS 4 with the recycling and circular economy of batteries.[161]

The IPCEI Microelectronics was already launched in 2018. Austria has been participating in it since March 2021. Other participating Member States include France, Italy and Germany; the UK is also involved. Private investment of €6.5 billion is being raised from the 32 direct partners, and the participating states are additionally distributing almost €1.9 billion in funding. In Austria, three companies (AT&S Austria Technology & Systemtechnik AG, Infineon Technologies Austria AG and NXP Semiconductors Austria GmbH) are receiving funding of up to €146.5 million in total as part of the IPCEI Microelectronics.[162] The IPCEI Microelectronics is also divided into various sub-projects, with Austrian companies participating in two of these: technology field 1 deals with solutions to make microchips more energy efficient; technology field 2 with the development of new power semiconductors as components in electric and hybrid cars as well as in smart devices.[163]

Planned projects with intended Austrian participation

Further IPCEIs are being planned and prepared, and participation in IPCEIs has been explored in four areas in Austria.[164]

IPCEI H2: IPCEI Hydrogen

In the field of hydrogen, the following two IPCEIs are in preparation: the IPCEI H2 Industry, which focuses on the decarbonisation of industry, and the IPCEI H2 Technology, which aims to develop technology in the mobility sector, among others. Phase 2 of the approval process – the evaluation of the project documents – has already been completed. A total of eight Austrian projects had been nominated by the European Commission by the summer of 2021. Notifications from IPCEI H2 Industry and IPCEI H2 Technology can be expected in 2022.[165]

In phase 2, stand-alone projects were submitted in the following areas:

1. 100% renewable hydrogen for industrial applications;
2. Integrated projects with 100% renewable hydrogen that link at least three pillars in the hydrogen value chain (production, transport, storage, use, energy service);
3. Projects with the goal of technology development and initial industrial implementation (generation, transport, storage, application, energy service).

Due to the limited funds available, it is important to induce investments that can quickly realise innovation potential and facilitate Austria's start in the re-

159 See European Commission (2021o).
160 See FFG (2021a).
161 See IPCEI Batteries (2022).
162 See FFG (2021b).
163 See IPCEI on Microelectronics (2022).
164 See FFG (2021c).
165 See BMK (2021b).

newable hydrogen economy in the next 5 years thanks to funding from the Recovery and Resilience Facility (RRF).[166]

IPCEI ME/CT: IPCEI *Microelectronics and Communication Technologies*

The IPCEI ME/CT has also already completed phase 2 of the approval process; participation by six Austrian companies has been notified to the Commission.[167] The focus has been on stand-alone projects along two socially relevant topic areas:

1. Microelectronics for climate protection with a focus on power electronics and new materials;
2. Digital sovereignty with a focus on electronic based systems, photonic sensor technology and secure connections.

A mandatory climate-related component must be presented, i.e. projects must demonstrate substantial greenhouse gas emission savings. The budget process is closely linked to the requirements of the European Recovery and Resilience Facility (RRF) and the Austrian Recovery and Resilience Plan 2020–2026.[168]

IPCEI *Health*

In the area of "Life Sciences", Phase 1 explorations are ongoing. A first call for expressions of interest ran until autumn 2021. The overall project is intended to accelerate the technological modernisation of the life sciences sector and to contribute towards securing or establishing independent production chains. The following priorities are envisaged[169]:

1. The development and production of innovative medicinal products, active substances as well as medical devices in order to strengthen the autonomy of the industries concerned in global competition;
2. The development and industrialisation of breakthrough innovations/technologies designed to drastically reduce production costs and development time;
3. Creation of modular, flexible and sustainable production capacities;
4. Innovative medical devices specifically applicable to medical products and in vitro diagnostics (using digital approaches such as artificial intelligence, creation of data sharing platforms, platform technologies, etc.).

IPCEI *Low CO_2 Emissions Industry*

A call for expressions of interest was launched in 2020 in the context of possible Austrian participation in an IPCEI Low CO2 Emissions Industry (LCI). The focus of the call for proposals was on CO_2-intensive industries that are e.g. subject to greenhouse gas emissions trading. Specifically, stand-alone projects were sought with reference to and with coverage of one or more of the following topic areas[170]:

1. Implementation and optimisation of workflows, processes, resources and technologies in order to be able to act along the entire value chain according to the principles of the circular economy (avoid, reuse, recycle);
2. Reduction in the dependence on fossil raw materials through appropriate substitution by means of renewable and/or sustainable resources, in accordance with the Austrian Bioeconomy Strategy.

Significant increase in resource and energy efficiency along the entire value chain and a gradual switch to renewable energy technologies to reduce greenhouse gas emissions in accordance with the integrated national energy and climate plan for Austria.

166 See BMK and BMDW (2021a).
167 See BMK (2020a).
168 See BMK and BMDW (2021b).
169 See BMDW (2021).
170 See BMK (2020b).

2.4 Topics with future relevance for Austria

To meet the major challenges and keep the economic cycle going, Austria needs, alongside a research-intensive industry, highly qualified employees, excellent scientists, active, competitive and economically independent small technology companies with distinctive research and development for the efficient implementation of research results, responsible entrepreneurial action (based on the OECD Guidelines for Multinational Enterprises), as well as knowledge-intensive highly innovative firms from the "soft" or "non-tech" sectors. Austria faces the challenge of transforming more R&D results into market-relevant products. Most notably, the speed of innovation ("time-to-market") lags behind in global comparisons. The creation of technology and knowledge-intensive companies is one of the most essential drivers of economic growth. Start-ups are considered to be of particular importance in the emergence of innovations, in strengthening the competitiveness of national economies and, above all, in the creation of new jobs.

Focusing on knowledge, talents and skills is the third main goal of the RTI Strategy 2030 – in particular, the development and promotion of human resources is an independent field of action that is specified in concrete terms in the RTI Pact. The topics of quantum computing, the circular economy and developments in the field of artificial intelligence are also included in the RTI Pact and are implemented through funding programmes and other measures. The following sections are therefore intended to provide a systemic overview of current developments in these four selected topic areas.

2.4.1 From career entry to excellence: people in science and research

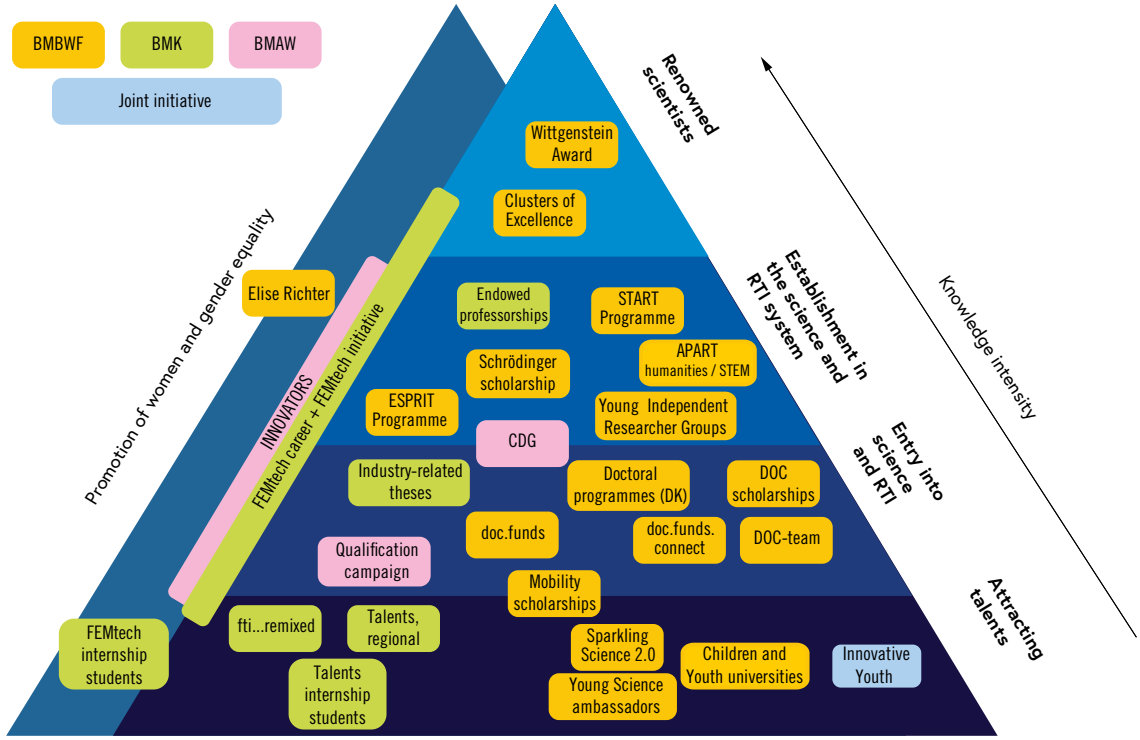
Research and innovation are inconceivable without the necessary people taking action, i.e. researchers and scientists. Therefore, the promotion of research and innovation activities must in itself also include the promotion of people in this field. The importance of talent is also expressed in the RTI Strategy 2030 (see Chapter 1.1), which names Goal 3 as "Focus on knowledge, talents and skills" and whose central fields of action are "developing and promoting human resources" and "supporting international perspectives of researchers and students". Educating and training young people as well as offering research-led teaching to prepare young people for their future activities in science, business and society – these are basic tasks of the education and science system.

Accordingly, the funding/instrument portfolio is aimed at researchers and scientists at all stages of their careers. A wide range of activities are used to attract people to RTI and to further develop their skills as well as to enable career perspectives. These (accompanying) funding instruments vary greatly in terms of their volume, resulting in a wide range in the portfolio and in the number of people receiving funding. This can be illustrated very effectively using the example of funding for doctoral candidates: In addition to the funding of doctoral students by the Austrian Science Fund (FWF) (2,131 individuals in 2021) and the Austrian Research Promotion Agency (FFG) within the framework of existing research funding programmes such as the structural programmes (e.g. COMET) or by non-university research institutions such as the AIT, there are specific instruments to support the PhD phase described in more detail below. Cumulative figures can also be found on person-related funding in Chapter 3 "Central Facilities". Furthermore, (intra-)university funding programmes are not explicitly presented in this section due to their multitude and heterogeneous nature; instead, an overview presents the differentiation of person-related funding in science, research and innovation alongside the required knowledge intensity.

Attracting talent

Young Science is aimed at ensuring cooperation between science and schools, which the OeAD handles on behalf of the Federal Ministry of Education,

Fig. 2-48: Overview of selected personalised RTI funding instruments



Source: Austrian Institute for SME Research.

Science and Research (BMBWF). Among other things, the centre brings together the Sparkling Science 2.0 programme (predecessor programme Sparkling Science), which promotes joint research projects between research and educational institutions with the possible involvement of civil society to generate innovative research results. Exchange between schools and science is also promoted via Young Science Ambassadors – researchers who visit schools (virtually) or organise online workshops. The promotion of children's and youth universities enables young people to gain their first insights into the university or to attend these courses in regular studies. The initiative also presents awards and seals of quality for research partner schools (Young-Science seal of quality) and for pre-scientific work or diploma theses (Young-Science Inspiration Award), also supported by the Young-Science thematic platform for pre-scientific work and diploma theses. Topics are also offered for research projects in which schools can participate, as well as competitions and funding opportunities for schools.

Young children are also the focus of the Regional Talents Funding Line within the framework of the Talents funding priority of the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK), which is handled by the Austrian Research Promotion Agency (FFG). To get more young people interested in research, regional projects are funded in which corporate partners, scientific partners and at least five educational institutions from nurseries through to secondary schools cooperate with each other and initiate age-appropriate, practical activities in the fields of natural science and technology. "The talents internship" for pupils enables young people aged 15 and over to gain their first practical experience in the scientific and technical field and offers companies, universities, universities of applied sciences, non-university research institutions, etc. the opportunity to promote young people and introduce them to their organisation at an early stage.

The "fti...remixed" science communication platform offers information on RTI in a target group-oriented format about current research projects, researching companies and researchers, everyday working life as a researcher, as well as information about other events, competitions and opportunities for internships. The platform also sees itself as an interface for enabling encounters between researchers and young people.

The "*Jugend innovativ*" (innovative youth) competition is supporting innovative projects by pupils and apprentices aged 15 to 20 years for the 35th time this year, regardless of the type of school involved. Awards are given for the best innovations and developments in the following categories "ICT & Digital", "Engineering", "Science and Design", "Entrepreneurship", "Sustainability" and "Energy"(special regional prize in Vorarlberg). The best projects receive cash prizes and, if possible, are sent to represent Austria in international competitions. In addition, further training measures to promote innovation and creativity are offered for teachers on the topics of "Teaching Innovation" and "Rights to Protect Work Results, Copyright, Data Security and Business Model Development" as well as practical workshops for pupils.

First Incubator is the only programme in Austria to focus its supporting measures on young people's first entrepreneurial experiences. In addition, the topic "Entrepreneurship Education" is aimed primarily at young women. First Incubator combines the transfer of essential skills and expertise (e.g. on economic and legal topics) and the strengthening of soft skills with monetary funding, with the primary focus placed on the transfer of start-up skills.

Getting started in science

Pre-doctoral students represent the primary target group for the entry into science and research. All research institutions with the right to award doctorates should be mentioned first of all here, including primarily the universities, which recruit a large number of pre-doctoral university assistants and provide these with the opportunity to complete a doctoral programme. ISTA is also authorised to establish PhD programmes or combined Master's/PhD programmes and provides a graduate school as internationally established doctoral training for top-level researchers in the STEM fields.

Pre-doctoral students are the focus of three FWF programmes funded by the Federal Ministry of Education, Science and Research (BMBWF) and the National Foundation. The *Doktoratskollegs* currently in the winding-up stage promote training centres at universities for highly-qualified early stage researchers from the national and international scientific community. The aim is to train doctoral candidates in a structured way, building on a medium-term and clearly defined (cross-disciplinary) research context.

The successor programme doc.funds offers additional funding within the framework of structured doctoral programmes for the integration of doctoral candidates in temporary research projects. Doctoral training between universities of applied sciences and universities and the establishment of a cooperational doctoral programme are funded by doc.funds.connect.

In addition, doctoral candidates at the OeAW are funded by means of DOC scholarships lasting between 24 and 36 months, which are intended to ensure that the scholarship holders concentrate on writing their theses. Within the framework of DOC-team, groups of three to four doctoral candidates receive support to work together on an interdisciplinary research question to promote the exchange and discussion of different disciplines. Immediately after completing the thesis, the scholarship is available to POST-DOC TRACK graduates in the humanities, social sciences and cultural studies who wish to pursue an academic career, to facilitate the transition to the post-doctoral phase.

In addition, the Federal Ministry of Education, Science and Research (BMBWF) offers (doctoral) students various scholarships for gaining experience abroad and for international networking during their studies, which are handled by the OeAD. Funding is provided both for Austrian students who complete

part of their studies abroad (outgoing) and for foreign students who spend part of their studies in Austria (incoming). Examples include the Marietta Blau Scholarship, the Doctoral Scholarship for the European University Institute Florence (outgoing) and the Ernst Mach Scholarship (incoming) as well as various exchange programmes with neighbouring countries.

Within the framework of the "Research partnerships – industry-related theses" programme financed by the National Foundation for Research, Technology and Development (NFTE) and the Austria Fund, the Austrian Research Promotion Agency (FFG) also funds industry-related thesis projects in the field of natural sciences and technology in companies and non-university research institutions. This is intended to facilitate entry into non-university research careers and make highly qualified staff available for Austrian industry. The Christian Doppler Research Association (CDG) – financed by the Federal Ministry of Labour and Economy (BMAW) – supports theses and master's dissertations at universities (CD Laboratories) and universities of applied sciences (Josef Ressel Centres – JR Centres) as part of the cooperation between science and business. This enables application-oriented basic research to be promoted in direct cooperation with companies. Going far beyond dissertations, the CD Laboratories and JR Centres are also associated with sustainable establishment in the science and research system by the respective laboratory or centre director.

The systematic development and expansion of research, development, innovation and digitisation skills in companies, as well as the transfer of knowledge and cooperation between science and business, are the focus of the "Qualification Campaign" by the Federal Ministry of Labour and Economy (BMAW) (predecessor programme "R&D Competences for Industry"). Digital Skills Cheques, Innovation Camps and Digital Pro Bootcamps promote professional development, cooperative qualification projects and higher qualifications among IT professionals.

Establishment in the science and research system

Several Austrian Science Fund (FWF) programmes funded by the BMBWF and the National Foundation for Research, Technology and Development (NFTE) enable post-doctoral students to finance their research projects. The FWF's ESPRIT Programme (Early-Stage-Programme: Research-Innovation-Training) is aimed at highly qualified post-docs of all disciplines who are at the beginning of their careers. They are carrying out an independent research project at an Austrian research institution and are supported by mentors. The Young Independent Researcher Groups funded by the National Foundation for RTD support internationally outstanding teams of post-docs whose doctorates date back a maximum of five years. The aim is to enable interdisciplinary research collaboration at a minimum of two research institutions or two organisational units of a research institution on a complex, current topic in mixed teams.

Scholarships for the first post-doc phase are also provided by APART-humanities, social sciences and cultural studies (GSK) as well as APART-STEM from the Austrian Academy of Sciences (OeAW) for excellent early stage researchers in the humanities, social and cultural sciences or mathematics, natural and life sciences, engineering sciences and medicine.

The mobility programmes enable students to gain experience abroad. The Schrödinger Scholarship (Erwin Schrödinger Fellowships Abroad with Return Phase) of the FWF supports work at leading research institutions abroad during the post-doctoral phase, as well as a return phase after the stay abroad if there is no permanent or longer-term employment contract with the Austrian research institution to which the return should be made. The Lise Meitner Programme from the FWF was aimed at post-docs from abroad or returnees who, at the invitation of an Austrian research institution, were seeking a (renewed) connection to the Austrian science system (the programme is currently being migrated over to the ESPRIT programme).

The START Programme from the FWF is aimed at excellent researchers with at least two years of research experience who want to qualify for a leading position, especially a professorship, by establishing and leading a research group. Just like the award winners of the Wittgenstein Award (see below), the projects (approx. 6 per year) are selected by an international jury and underline the character of excellence within the programme.

With the endowed professorship instrument *(Stiftungsprofessur)*, the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) is promoting the development and establishment of new topics at Austrian universities that are of particular strategic relevance for Austria as a location for innovation by appointing outstanding researchers as new professors at Austrian universities. Depending on the university, the person appointed receives a permanent position right at the beginning or this is held out as a prospect, provided that they receive a positive evaluation. In addition to achieving a sustainable critical mass in the respective research field, the focus here is on establishing strategic cooperation between universities and companies and strengthening the research teams by training early stage researchers.

Renowned scientists

As the most important funding award and with the highest endowment in Austria, the Austrian Science Fund (FWF) Wittgenstein Award is awarded once a year by the Minister of Science to a scientist from an Austrian research institution who is firmly established in the international scientific community and has made outstanding scientific achievements. The prize money is intended to enable the award winners to further improve and expand their research activities and to establish research groups with the greatest possible freedom and flexibility.

As the first of three pillars of the excellent=austria funding campaign, the Clusters of Excellence (COE) enable groups of scientists at Austrian research institutions to achieve outstanding cooperative research achievements in a scientific or artistic/scientific field or in an interdisciplinary manner and to incorporate this field of research into the top international level in Austria in the long term. Promoting early stage researchers and research-led education are a central component of the COEs in this regard.

Specific measures to increase equal opportunities in science and research

Gender equality in research is a concern of the FWF, and is implemented through specific programmes as well as gender mainstreaming in all areas. Until 2020, the Hertha Firnberg Programme was aimed at female post-docs who were at the beginning of their scientific career. The ESPRIT Programme (see above), which pays special attention to the goal of promoting women, has been available since 2021. Highly-qualified female researchers are also eligible for the Elise Richter Senior Post-doc Programme (Elise Richter PEEK for women working in the arts and sciences). Funding is provided for a project or planned post-doctoral thesis that qualifies for application for a professorship at the end of the funding period.

Within the framework of the L'ORÉAL Austria funding programme, scholarships are awarded by the OeAW to highly-qualified young female researchers in medicine, the natural sciences or mathematics. Funding is provided to projects by pre-docs and post-docs in basic research to support the start of their scientific career or (re-)entry into a scientific career.

All activities and measures by the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) to promote equal opportunities in RTI operate under the FEMtech label. The FEMtech initiative includes services and networking initiatives. Accordingly, the FEMtech expert database currently contains over 2,000 female experts from various disciplines with a focus on science and technology. The spotlight each month is on the "FEMtech Expert of the Month" and this individual also appears on the FEMtech website. Publica-

tions and data as well as career information on gender-relevant topics in RTI can be found under "FEMtech Knowledge". In addition to keynote speeches and panel discussions, the FEMtech network meetings held approximately twice a year provide a space for informal exchange and discussion between researchers and those interested in promoting diversity in RTI.

The "FEMtech internships for female students" programme line under the Talent funding priority specifically supports early stage female researchers in gaining a foothold in applied research in science and technology. Here, female students learn about career entry and advancement paths and gain an insight into applied research during the internships, which last up to 6 months. FEMtech Career addresses the structural level for establishing equal opportunities. The funding supports companies in the field of research and development as well as non-university research institutions in natural sciences and technology with targeted promotion for women and implementation of equal opportunities measures. Project activities eligible for funding include those aimed at building gender competence in the company, improving human resources management, creating a work/life balance, promoting and developing the careers of qualified female employees, redesigning public relations and developing gender equality plans.

With *"INNOVATORINNEN"* (FEMALE INNOVATORS) (formerly *w-fFORTE*), the Federal Ministry of Labour and Economy (BMAW) aims to provide targeted support for women in location-specific research and innovation (R&I) and ensure visibility for these. Highly-qualified women are encouraged to develop their ideas, establish new network connections and achieve more creative freedom and professional advancement. The BMAW's programme in particular offers workshops, events, the *INNOVATORINNEN* LEADERSHIP programme, an alumnae network (under development) and the new *INNOVATORINNEN* CLUB (also under development) to female researchers, innovators and R&I entrepreneurs.

Specific measures in the STEM area

There are numerous activities aimed at supporting the development of STEM in Austria, all of which are also intended to contribute towards achieving the goals in the RTI strategy, namely to strengthen education and training – especially in the area of STEM, to increase the share of mathematics, information technology, natural sciences and technology (STEM) graduates by 20%, to increase the share of female graduates in technical subjects by 5%, and to increase the number of Austrian STEM students who complete a degree or study semester abroad through funding programmes by 100% by 2030. Some initiatives are therefore briefly outlined below.

STEM Ideas Competition – Girls Challenge is a joint Austria-wide initiative of the Federal Minister for Women, Family, Youth and Integration (Federal Chancellery), the Federal Minister for Digital and Economic Affairs and the Federation of Austrian Industry. Austria needs a high proportion of women in STEM fields so that old role models and stereotypes can finally be broken down and the participation and visibility of girls and young women in future industries can be clearly strengthened. The aim is to counteract the shortage of skilled workers in Austria as a place for business.

The STEM quality seal joint initiative of the Federal Ministry of Education, Science and Research (BMBWF) and Federation of Austrian Industry is aimed at increasing interest in the STEM subjects. The seal of quality is awarded to educational institutions that promote innovative and inspiring learning in mathematics, information technology, natural sciences and technology through various measures. The STEM map shows all educational institutions that have been awarded the STEM quality seal. Schools can be supported in their efforts towards becoming a STEM school by means of brochures and STEM coaching. The STEM Gender Segregation Expert Circle set up in 2021 at the Federal Ministry of Education, Science and Research (BMBWF) and consisting of school and higher education institution experts will develop a strategy in 2022 aimed at attracting more girls and

women or more people generally to train in technology and computer science.

Performance agreements were entered into in 2021 with the 22 public universities for the 2022–2024 period. These will continue to focus on STEM, as was already the case in the 2019–2021 performance agreements. The universities offering STEM courses were able to record high budget increases, which serve, amongst other things, to improve support and supervision ratios and strengthen the STEM field. The STEM focus area of computer science and technology is of particular importance here, partly because of the shortage of skilled workers. The projects and objectives agreed with the universities can be divided into the following categories: Creation of new study programmes to strengthen STEM/AI, measures to recruit students and to operate at the school/higher education interface, recruitment and promotion of women in STEM studies, supporting measures at the start of studies, and supporting measures to increase studying feasibility and to reduce dropouts or job outs.

Conclusion

The importance of promoting talent for the Austrian science and research system is taken into account through a variety of measures and funding programmes. These programmes are used to provide additional support and targeted funding for talented candidates at schools, higher education institutions and research institutions. The target group is defined very broadly, with children and young people addressed before a possible entry into the sector as well as early stage researchers and established scientists who would like e.g. to qualify for a professorship. A range of different funding instruments are available in accordance with the heterogeneous nature of the target group, and the responsible ministries and research funding institutions set priorities according to their responsibilities and narrower target group.

The effectiveness of the programmes is reviewed through regular evaluations. It is evident that the effects are all the more difficult to assess the earlier they begin in the "research career". Measures aimed at introducing children and young people to research and offering insights into the system are only one factor among many in their later choice of education and career.

Most of the instruments also link to individuals and aim to improve individual factors that can contribute towards becoming established and remaining in the science and research system (e.g. theses, leading research projects, experience abroad, establishing and leading research groups). This can have very positive effects at the individual level, but the attractiveness of the research location depends crucially on the systemic framework conditions. The promotion of sustainable talent and early stage researchers, which both attracts talent to science and research and also retains this, requires examination of these framework conditions, especially with regard to career prospects, planning ability and work/life balance. Sustainable and comprehensive support for people must consider and address both the individual and the structural levels. The importance of supporting (potential) researchers can also be promoted more broadly by establishing this as a cross-sectional issue and giving it greater consideration in selection processes.

2.4.2 Quantum research & high-performance computing

Lasers, semiconductors, satellite navigation and magnetic resonance tomography: these all belong to the first generation of quantum technologies and are based on the use of the collective properties of quantum systems. The term quantum refers to the smallest possible particles of light, matter and energy known to us. Second-generation quantum technologies, which make it possible to harness not only the properties of entire quantum systems, but also those of individual particles, are currently facing a decisive turning point in the further development of application-relevant key technologies. In the future, the underlying physical principles will open the door to completely new applications involving highly com-

plex computations (quantum computing), in communication security (quantum communication and cryptography), or in measurement technology (quantum metrology, optics, sensor technology).[171]

Quantum computing

Future quantum computers are said to have the potential to perform complex calculations in a fraction of the time – normally taking conventional systems many years to complete. While conventional systems carry out the respective computing steps sequentially, quantum computers are able to process them simultaneously. This is made possible by the phenomenon known as "quantum superposition", according to which quanta can assume two states, such as 1 and 0, at the same time, forming a qubit. The phenomenon of "quantum entanglement" also enables the linking of quanta across spatial frontiers, creating further potentials in simultaneous execution. Since the state of superposition, as well as other quantum physical phenomena, can be lost by the slightest perturbation, not only generation but also maintenance and error resilience are key hurdles in the development of a working quantum computer.[172]

The most relevant platforms according to current research are superconductors or ion traps. A superconducting qubit offers the advantage of accelerated computing speed compared to other platforms, but at the cost of increased error-proneness. In addition, the functioning of such a system requires a temperature around absolute zero of -273.15 °C. In contrast, the operation of a quantum computer based on the ion trap principle is possible at room temperature and takes place under vacuum. The platform offers higher accuracy, but is slower. The increased computing power and speed of quantum computers could find economic application in solving complex mathematical optimisation tasks, amongst other things. At times cost- and time-intensive experiments would enable accelerated findings on new substances, the optimisation of industrial chemical processes or artificial intelligence. However, the enormous potential of quantum computers could also make many currently used encryption methods easy to "crack" in the future.[173]

Quantum communication and cryptography

This is where quantum communication and so-called quantum-safe cryptography come in, whose encryption even a quantum computer cannot crack. Besides the potential threats to communication security on the one hand, quantum technologies on the other hand offer possibilities of a probably completely tap-proof quantum communication. This is made possible by the quantum phenomenon, which is also known as the "observer effect". Due to this effect, a quantum-based key (Quantum Key Distribution, QKD) can neither be copied (error-free) nor read out, because the observation or reading out in itself represents an interaction that changes the quantum properties and therefore also the properties of the key. At the same time, however, this is also a challenge for the range of such communication systems – a range currently spanning a maximum of 100 kilometres for transmission via optical fibre. Since it is not possible to transmit or amplify the signal with the given possibilities without interacting with the key and thereby changing it, further research efforts are required with regard to new technical solutions in order to realise a long-range quantum communication network.[174] Current developments, such as in the course of the EuroQCI initiative, focus on networking terrestrial and space (ground stations and satellites) elements.

171 See acatech (2020a).
172 See AIT (2019), acatech (2020a).
173 See acatech (2020a).
174 See AIT (2019), acatech (2020a).

Quantum sensing (imaging, metrology, optics)
Another technology field in quantum research that is growing fast is quantum sensing/metrology/optics, which summarises potential applications in control and measurement technology. Measured in terms of publication and patent dynamics, it represents a relatively young research field compared to the other application fields of quantum computing and communication. The measurement precision made possible by quantum-based systems allows, for example, an even more precise definition of physical units such as metres, kilograms, seconds, etc. This would enable even the smallest changes to be perceived, and quantities treated as constants may appear in a new light. Forces such as magnetism or gravitation and their effects can be comprehended in an increased degree of detail through quantum sensor technology, which could, amongst other things, improve the efficiency in medical diagnostics. Quantum-based optical systems have the potential to provide new insights into the microcosm through, amongst other things, increased resolution and the possibility of examining light-sensitive objects.[175]

For the last few years, leading industrial nations have been increasingly competing for an international leading position in the economic use of quantum technologies, and currently significant investments in large-scale quantum funding programmes can be observed around the world. Despite high expectations for future technical applications, however, quantum technologies are still – depending on the area of application – in very different stages of realisation and are still a field of basic research in many areas. A transfer to large-scale industry, SMEs and start-ups represent a key prerequisite for realising their potential. Furthermore, broader application perspectives and utilisation possibilities in the field of quantum technologies also increasingly require a debate of long-term ethical and social as well as legal and security policy aspects.[176]

Europe can already look back on decades of excellent research efforts in the field of quantum technologies, as can Austria, where a large number of institutions are researching quantum technologies, including the Universities of Vienna and Innsbruck, TU Wien, the OeAW or the AIT.[177] The number of publications on quantum technologies altogether underpins Europe's technologically important position (EU incl. non-EU). In addition, a significant proportion of publications originating from Europe are found within the most cited (top 10%) research papers. The quality and citation rate of publications from Austria is particularly high, positioning the location internationally as an important centre of excellence (see also Chapter 2.2).[178]

However, when it comes to translating scientific competence into an application-oriented context (measured, for example, by the share of patents in the field of quantum technologies), Europe, with the exception of the United Kingdom, lags clearly behind countries such as the United States and China.[179] There is therefore a need for action to bundle Europe's quantum technology competences and to translate them into applications so as not to lose out internationally. As a result, the efforts of the EU, dedicated to the research and development of quantum technologies in a variety of initiatives, are all the more important. Current European support activities are manifested in the Quantum Flagship initiative, in QuantERA or also in the form of infrastructure initiatives such as EuroQCI (European Quantum Communication Infrastructure) or EuroQCS (European Quantum Computing and Simulation) as well as the joint undertaking EuroHPC.

175 See iit (2019), acatech (2020a).
176 See Fraunhofer (2021a), ITA and AIT (2021).
177 See ITA and AIT (2021).
178 See iit (2019), Bornmann et al. (2019).
179 See iit (2019).

The European flagship initiative "Quantum Technologies (QT) Flagship"[180] on quantum technology was launched by the EU in 2018. *It was created on the basis of the EU Commission's 2016 Quantum Manifesto*[181] signed by more than 3,500 representatives of the field from across Europe with the aim of promoting Europe's scientific leadership role and excellence in quantum through the development of a competitive quantum industrial and research ecosystem.[182] The EU's detailed objectives for quantum R&I in the coming decade are set out in the Strategic Research Agenda of the Quantum Flagship and the associated Key Performance Indicators on quantum computing, simulation, communication and sensing and metrology.[183] Projects in each of these areas are currently supported by the Flagship by other EU research initiatives and by national programmes, and now embedded in Horizon Europe (2021–2027), quantum research and technologies will continue to be massively supported and expanded in the future.[184]

In the three-year project start-up phase of the Flagship, 20 projects with a total funding volume of €152 million were funded by the EU Research Framework Programme Horizon 2020. Austrian research teams are involved in six of them, and two of the projects are being led under Austrian coordination[185]: The UNIQORN[186] project (led by AIT) aims to miniaturise systems for quantum communication – currently mostly found only in laboratories – into compact, robust and integrated circuits, and AQTION[187] (coordinated by the University of Innsbruck) aims to realise a scalable ion-based quantum computer with a performance of 50 qubits. In this context, the foundation of the quantum computer start-up Alpine Quantum Technologies (AQT)[188] in Innsbruck also sends important signals globally for the further commercialisation of quantum technology from Austria.

With QuantERA[189], there is also a European network for the coordination of national and regional research programmes in the field of quantum technologies. The goal of the programme, which was launched in 2016 as ERA-NET COFUND, is to support transnational partnerships of research institutions and business enterprises in the field of quantum technology. QuantERA acts as a complementary project to the Quantum Technologies Flagship; ideas and projects developed under QuantERA can contribute to QT Flagship projects or be integrated as such. Among QuantERA partner countries, many also invest in other transnational or national programmes on quantum technologies. A current QuantERA report finds considerable differences in national budgets, and shows that Austria invests above average in quantum research funding programmes compared to other EU countries – only Germany and the UK invest more.[190]

QuantERA calls for proposals are coordinated at EU level, but implemented by the funding agencies of the individual nation states. Funds also come from both the EU and national funding programmes. For example, under QuantERA I, a total of €45 million in national/regional funding and €11.5 million in EU funding was invested in two calls (2017 and 2019). Within the scope of the 2019 call for proposals, 12 projects were supported. Three of them are with Austrian participation, one is coordinated at the Uni-

180 https://qt.eu/
181 https://qt.eu/app/uploads/2018/04/93056_Quantum-Manifesto_WEB.pdf
182 https://science.apa.at/power-search/3527850200550234531
183 See European Quantum Flagship (2020).
184 See European Commission (2021p).
185 https://www.ffg.at/news/quanten-pionier-oesterreich-schneidet-bei-europaeischem-quantum-flagship-hervorragend-ab
186 https://quantum-uniqorn.eu/; https://cordis.europa.eu/project/id/820474; https://science.apa.at/power-search/7815338101483130338
187 https://www.aqtion.eu/; https://cordis.europa.eu/project/id/820495/de
188 https://www.aqt.eu/
189 https://www.quantera.eu/
190 QUANTERA (2020).

versity of Innsbruck.[191] QuCoS is researching new, alternative approaches for quantum computers, as part of the MAQS, a magnetic atom-based quantum simulator is being developed, eDICT is working on secure quantum cryptography and PACE-IN is researching suitable interfaces for quantum communication devices.[192]

In the meantime, the QuantERA Call for Proposals 2021 was closed last year. 39 projects with a total funding volume of €43.5 million were selected.[193] Austrian research teams are involved in a total of ten projects, three of which are coordinated under Austrian leadership: PhoMemtor (University of Vienna) and STAQS (University of Innsbruck) in the field of basic research, and the SIQCI project (Alpine Quantum Technologies GmbH) in the field of applied research.[194]

QuantERA Calls for Proposals are carried out in Austria within the framework of the national quantum technology programme Quantum Science and Technology (QFTE) by the FFG in cooperation with the FWF. The goal of the QFTE project is to expand the competences and capacities in quantum research and technology in Austria and to strengthen the involvement of Austrian players in European quantum technology initiatives. Cooperative relationships between science and industry are to be supported in order to increase the transfer of knowledge from basic research into future fields of development and application of research-active companies.[195]

The transnational Calls for Proposals of the QuantERA Programme are also supported monetarily by the Quantum Research and Technology (QFTE) Programme; for example, the QuantERA Call 2021 was supplemented by a total of €2 million from the funds of the National Foundation for Research, Technology and Development (NFTE). [196] However, purely national calls for proposals also took place via the QFTE Programme in the years 2018 to 2020. The volume in each case was between €4.2 and €4.5 million and also came from NFTE funds.[197] Within the framework of the national call for proposals in 2020, projects from the field of quantum computing were most recently selected. For example, work is being done on ion trap-based quantum processors, scalable quantum chips and a quantum architecture specialised in optimisation tasks.[198]

Additionally, the QKD4GOV project – Quantum-safe Cryptography for Securing Governmental data – is managed via the national funding programme KIRAS.[199] In the Digital Europe Programme (Work Programme 2021–2022), the first expansion stage of EuroQCI is also funded through three Actions.[200]

With the aim of providing sustainable economic impetus in the wake of the COVID-19 crisis and continuing to ensure Austria's competitive position, the Quantum Austria funding offensive was also launched. The initiative is part of Austria's Recovery and Resilience Plan and can be counted as part of the RTI Strategy 2030. Its goal is to intensify basic

191 https://quantera.eu/statistics-of-the-quantera-call-2017; https://quantera.eu/statistics-of-the-quantera-call-2019/
192 https://quantera.eu/project-catalogue-2019/
193 https://quantera.eu/quantera-call-2021-39-european-excellent-projects-awarded-funding/
194 https://quantera.eu/wp-content/uploads/2022/01/QuantERAII_Call_2021_Funded_Projects_alford1.pdf
195 https://www.ffg.at/quantenforschung-und-technologie
196 https://www.ffg.at/2021-ausschreibung-qfte-transnational
197 https://www.ffg.at/quantenforschung-und-technologie
198 https://projekte.ffg.at/projekt/3995850; https://projekte.ffg.at/projekt/3996896; https://projekte.ffg.at/projekt/3995844
199 https://www.kiras.at/gefoerderte-projekte/detail/qkd4gov
200 https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-search;callCode=DIGITAL-2021-QCI-01;freeTextSearchKeyword=;matchWholeText=true;typeCodes=1;statusCodes=31094501,31094502,31094503;programmePeriod=null;programCcm2Id=null;programDivisionCode=null;focusAreaCode=null;destination=null;mission=null;geographicalZonesCode=null;programmeDivisionProspect=null;startDateLte=null;startDateGte=null;crossCuttingPriorityCode=null;cpvCode=null;performanceOfDelivery=null;sortQuery=sortStatus;orderBy=asc;onlyTenders=false;topicListKey=callTopicSearchTableState

research in the field of quantum physics and quantum computing as well as to successfully use already existing quantum technologies in products and services. The focus of this initiative is in particular on the further upgrade of capacities and infrastructure in the area of quantum computing and High-Performance Computing (HPC). A total of €107 million is being made available for this purpose between 2021 and 2026 from the European recovery plan NextGeneration EU. In the national implementation of the Quantum Austria funding initiative, the FFG and the FWF work closely together as processing and implementing agencies on behalf of the BMBWF.[201] In the first call for proposals phase, from December 2021 to the end of March or May 2022, about €39 million will be made available via the FFG, and four different project types will be funded: Collaborative and stand-alone projects in the area of applied research, flagship projects (projects with costs of at least €2 million in which at least two companies and one research institution are working), and projects to build up the R&D infrastructure. In the area of basic research, the FWF provides funding within the framework of existing Quantum Austria-relevant funding programmes: Projects (Stand-Alone-Projects), career advancement (ESPRIT & Erwin Schrödinger Fellowships) and collaborations (1000 Ideas Programme). A total of about €29 million is made available for this purpose, and applications can be made on an ongoing basis until June 2024.[202]

High-Performance Computing

High-Performance Computing (HPC) is a key driver of the digital transformation and an umbrella term for all computing tasks that require high computing power and storage capacities. In HPC, a large number of processors are interconnected in highly integrated systems and computing power is aggregated in so-called supercomputers. These are many times more powerful and faster than conventional computers (e.g. desktop computers) and can process large amounts of data. To be able to employ components (computing architectures and algorithms) that are optimally coordinated in the hardware-software-code design for different research and application fields, new types of supercomputers are modularly constructed according to the modular design principle and are usually organised in clusters. Networking and interconnecting these highly specialised components thus enable high-performance, task-optimised, scalable and flexible computing.[203]

In addition to massively parallel processing and edge computing concepts, disruptive technologies such as neuromorphic computing and quantum computing are also being employed for high-performance computing.[204] These approaches, in turn, form the basis for next-generation computing infrastructures (exascale supercomputers), promising a massive acceleration of innovation processes. In addition to computing power, however, the energy efficiency of computing technologies (Green IT or Green HCP) will play an increasingly important role in the growing use of HPC applications and systems in the future. With the aim of making a significant contribution to the Green Transition goals as part of the Green Deal in the energy-intensive HPC sector, future investments in Green HPC will increasingly focus on renewable energy use and sustainable energy efficiency.[205]

HPC is already an integral part of numerous research and application fields. Many issues in science and industry require increasingly complex models and can only be answered through the use of mas-

201 https://www.ffg.at/quantum-austria; https://www.ots.at/presseaussendung/OTS_20211125_OTS0059/oesterreich-startet-forschungsoffensive-quantum-austria; https://www.bundeskanzleramt.gv.at/eu-aufbauplan/projekte/quantum-austria.html

202 https://www.fwf.ac.at/de/forschungsfoerderung/fwf-programme/foerderinitiative-quantum-austria; https://www.ffg.at/quantum-austria/1-ausschreibung; https://www.ffg.at/quantum-austria/1-ausschreibung-leitprojekt

203 See BMF (2021); Fraunhofer (2021b).

204 One example, amongst others, is the project High-Performance Computer and Quantum Simulator hybrid (HPCQS), which can be seen as a pioneer for a federated quantum supercomputing ecosystem in Europe (https://www.hpcqs.eu/).

205 See BMF (2021); Fraunhofer (2021b).

sive computing power. An important field of application for high-performance computers is scientific computing in meteorology, astrophysics and particle physics, material sciences, systems biology, genetics, quantum chemistry and fluid mechanics. Artificial intelligence, machine learning and Big Data analyses are opening up further research and application areas, and almost every industry now benefits from the enormous computing power, be it the pharmaceutical industry, the chemical industry, the finance and insurance industry, the automotive and mobility industry, etc.

As a key technology of the 21st century, HPC is also an increasingly important topic at the European level, and European initiatives such as the European High Performance Computing Joint Undertaking (EuroHPC)[206] aim to secure Europe's digital sovereignty by expanding access to key HPC technologies and thus the competitiveness of research and industry.

EuroHPC is constituted as a European partnership between the European Union, participating countries and industry associations in the form of a Joint Undertaking. In 2021, against the backdrop of developments in high-performance computing, the 2018 Regulation was revised to ensure the continuation of the initiative.[207] The new regulation was aligned with the EU's Multiannual Financial Framework for 2021–2027, allowing the Joint Undertaking to use funds from EU programmes such as Horizon Europe, Digital Europe and the Connecting Europe facility. EuroHPC projects aim to create a world-leading federated, secure and hyper-connected ecosystem for high-performance computing, quantum computing, services and data infrastructures in the EU and sustain it over the long term through on-going enhancements. The European Processor Initiative (EPI)[208] already initiated under Horizon 2020 – the first phase of which was successfully completed at the end of 2021[209] – brings together 28 partners from ten European countries with the common goal of making Europe less dependent on suppliers from countries such as the USA and China for important computer components (microprocessors, HPC systems for chips and accelerator units) and to develop the prerequisites for an exascale supercomputer based on European technology. Other EuroHPC projects such as EuroCC and CASTIEL[210] are building a Europe-wide network of centres of excellence in supercomputing. The aim of the EuroCC cooperation involving 33 participating countries is to raise Europe's HPC skills to a higher level as well as to make HPC expertise available to various users from science, industry and the public sector.[211]

Austria has also invested in the expansion of HPC infrastructure in recent years, and there are numerous HPC initiatives or corresponding participations in European projects such as PRACE[212] (Partnership for Advanced Computing in Europe) and EuroCC. The national competence centre EuroCC Austria, founded in 2020, uses publicly visible and selected research infrastructures to illustrate the Austrian development of a competitive supercomputing ecosystem and is operated within the framework of the Vienna Scientific Cluster (VSC) consortium by the University of Vienna, TU Wien, the University of Innsbruck, the University of Natural Resources and Life Sciences Vienna and the Graz University of Technology, in close cooperation with the business incubator INiTS, as a national node in the European network.[213]

In the VSC, a VSC-5 is currently being set up at TU Wien with significant support from the BMBWF. The

206 https://eurohpc-ju.europa.eu/
207 https://data.consilium.europa.eu/doc/document/ST-9273-2021-INIT/de/pdf
208 https://www.european-processor-initiative.eu/
209 https://www.european-processor-initiative.eu/successful-conclusion-of-european-processor-initiative-phase-one
210 https://digital-strategy.ec.europa.eu/en/news/eurocc-and-castiel-two-new-projects-boost-european-hpc-knowledge-and-opportunities
211 https://eurocc-austria.at/ueberuns/eurocc
212 https://prace-ri.eu/; https://www.aco.net/prace.html
213 https://eurocc-austria.at/ueberuns/eurocc; https://forschungsinfrastruktur.bmbwf.gv.at/de/cluster/high-performance-computing-eurocc-austria_1?sort=datum&page=1&per-page=10

Fig. 2-49: HPC research institutions and infrastructures in Austria

Source: https://forschungsinfrastruktur.bmbwf.gv.at/de/cluster/high-performance-computing-eurocc-austria_1

system will consist of almost 99,000 AMD cores – more than two and a half times the 37,920 cores that made up the predecessor VSC-4.[214] TU Wien is also part of the first European Master's Programme in High Performance Computing. Universities, research and supercomputing centres, as well as industrial partners, are joining forces at the initiative of EuroHPC to train highly qualified specialists and launch a training programme. The consortium of 60 partners is led by the University of Luxembourg and the first courses are scheduled to start as early as in fall 2022.[215]

At present, users of HPC installations still come predominantly from the academic sector. For an increasingly (application-oriented) industrial use, corresponding service structures and funding initiatives will also be needed in the future. A good example of this are calls for proposals initiated by the BMK, such as the call for HPC exploratory studies[216] as part of the funding programme ICT of the Future. The goal of this national call is to make the existing HPC ecosystem accessible to Austrian companies, especially SMEs, and to promote the use of this ecosystem for company-specific HPC use cases. In the EuroHPC Calls 2019 (Towards Extreme Scale Technologies and Applications)[217] and 2020 (Advanced Pilots Towards the European Exascale Supercomputers)[218], which were also launched by the BMK, transnational collaborative industrial research projects were funded.

2.4.3 Circular economy & sustainability

The federal government attributes a key role to research and innovation in the transition to a socially and environmentally sustainable economy. To this end, the national climate and energy strategy #mission2030[219] foresees intensive efforts in the further development of energy and environmental technologies. In parallel, climate protection was anchored as a priority field for research and development in the national RTI strategy.[220]

To meet major societal challenges such as climate change, biodiversity loss and resource scarcity, research funding needs to adopt a more goal-oriented, thematic orientation and an increased focus on the transfer of innovative solutions into practice. Accordingly, the funding portfolio has already been enriched with significant environmental and climate-related programmes and new instruments for promoting local and regional demonstration projects and innovation laboratories.[221] Exemplary for this are funding programmes such as *Vorzeigeregion Energie* (Flagship region Energy) and the Smart Cities Demo, which are intended to contribute to the development of holistic, integrated and local solutions for achieving climate goals.[222]

With the introduction of the "circular economy" as a new, interdisciplinary and cross-thematic RTI focus area, the federal government is taking another decisive step towards addressing the ecological challenges of our time and the development of a new

214 https://www.tuwien.at/tu-wien/aktuelles/news/news/ein-neuer-supercomputer-fuer-oesterreichs-forschung; Note: The VSC-4 is currently considered the fastest supercomputer in Austria (ranked 199th, as of November 2021) in the worldwide ranking of the top 500 supercomputers (https://www.top500.org/)

215 https://www.tuwien.at/tu-wien/aktuelles/news/news/europaeisches-masterprogramm-fuer-high-performance-computing

216 See BMF (2021); https://www.ffg.at/eurohpc/sondierung

217 See BMK (2019); https://www.ffg.at/eurohpc/Call2019

218 See BMK (2020); https://www.ffg.at/ausschreibung/eurohpc-ausschreibung-2020

219 See BMNT and BMVIT (2018).

220 See Federal Government of the Republic of Austria (2020b).

221 See Wieser et al. (2021).

222 A concise summary of climate-related research in Austria can be found in the Austrian Research and Technology Report 2021.

economic model to secure the local supply and performance of the Austrian economy.[223] For the years 2022 and 2023, a total of €60 million is available for this from the funds of the climate protection and economic stimulus package.

From energy to resources: Circular economy as a new RTI focus area

The new strategic objectives are accompanied by a significant widening of the research and development projects previously supported in thematic funding programmes (see Figure 2-50). Compared to the focus on the development of sustainable energy systems, the concept of the circular economy is based on a broader understanding of resource efficiency.[224] On the one hand, a circular economy takes into account both energetic and material resources, meaning that the energy tied up in processed products or infrastructures, as well as problems of material scarcity and the disposal of materials discarded, also come into focus. On the other hand, resource efficiency in a circular economy is not only measured in terms of the resources used for existing products but also in terms of all the resources required for the performance of a service. A circular economy therefore looks for holistic solutions that allow meeting individual needs with as little resource inputs as possible.

A circular economy is thus based on much more than the recycling of valuable resources (see Fig. 2-50). Instead, the aim is to both close, slow and narrow energy and material cycles. This also includes a far-reaching conversion to regenerable resources in the sense of a bioeconomy[225], which is therefore understood as an integral part of the Circular Economy RTI focus area.

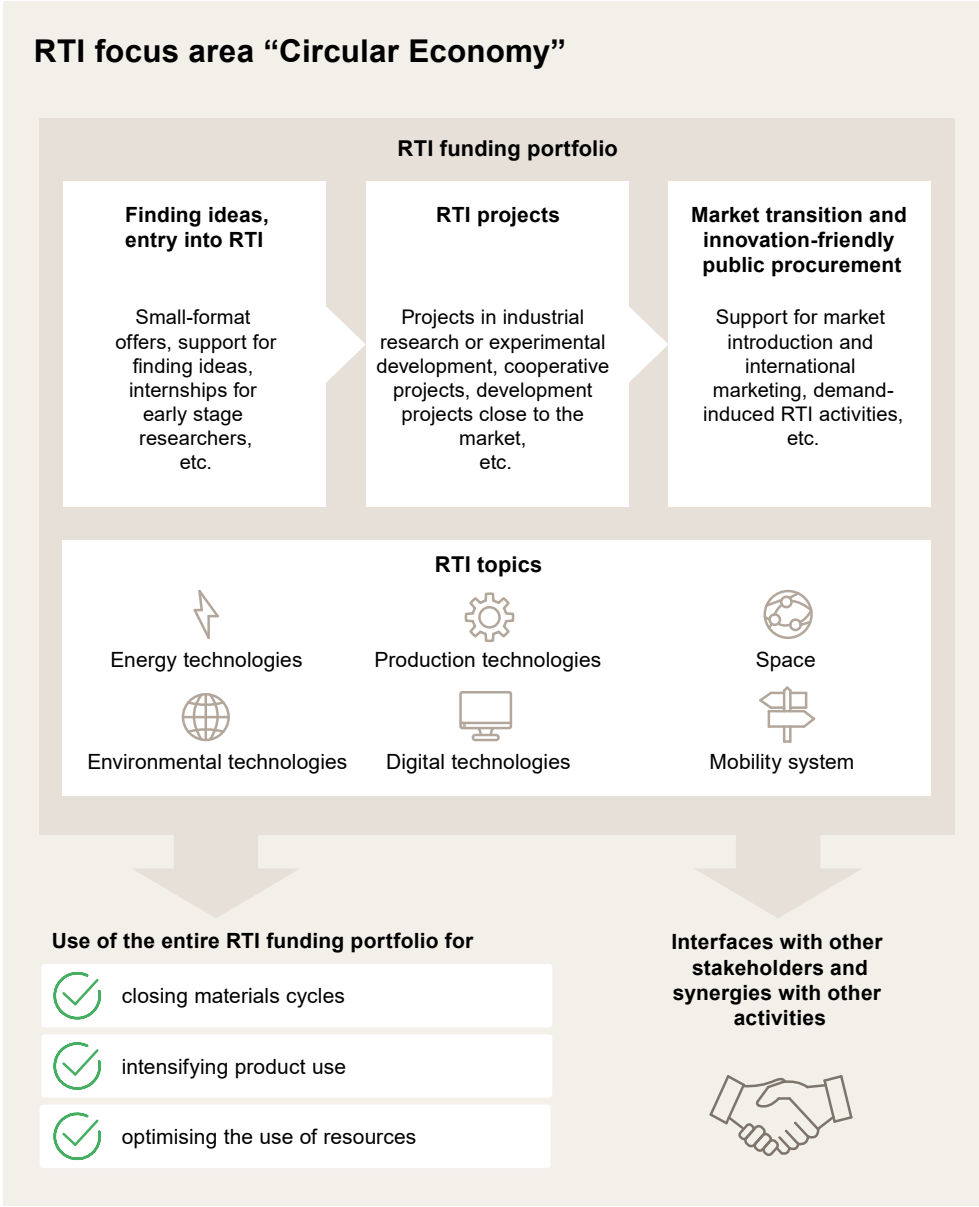
To achieve the mission *"Österreich auf dem Weg zu einer nachhaltigen und zirkulären Gesellschaft"* (Austria on the way to a sustainable and circular society), the federal government has the following RTI objectives[226]:

- RTI Objective 1: Closing material cycles: Research and development projects explore, develop and test systemic innovations that holistically consider the value retention of goods throughout their entire life cycle. The participation of actors along the entire value chain (material/product manufacturers, logisticians, end users, collection/sorting/recycling companies, etc.) is essential in the development of innovative value cycles.
- RTI Objective 2: Intensification of product use: Through reuse, repair, refurbishment, remanufacture, repurpose and further strategies, research and development projects contribute to a significant extension of the life and functional upgrading of products, whereby innovative business models can contribute to the more frequent use of these products.
- RTI Objective 3: Optimised use of resources: Research and development projects in the area of intelligent product design or process engineering contribute to saving primary raw materials and/or substituting them with secondary raw materials or biogenic raw materials, and to minimising waste. The aim is to significantly reduce the use of energy and raw materials in the manufacturing process while retaining all relevant properties.

To do justice to the new thematic spectrum that goes hand in hand with this extension compared to previous cross-cutting themes, the federal government has made adjustments to existing funding programmes as well as introduced new programmes in recent years. In doing so, it can also build on important knowledge bases and high-performance fields of the Austrian RTI community that have already been the focus of public research promotion for many years.

223 See BMK (2021c).
224 See Köppl and Schleicher (2019).
225 See BMK (2021d).
226 See BMK (2021e).

Fig. 2-50: RTI focus area "Circular Economy"



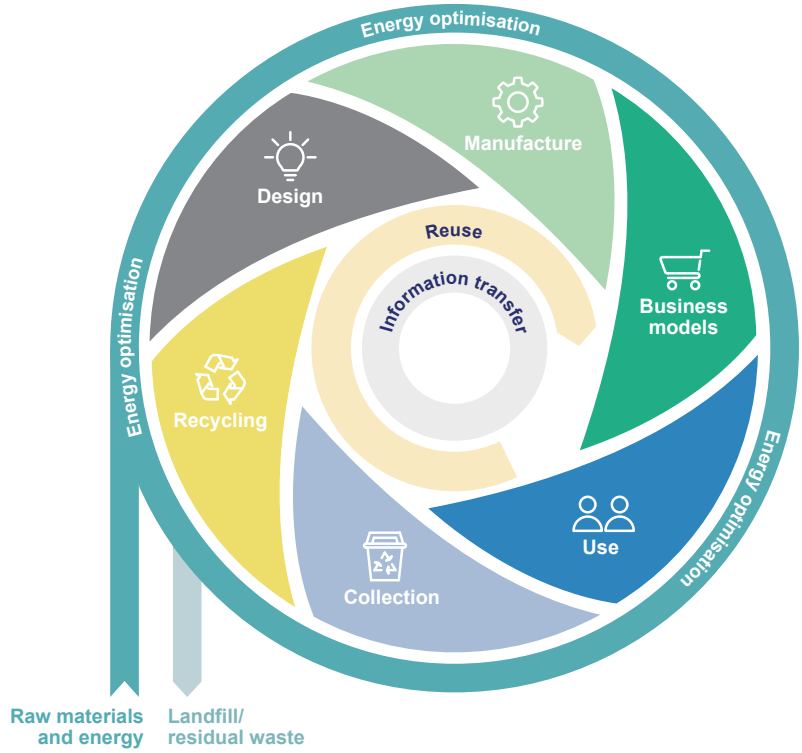
Source: https://nachhaltigwirtschaften.at/de/themen/kreislaufwirtschaft

Circular economy in existing RTI initiatives

Austria has numerous high-performance clusters and networks in both technological and economic fields (Cluster Platform Austria[227]). These stand for innovation and cooperation and thereby enhance, amongst other things, the national and international competitiveness of their cluster companies, the resilience of the business location, the robustness of value chains and the ability to cooperate across industry and federal states borders. The European Cluster Expert Group recommends focusing national cluster activities on the following three topics: Leading the green

227 See https://www.bmaw.gv.at/Themen/Wirtschaftsstandort-Oesterreich/ClusterplattformOesterreich.html, and European Cluster Expert Group: https://clustercollaboration.eu/sites/default/files/news_attachment/European%20Expert%20Group%20on%20Clusters%20-%20Recommendation%20Report.pdf

Fig. 2-51: Schematic representation of the circular economy



Source: https://nachhaltigwirtschaften.at/de/themen/kreislaufwirtschaft

transition; Accelerating the digital transition and/or Building resilience.

The circular economy is already a fixed reference point of research and development projects within the scope of 12 cluster initiatives. Within the Green Tech Cluster Styria, around 250 companies and research institutions are shaping the green solutions of the future. The Cleantech Cluster Upper Austria strengthens the innovative potential, competitiveness and visibility of its partner companies. It contributes to market growth in the area of sustainable environmental and energy technologies along the value chain. Key thematic priorities of the cluster are the areas of Circular Economy innovation and resource efficiency in production. The Cluster Renewable Energies Tyrol represents a network of around 85 highly innovative enterprises, institutions and higher education institutions. The cluster members cover a wide variety of technology fields, such as solar heat, photovoltaics, heat pumps, biomass, biogas, cogeneration of heat and power, electromobility, energy efficiency and energy-efficient building.

The area of optimised and bio-based use of energetic and material resources, in particular, can be considered a field of strength of Austrian research in the field of circular economy.[228] Funding programmes have made a significant contribution to the development of this field of strength and are also expected to contribute to its further development in the future (see RTI Objective 3).

RTI programmes with established linkages to the circular economy

The optimised allocation of resources has already been the subject of research and development projects in the context of City of Tomorrow (in relation to

228 See BMK (2021c).

buildings and districts), Production of the Future (in relation to industrial production) and Mobility of the Future (MdZ) (in relation to vehicles and infrastructure) for many years now. Key cross-cutting focus areas include urban mining, the use of bio-based raw materials and the reduction in the use of materials by means of lightweight construction. The Production of the Future initiative saw the launch of a new innovation laboratory, BioBase, in 2021, aimed at supporting RTI and networking activities in the field of the bioeconomy. The Mobility of the Future programme also supports the development of alternative mobility concepts based on the ideas of mobility as a service (MaaS) and vehicle sharing – measures intended to boost the resource efficiency of mobility services (see RTI objective 2).

The development of further circular solutions and strategies, such as repair, product longevity, reuse or recycling, has thus far been promoted mainly at regional level and through EU schemes. Two calls for proposals for applied research on the circular economy were recently launched in the federal states. In the Future Fund Styria's 13th call for proposals – "Green Tech 100 – 1 Earth, 0 Carbon, 0 Waste"– launched in 2020, for example, the organisation placed the spotlight on recycling technologies, and a total of six research projects were granted funding. In the Circular Economy call for proposals launched by the Upper Austrian *Wirtschafts- und Forschungsressort* (Department of Economics and Research) in 2021, €3.5 million was allocated to supporting six projects on recycling and reuse of raw materials. The European Commission's Horizon Europe programme, which puts special emphasis on the circular economy, plays a particularly important role when it comes to conducting research in this field. Austrian project participations seeking to tackle the "Climate change, environment, resource efficiency and raw materials" societal challenges have been granted €81.4 million in funding to date. Even though Austrian research institutions have an above-average success rate of 21.6%, the share of funded projects headed up by Austrian organisations is still slightly below that in other areas, indicating that there is still untapped potential in this regard.[229]

Important research and development projects on the circular economy were also funded as part of programmes examining broader issues. In the area of basic climate research, for example, two projects on the circular economy have been funded at national level since 2020 – one by the Austrian Climate Research Programme (Circular Economy and Decarbonisation: Synergies and Trade-offs) and the other by StartClim (BeLONGevity: Innovationen für eine nachhaltige und sozial inklusive Kreislaufwirtschaft [Innovations for a Sustainable and Socially Inclusive Circular Economy]). Of the bottom-up programmes referred to above, the COMET programme was particularly successful in highlighting the importance of conducting research into the circular economy. In addition to one COMET Module and five COMET Projects, several COMET Competence Centres – "acib GmbH – The Austrian Centre for Industrial Biotechnology", "BEST – Bioenergy and Sustainable Technologies GmbH", "Competence Center CHASE GmbH – Competence Center for Chemical Systems Engineering", "KI-MET GmbH – Metallurgical Competence Centre" and "Wood K plus – Kompetenzzentrum Holz GmbH", – which all have a clear focus on the bioeconomy and circular economy, are also being funded at present.

RTI programmes with new linkages to the circular economy

The introduction of the circular economy as a new RTI focus area has also already led to the implementation of changes in existing RTI programmes, including at the Climate and Energy Fund. Its energy research programme placed the focus of its 2021 call for proposals on materials research for energy technologies, seeking to support research and innovation projects aimed at substituting ener-

229 FFG EU-Performance Monitor – https://eu-pm.ffg.at

gy-intensive materials, advances in lightweight construction and improvements in the circularity or recyclability of materials in the context of energy technologies.

The Climate and Energy Fund also issued a call for proposals for a priority region in the field of the bioeconomy/circular economy as part of the Climate and Energy Model Regions programme, for which a total of €1 million in funding was available. With 14 applications having been submitted, Styria's "Vulkanland Steiermark" region, which comprises 31 local governments, ultimately succeeded with a project aimed at developing a diversified approach to agriculture in which renewable raw materials are to be used in cascade within the region. Energy Transition 2050 was another programme in which a focus with clear relevance to the circular economy was established in 2020, making it possible for two projects aimed at developing sustainable cycles in urban areas (DIRECT HUBS and FOOD STORIES: *Nachhaltige Kreisläufe rund um Ernährung* (Promoting Sustainable Food Cycles)) to be funded.

New RTI initiatives and institutions for a circular economy

Incorporating the circular economy into existing thematic funding programmes is an essential prerequisite for ensuring that circular solutions are compatible with sustainable change in key fields of action such as mobility or industry. That being said, in the transformation to a circular economy, it is also vital that integrative solutions are developed throughout entire energy and material cycles and that cross-cutting issues that have previously only been addressed to a limited extent in thematic focus areas are explored.

The Circular Economy RTI initiative, which was launched by the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) in 2021, is doing just that – funding research projects throughout the entire value creation cycle. Its first call for proposals focused on 1) innovation for circular economies, 2) circular procurement and manufacturing, 3) intensification of product use and 4) recycling. A total of €10 million was made available for this first call for proposals[230], most of which was distributed through the "collaborative R&D projects", "flagship project" and "R&D services" funding instruments. The remaining €2 million was set aside to support a series of projects from the Austrian Research Promotion Agency (FFG)'s general programmes.

Funding was granted to a total of five collaborative research and development projects on the topics of bio-based industry ("QB3R"), recycling technologies and extraction of secondary raw materials ("EPSolutely" and "Abwasser-Kreislauf" [Wastewater Cycle]), process engineering in circular goods manufacturing ("LightCycle"), and rethinking products ("BuildReUse"), as well as one flagship project on the mechanical recycling of plastics ("circPLAST-mr") and one research and development service on each of the following topics: innovative circular service models ("PRO_Service"), innovations in steel recycling ("IRONER"), digital key technologies for circular production ("DigiTech4CE") and measures for changing consumer behaviour ("CE4ALL").

The "Circular Economy" RTI initiative's second call for proposals was open between March and June 2022. With a budget of €12 million to be used for "collaborative R&D projects" and a "flagship project", the focus is on the following topics: 1) innovation for circular economies, 2) circular procurement and manufacturing and 3) waste materials and recycling.

2022 will also see the implementation of further RTI activities on the circular economy as part of the BMK's established RTI programmes described above, including measures on production technologies, digital technologies, mobility and space technologies and climate-neutral cities, among others.

There were also increased efforts to bundle RTI projects with relevance to the bioeconomy and cir-

230 For the second call for proposals, the budget was increased from €10 million to €12 million.

cular economy in selected value creation cycles in 2021, with the BRA.IN Packaging Initiative and the Austrian Wood Initiative's new THINK.WOOD.Innovation funding programme. The BRA.IN Packaging Initiative mobilises the Austrian Research Promotion Agency (FFG)'s thematic funding instruments to expedite the development of solutions for the entire packaging process chain, with one of four focus areas centring on the environment and recycling. The first call for proposals in the context of THINK.WOOD.Innovation was awarded €18 million by the Federal Ministry of Agriculture, Regions and Tourism (BMLRT). The funding priorities related to the circular economy in this case were the development of resource-efficient wood-based hybrid materials for the construction industry, the substitution of energy-intensive building, base and other materials, and the development of a sustainable and innovative value chain.

Conclusion

By introducing the circular economy as a new RTI focus area, the federal government is significantly expanding the range of thematic funding programmes. This can already be seen in practice thanks to the implementation of clear adjustments in established thematic funding programmes and the introduction of significant new RTI initiatives. Further steps will need to be taken in order to transform the circular economy in its various forms into a firm fixture of the Austrian RTI landscape. The circular economy represents a considerable challenge for the RTI community in that it goes hand in hand with an increased need for expertise on issues relating to social science and the economy and challenges some existing paradigms in established fields of technology. There is, therefore, also a need for corresponding accompanying measures to be implemented in addition to the expansion of the thematic funding programmes. A series of key initiatives to promote the transfer of knowledge and expertise are already in the pipeline with the establishment of a "Circularity Lab Austria" and a "Bioeconomy Cluster".

2.4.4 Artificial intelligence

Artificial intelligence (AI) has been considered a key technology for digitalisation in Austrian and international innovation systems for some years now, and one whose growth is being accelerated further by advances in technology.[231] Numerous countries, including Austria and the European Union (EU), have come to recognise the potential of intelligent, artificial systems and formulated a range of forward-looking strategies.[232] Austria's AI strategy[233] sets out to take account of the many different uses, areas of potential and challenges of AI systems and is therefore firmly embedded in the strategic orientation of the EU. The European approach puts the spotlight on the excellence and trustworthiness of AI – two topics that will ensure that investments in AI are stepped up, national AI strategies are implemented and aligned, and AI developments are based on regulations that ensure the functioning of markets and the public sector and the protection of people's fundamental rights when using AI.

Definition of AI

There is no generally applicable definition of artificial intelligence (AI). The term encompasses a variety of approaches, methods and technologies. According to the Austrian AI strategy[234] (see also Chapter 1.2), AI refers to computer systems "that exhibit intelligent behaviour, i.e. that are capable of performing tasks that previously required human cognition and decision-making skills". The High-Level Expert Group on Artificial Intelligence set up by the EU Com-

231 See BMBWF et al. (2020), Prem and Ruhland (2019).
232 See AI Watch (2022).
233 See BMK and BMDW (2021c).
234 Ibid.

mission[235] defines AI as "systems with 'intelligent' behaviour that analyse their environment and act with a certain degree of autonomy in order to achieve specific objectives. Not only can AI-based systems work in a virtual environment on the basis of software alone (e.g. voice assistants, image analysis software, search engines, voice and facial recognition systems), they can also be embedded in hardware systems (e.g. modern robots, self-driving cars, drones or "Internet of Things" applications)."

The development and broad field of application of AI are leading to (potentially disruptive) changes in the economy, our everyday working lives and social coexistence, and promise to generate financial and societal benefits in areas ranging from healthcare and production through to climate protection. Despite the financial and societal benefits associated with the use of AI, the increased complexity of the systems and growing use of such technology (voice and facial recognition, search engines, chatbots or robots) have increasingly called both ethical and legal matters into question in recent years.[236]The possible bias of AI systems, intrusions into people's private lives, increasing problems of traceability associated with black box AI and the sheer volume of data involved are key aspects of broad-ranging expert discussions and debates, which have given rise to recommendations on the use of AI systems and the ethics of this type of technology being drawn up by the OECD[237] and UNESCO[238], respectively. In the EU, on the other hand, building on the 2020 European AI Strategy,[239] a concept drawn up by the European Commission on the basis of trust and excellence[240] has been put forward with the aim of promoting the use of AI, taking into account the associated risks and based on European values, thereby ensuring the EU's technological leadership and independence in the long term. The EU Commission's concept sets out policy options for building an ecosystem of excellence and trust. To achieve this, more measures need to be taken with regard to cooperation between member states and with international actors, focusing the activities of the research and innovation community, promoting skills and small and medium-sized enterprises, supporting public-private partnerships and the use of AI in the public sector, ensuring access to data and computing infrastructures.

Trustworthy AI

According to the ethical guidelines issued by the Expert Group on AI[241], set up by the EU Commission, AI systems are considered trustworthy if the following requirements are met: primacy of human agency and human oversight, technical robustness and safety, privacy and data quality management, transparency, diversity, non-discrimination and fairness, social and environmental wellbeing, and accountability. These are based on four ethical principles: 1. Respect for human autonomy, 2. Prevention of harm, 2. Fairness and 4. Explicability.[242] AI systems are therefore considered trustworthy if they take these ethical principles or criteria into account. Self-assessments of AI systems can be carried out using the Commission's Assessment List for Trustworthy Artificial Intelligence (ALTAI).[243]

235 High-Level Expert Group on Artificial Intelligence (2019, 1).
236 See Kaufmann and Petzlberger (2022).
237 See OECD (2019).
238 https://en.unesco.org/artificial-intelligence/ethics
239 https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/excellence-trust-artificial-intelligence_de
240 See European Commission (2020p).
241 High-Level Expert Group on Artificial Intelligence (2019).
242 See Federal Ministry of Education, Science and Research (BMBWF) et al. (2020).
243 See Assessment List for Trustworthy Artificial Intelligence (ALTAI), https://futurium.ec.europa.eu/en/european-ai-alliance/pages/altai-assessment-list-trustworthy-artificial-intelligence

When it comes to the implementation of the European ecosystem for trust in AI, the trustworthiness of AI systems in particular forms a key basis for counteracting potential damages and threats posed by the technology, for strengthening the trust of users and for boosting public acceptance of AI. The ethics guidelines issued by the High-Level Expert Group[244] established by the EU Commission in 2019 are taken into account. The greatest risks in the eyes of the EU Commission are related to the protection of fundamental rights and to security and liability issues[245], as the use of such technology does come with significant risks in addition to the wealth of potential benefits for individuals and society as a whole. The threats that this entails include infringement upon fundamental rights such as the protection of privacy, personal data and non-discrimination and can cause both material (e.g. property damage or loss of human life) and intangible damage (e.g. loss of privacy, human dignity or discrimination when applying for a job).[246] The aim of creating a new legal framework and harmonised regulations for AI in Europe and minimising potential threats was ultimately achieved with the development of a legal framework for trustworthy AI in 2021 that considered a risk-based approach to regulating AI systems.

New legal framework for AI

The draft regulation on the harmonisation of regulations for AI was submitted to the EU Commission in April 2021. Moving forward, the new regulations will apply to public and private actors who place AI systems on the EU market, launch them, or equally where people in the Union are affected by their use. A risk-based approach[247] with four gradations is proposed in this regard:

1. Unacceptable risk: certain AI systems that violate fundamental rights, such as the evaluation of social behaviour ("social scoring") or real-time biometric recognition by law enforcement authorities, are prohibited.
2. High risk: if AI applications have a negative impact on the safety or fundamental rights of people, they are classified as high risk. This classification is made on the basis of a (revisable) list of AI systems that must fulfil various requirements (see standardisation efforts). Discriminatory practices by AI, in particular, should be prevented.
3. Low risk: various AI systems, such as chatbots, must fulfil transparency obligations to avoid false or misleading declarations.
4. Minimal risk: these applications are not bound by any legal obligations (e.g. video games or spam filters), but may voluntarily apply requirements for trustworthy AI or codes of conduct (see standardisation efforts).

In the event of infringements, the legal framework provides thresholds against which Member States can base sanctions. The responsibility for overseeing this lies with the national market surveillance authorities and the European Committee on Artificial Intelligence. The new legal framework will also be supplemented by a new machinery directive[248], which is intended to ensure the safe integration of AI systems in machinery. It is not yet known to what extent the draft regulation will change further, as it has to be adopted by the European Parliament and the Member States.[249] Once the legal framework has been adopted, the regulation will be applicable throughout the EU with immediate effect.

High-risk AI applications will, in future, have to ful-

244 See BMBWF et al. (2020).
245 See European Commission (2020r).
246 See European Commission (2020q).
247 See European Commission (2021q).
248 See European Commission (2021r).
249 https://www.bmwi.de/Redaktion/DE/Pressemitteilungen/2021/10/20211014-EU-digital-und-telekommunikationsminister-und-ministerinnen-beraten-ueber-regeln-fuer-kuenstliche_intelligenz.html

fil certain requirements [250] in accordance with the European Parliament's proposal for a regulation and the Council's establishment of harmonised regulations for artificial intelligence[251]. Harmonised standards, in particular, are expected to play an important role in demonstrating the conformity of high-risk AI systems with these requirements.[252]

For AI applications that are not classified as "high-risk", the European Commission relies on the establishment of codes of conduct that are to be adhered to on a voluntary basis, requiring binding standards to also be met in order to confirm compliance with these codes of conduct. The way in which these standards or norms will be structured is not yet known.

Standardisation

The development of standards and norms for artificial intelligence is relevant for a number of different reasons and is welcomed by both the European Commission and the Austrian federal government. Standardisation can be used not only to increase the quality and safety of products or to ensure their interoperability, but also to support the translation of ethical principles into technical solutions. Norms and standards can provide criteria for this, which AI developers can use as guidance, ultimately allowing them to implement solutions more quickly.[253] Conformity with legal requirements will also play an important role in this regard in the future.

This is why the federal government's current AI strategy includes a field of action for the creation of AI standards, to which two measures have been assigned. The first measure is to promote the technical standardisation of AI at national, European and international level. In this context, companies and research institutions, in particular, should also be supported in incorporating their expertise into the creation of standards. A further measure involves "the federal government working together with European and international partners to drive forward the standardisation of AI applications in the relevant forums so that a secure framework can be created for the development, operation and use of trustworthy AI applications."[254]

Another significant aspect is ensuring that products meet certain health, safety and environmental requirements, which is why the European Union has drawn up a set of product safety regulations in which standardisation features as an essential element. A European Commission[255] report on the impact of artificial intelligence with regard to safety and liability outlines a series of challenges with specific characteristics, such as a certain autonomy in making decisions, the complexity of the systems or a lack of traceability or transparency. In some circumstances, for example, independent learning may change the manner in which AI solutions work in ways not originally intended by the manufacturer. This may, in turn, have an impact on the safety of using such AI solutions. In the area of liability, amendments may also need to be made to legal requirements in the future, for example with regard to the concept of determining culpability in road traffic accidents, which may have to be applied differently to self-driving vehicles than to those driven by humans in order to ensure an adequate level of insurance cover.

Both the International Organization for Standardization (ISO), in cooperation with the International Electrotechnical Commission (IEC) and the Institute of Electrical and Electronics Engineers (IEEE) have already launched AI standardisation initiatives. With-

250 These include provisions regarding the risk management system, data and data governance, technical documentation, reporting obligations during the operation of high-risk AI systems, transparency and provision of information to users, human oversight, accuracy, robustness and cybersecurity (European Commission 2021s).

251 See European Commission (2021s).

252 See Article 40 of Harmonised Standards in the European Commission (2021s).

253 See DIN and DKE (2020).

254 BMK and BMDW (2021c, 33).

255 See European Commission (2020s).

in ISO/IEC, the ISO/IEC JTC 1/SC 42 sub-committee addresses the matter of artificial intelligence as part of the technical committee on information technology. Austria (Austrian Standards International – Standardisation and Innovation) is one of the countries that is actively represented on this committee. Since 2018, the sub-committee has published ten AI standards, with a further 22 currently under development[256]. The IEEE has launched a global initiative on the ethics of autonomous and intelligent systems with the mission of ensuring that ethical principles are considered in the development and design of AI systems. For this purpose, a number of working groups have been created in which corresponding standards are to be elaborated. Particularly relevant in this context are the standards of the IEEE 7000 series, which address key social and technical issues identified in a document[257] (Ethically Aligned Design – EAD) prepared with the involvement of numerous stakeholders. The IEEE is also developing a certification for Autonomous and Intelligent Systems (ECPAIS[258]), which will make it possible to identify systems of this kind.

At European level, the European Committee for Standardization (CEN) and the European Committee for Electrotechnical Standardization (CENELEC) have joined forces to set up a Technical Committee on Artificial Intelligence[259], which is responsible for developing and adapting AI standards (including ISO/IEC JTC 1/SC 42 standards) and advises other technical committees on this matter[260].

European and national initiatives giving consideration to trustworthy AI

A number of European initiatives aimed at supporting research into and the development, application and circulation of trustworthy AI systems have been launched.[261] The CLAIRE Research Network is a European initiative supported by more than 1,000 AI experts which aims to bring together the European AI community and thereby increase its visibility and promote the exchange of knowledge. The focus of the initiative is on "trustworthy AI that augments human intelligence rather than replacing it, and that therefore benefits the people of Europe"[262]. The European Network of Human-Centered Artificial Intelligence is an initiative involving 53 organisations from 20 European countries. The initiative aims to design AI in such a way that it benefits both individuals and society as a whole, and complies with ethical, social, cultural, legal and political standards[263].

Horizon Europe and the Digital Europe programmes (DIGITAL) are also setting aside an increasing amount of funding for trustworthy AI projects. Every year, the EU earmarks about €1 billion for AI.[264] In doing so, Horizon Europe supports competitive and trustworthy key technologies, in particular through the "Digital, Industry and Space"[265] cluster, to ensure the competitiveness of European industry. In addition to artificial intelligence, this also includes the topic of quantum technologies (see Chapter 2.4.1 above). The research funding programme also intends to establish European partnerships for strate-

256 https://www.iso.org/committee/6794475.html

257 https://standards.ieee.org/content/dam/ieee-standards/standards/web/documents/other/ead1e.pdf?utm_medium=undefined&utm_source=undefined&utm_campaign=undefined&utm_content=undefined&utm_term=undefined

258 https://standards.ieee.org/industry-connections/ecpais.html

259 https://www.cencenelec.eu/areas-of-work/cen-cenelec-topics/artificial-intelligence/

260 For an overview of global AI standards or standards adopted in different countries in the field of artificial intelligence, see: https://ethicsstandards.org/repository/

261 For a more detailed overview of international initiatives in the field of trustworthy AI, see Kaufmann and Petzlberger (2022), Marcher and Wieser (2022).

262 "CLAIRE will focus on trustworthy AI that augments human intelligence rather than replacing it, and that thus benefits the people of Europe", https://claire-ai.org/vision/

263 https://www.humane-ai.eu/vision/

264 https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/excellence-trust-artificial-intelligence_de#eu-und-ki

265 https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/cluster-4-digital-industry-and-space_en

gic areas, such as the European Partnership on Artificial Intelligence, Data and Robotics[266], which aims to ensure Europe's sovereignty in the development and application of trustworthy, secure and robust AI, data and robotics by 2030. The DIGITAL programme, which has a keen interest in AI, sets out to bridge the gap between research and market implementation.[267] To ensure that this can be achieved, the EU is focusing on building core AI capacities (data resources, libraries) for open use by businesses (especially SMEs) and public administrations. European Digital Innovation Centres are also expected to facilitate access to technologies such as AI. Three to six of these innovation centres are currently planned for Austria, and the selection process has not yet been completed.[268]Further AI support services are provided by the European Research Council and the European Innovation Council.[269]

The new, trend-setting framework conditions and standardisation efforts for AI-based systems and innovations put forth by the European Commission have already been taken into account in Austria's AI strategy and have a corresponding impact on the national portfolio of instruments. Two programmes with a strong focus on significant fields of application and the consideration of trustworthy AI have been launched in recent years. In 2020 and 2021, for example, the *aws Digitalisierung – vertrauenswürdige künstliche Intelligenz* [aws Digitalisation – Trustworthy Artificial Intelligence] programme launched by Austria Wirtschaftsservice (aws) funded a series of trustworthy AI projects being implemented by companies in key future industries such as energy, environmental and climate protection, information and communication technologies, production, mobility and healthcare. Selected projects were awarded funding of up to €200,000.[270] The BMK's "Artificial Intelligence (AI) for Green"[271] call for proposals, for which funding in the amount of €7 million was made available, was launched in summer 2021. The initiative supports collaborative R&D projects being implemented by companies, research institutions and other non-profit organisations that address environmental, climate, nature and species protection (mitigation) and adaptation to the consequences of climate change. The European guidelines for implementing trustworthy AI need to be considered, while trustworthy AI is also a technological focus in its own right.

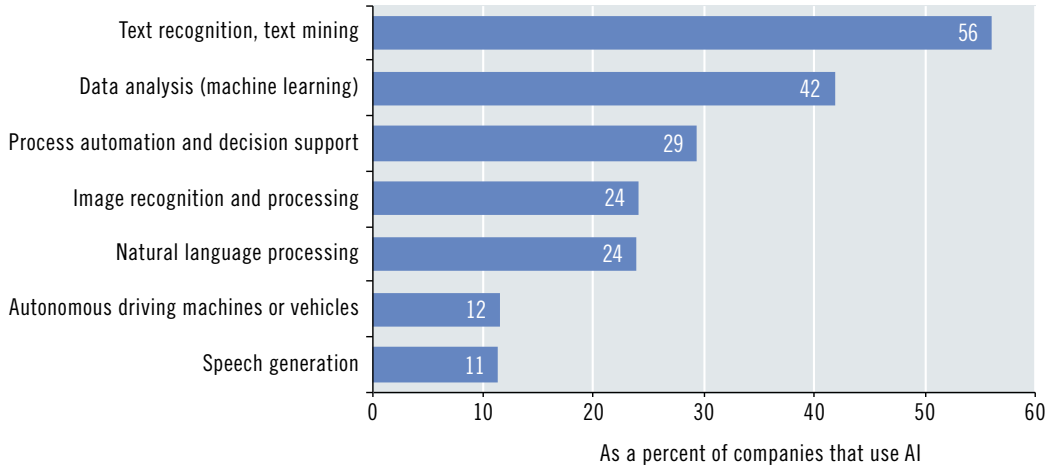
Recent studies and the AI ecosystem in Austria

enlite AI[272] has attempted to provide an overview of the entire AI ecosystem in Austria with the AI Landscape Austria. Organisations are divided into AI start-ups and AI companies (by sector or field of technology), public and private "early adopters" *and "enablers & extended ecosystem*" (including universities and educational institutions, research organisations, public organisations, accelerators, incubators and investors, media, communities and conferences)[273]. Information about AI organisations is collected via desk research, interviews and events, and is supplemented on an ongoing basis. The landscape also changed in 2021 compared to previous years – although there was only a small increase in new areas (e.g. gaming), the existing green tech/clean tech areas continued to evolve.

Despite the high topicality of the subject, the

266 https://ai-data-robotics-partnership.eu/
267 https://digital-strategy.ec.europa.eu/en/activities/digital-programme
268 https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool
269 https://ec.europa.eu/info/research-and-innovation/research-area/industrial-research-and-innovation/key-enabling-technologies/artificial-intelligence-ai_en#funding-for-ai
270 https://www.aws.at/aws-digitalisierung/kuenstliche-intelligenz/
271 https://www.ffg.at/ai#:~:text=Im%20Rahmen%20von%20AI%20for%20Green%20werden%20forschungsintensive,an%20die%20Folgen%20des%20Klimawandels%20%28Adaptation%29%20einschlie%C3%9Fen%2C%20gef%C3%B6rdert
272 https://www.enlite.ai/insights/ai-landscape-austria
273 The landscape includes organisations for which AI is a key component of the software or service offered, which can demonstrate the use of AI and which are based in Austria.

Fig. 2-52: Technologies based on artificial intelligence in companies in 2021



Source: Statistics Austria, ICT use in companies in 2021, values rounded. Graphic: Austrian Institute for SME Research

increase in start-ups and numerous political initiatives, AI technologies are still comparatively less widespread in Austrian companies, as the 2021[274] survey on ICT use in companies shows. It suggests that AI technologies are used by approximately 9% of the surveyed companies with 10 or more employees. There are, however, differences in the extent of AI use depending on the size class of a company: while some 32% of large enterprises (250 employees and more) already use AI, it is only used by 15% of medium-sized companies and 7% of small companies (10 to 49 employees). The most common areas of application are text recognition and processing and data analysis. Within companies, AI is primarily used in business management processes and in marketing and sales. According to the companies surveyed, the biggest obstacles to the use of AI include a lack of expertise within the company and excessively high costs[275].

The *AI Watch*[276] and *OECD.AI Policy Observatory*[277] platforms also have data on AI in Austria. Both platforms make reference to each other and supplement specific information. The AI Watch website receives country-specific information, subdivided into strategy reports, the AI Landscape and AI Investments. The linked pages provide further information on strategic initiatives and instruments, AI actors (by organisation type), publications on AI, the number of AI patent applications, the number of research projects funded by the European Commission and investments in AI. The OECD.AI Policy Observatory provides country-specific information on Austria under the two sections "Trends & data" and "Countries & initiatives". In addition to a list of initiatives, the latter also contains detailed information on publications (e.g. co-publications, top publications, type of publications, top research institutes). "Trends & data"contains data on AI research, AI software development, AI search trends (e.g. Google searches), AI jobs and skills and investments in AI. Both AI Watch and OECD.AI Policy Observatory have also implemented a newsfeed.

274 The survey is being conducted uniformly throughout Europe as a random sample survey. In Austria, Statistics Austria surveyed around 3,050 companies with ten or more employees in various economic sub-sectors (ÖNACE 2008). For an overview of all economic sub-sectors considered, see https://statistik.at/en/statistics/research-innovation-digitalisation/digital-economy-and-society/ict-usage-in-enterprises

275 Ibid.

276 https://knowledge4policy.ec.europa.eu/ai-watch_en

277 https://oecd.ai/en/

A recent study by the BMK[278] provides a supplementary overview of the research potential of AI for the Austrian media landscape and identifies challenges and opportunities for action in this regard. The diverse fields of application of AI in the media sector range from text and media analyses to content generation. The transparency of AI systems is a key criterion here. Although research is predominantly influenced by international players, Austrian companies do also have an active part to play. According to the study, the potential of AI in the media sector can be increased through cooperation in particular. A concept for a secure data room is also needed in the future, as is better consideration of the legal framework of the media world for AI applications.

2.5 RTI Evaluation Culture and Practice

Austrian research, technology and innovation policy (RTI policy) has for more than 25 years been characterised by an evaluation culture which aims to ensure quality and transparency. Programmes, and increasingly institutions and funding instruments too, are assessed regularly to evaluate the extent to which they achieve their objectives, and their impact and efficiency. Most of the evaluation reports are available to the public, and can be accessed in the online repository of the Austrian Platform for Research and Technology Policy Evaluation (fteval). This platform brings together representatives of institutions that commission, conduct or are themselves subject of evaluations. To ensure an open approach to geographical, methodical and thematic focus, fteval is connected with other related initiatives such as the German DeGEval – Evaluation Society, the Platform for Registry Research (Plattform für Registerforschung) and the Vienna Evaluation Network (VEN). Core activities include the development and publication of evaluation standards (latest version dated 2019) and publication of the fteval Journal, where key findings from evaluations are discussed from both academic and practical perspectives. Another focus area is the organisation of events – one of which is the international conference: this takes place every three years, putting Austria at the centre of discussions about methods, challenges and the role of evaluations in RTI.

2.5.1 Current trends

As was the case in the previous year, 2021 continued to be dominated by the COVID-19 pandemic, which also had an impact on evaluations. Thanks to the experience gained and adaptations made, however, the situation was able to be incorporated more successfully into the planning process with regard to evaluation practice.

One development relevant to evaluation culture is the amendment of the Austrian Federal Statistics Act (Bundesstatistikgesetz) and the Research Organisation Act (Forschungsorganisationsgesetz) passed in December 2021. Both acts enable research institutions to obtain remote access to anonymised individual statistical data from the Statistics Austria federal office and data from authorities' administrative registers in the future so that they can conduct statistical analyses with an academic or scientific bent. Statistics Austria will set up the BMBWF-funded Austrian Micro Data Center (AMDC)[279] to enable data to be transferred anonymously and securely. The first test runs for the AMDC are slated for the second quarter of 2022, with the platform set to go live on 1 July 2022. Having this access to data will also make it possible in future to draw on a much broader basis of evidence when preparing evaluations and thus improve their quality and objectivity.

278 See BMK (2021f).

279 https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=10006095 and https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=10009514

2.5.2 Selected evaluations

The RTI evaluations completed since the publication of last year's Austrian Research and Technology Report are presented with due brevity below. The original, much more detailed evaluation reports are available to read at https://repository.fteval.at/. The evaluations outlined below cover a particularly wide range of initiatives and programmes, from the promotion of networking, exports and women through to the exploitation of IPR, centres of excellence, funds for higher education and structural development, investment premiums and arts-based research. Concurrent, ex post and mid-term evaluations were carried out, making impressive use of various different data collection and analysis techniques as well as qualitative methods.

Evaluation of the 2013 Higher Education Area Structural Funds (HRSM) call for proposals for start-up funding for university partnerships in the fields of teaching, research/development and inclusion of the arts as well as administration. Evaluation of the 2016 Higher Education Area Structural Funds (HRSM) call for proposals for partnerships in the field of teaching

The Higher Education Area Structural Funds (HRSM) were an indicator-driven, performance-based and output-focused instrument of public-sector university funding and formed part of the universities' global budget until 2018. They replaced the formula budget and were enshrined in law. The funds were disbursed for the first time in 2013–2015 as part of a call for proposals and then on three further occasions during the 2016–2018 performance agreement period, specifically for the fields of teaching, research/development and inclusion of the arts, and innovation in administration.

The evaluation[280] conducted by WPZ Research and the Austrian Institute of Technology (AIT) aimed to take a closer look at the 2013 Higher Education Area Structural Funds (HRSM) call for proposals for start-up funding for university partnerships in the fields of teaching and research/development and inclusion of the arts, and administration as well as the 2016 HRSM call for proposals for partnerships in the field of teaching. These evaluations focused mainly on how effective the instrument was proving to be and the relevant question of what potential could be leveraged for future calls for proposals. The evaluation is based on an online survey of project leaders and non-funded applicants, a portfolio analysis, an analysis of performance agreements and development plans, interviews with experts and a network analysis.

The Federal Ministry of Education, Science and Research (BMBWF) conducted a call for proposals involving a total grant volume of €63 million in 2013 as part of the Higher Education Area Structural Funds (HRSM). Out of the 218 projects submitted, a total of 83 secured BMBWF funding. Teaching accounted for 8% (€5.17 million) of the funding volume, research/development and inclusion of the arts for 68% (€42.83 million), and administration for 24% (€15.0 million). The Federal Ministry of Education, Science and Research (BMBWF) covered up to a third of the project costs across the board.

The Higher Education Area Structural Funds (HRSM) call for proposals in 2016 focused on teaching in particular, specifically in order to support the development and implementation of the *"PädagogInnenbildung Neu"* ("Teacher Training Re-envisioned") initiative in the four development associations (West, Central, North-East and South-East). Funding was also granted for other teaching projects designed to further encourage partnerships in teaching. A total of €35.3 million was awarded, 84% (€29.8 million) to *"PädagogInnenbildung Neu"* and 16% (€5.5 million) to other teaching projects. Out of 48 projects submitted, a total of 32 secured BMBWF funding.

Overall, the Higher Education Area Structural Funds (HRSM) evaluations paint a very positive pic-

280 https://pubshop.bmbwf.gv.at/index.php?article_id=9&type=neuerscheinungen&pub=899

ture. The Higher Education Area Structural Funds (HRSM) were a key pillar of university funding, and the human resources that they funded were embedded and maintained in the respective performance agreements. The Climate Change Center Austria can be regarded as a successful example of this. With the introduction of teacher training, the 2016 call for proposals resulted in a policy objective being successfully implemented. Since a partnership needs to be sustainable in order to be successful, greater overlaps and networking are recommended. With the Higher Education Area Structural Funds (HRSM) being highly strategically relevant, the recommendation was made to make their systemic impact even more visible in the future.

Evaluation of the COMET programme

In May 2020, the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) and the Federal Ministry for Digital and Economic Affairs (BMDW, now BMAW) commissioned Technopolis to conduct an interim evaluation of the COMET programme.[281] COMET receives €50 million in federal and some €25 million in regional funding every year. The evaluation covers the 25 centres operating at the time it was carried out and focuses on their characteristics as well as on COMET's monitoring and key performance indicators. The main sources include a survey of the centres and of corporate and academic partners as well as the database maintained by the Austrian Research Promotion Agency (FFG) in order to enable its use for new forms of analysis (historical review, cluster and network analysis). Anyone can access the e-dashboard for the COMET survey anonymously.[282]

The key features of COMET include: the scope of its funding; the external independent evaluation by an international panel at the start and following the end of the first funding phase; a research programme defined jointly by business leaders and academics; and setting up the centres as legal entities in their own right.

The evaluation confirms that COMET centres have been and remain an essential tool for improving the basis for cooperation and strengthening partnerships between academic and applied/industrial research. However, its conclusions contain a series of recommendations for design and programme management:

- In hindsight, the centres of excellence programmes have proved to constitute the long-term promotion of structures for connecting up research and industry in centres that, in some cases, have been around for two decades. This must be taken into account when considering further development; a total or partial exit strategy must be provided for, as must the possibility of setting up new topic areas or new centres.
- COMET centres are active in some areas of sustainable development, digitalisation and health and are well suited to exploring new paths in these areas. Thematic priorities should be set alongside structural development aspects.
- COMET is part of the European research and innovation landscape and, in recognition of its network-like character and its areas of strength that span centre boundaries, should adopt a more prominent position within this landscape.
- Although COMET is in the right place within the FFG's structural programmes, there is a lack of integration across centres and funding periods and not enough strategic governance of the programme.
- Despite their long-term nature, the future of the COMET centres should be planned flexibly and in a way that builds on their high network quality. COMET could tackle "transition failors" relating to societal challenges through dialogue with various stakeholders.

281 http://repository.fteval.at/id/eprint/571

282 https://app.powerbi.com/view?r=eyJrIjoiNDI1YzcyNmEtYzQzMC00ZDQ1LTg5NjgtZjYxYWU2ZTQ4N2VmIiwidCI6IjlmZDk2NzU-5LWNjOTItNGU0MS04MTczLWJjOGY0OWIwMzllZCIsImMiOjh9

Evaluation of the FWF's Programme for the Development and Inclusion of the Arts (PEEK)

By launching the Programme for the Development and Inclusion of the Arts (PEEK) in 2009, the Austrian Science Fund (FWF) was responding to the 2002 Higher Education Act placing the universities of the arts on an equal footing with other universities. An approach to research that mirrored the character of the universities of the arts was developed with the help of arts-based research.[283]

The FWF-commissioned evaluation, which was carried out by the Centre for Social Innovation (ZSI) together with Prof. Stalder from Zurich University of the Arts, looked into the management of the programme, the extent to which it had achieved its objectives and its position within the FWF's funding portfolio and the Austrian research landscape in general.

Overall, it concluded that, with the Programme for the Development and Inclusion of the Arts (PEEK), the Austrian Science Fund (FWF) had injected significant momentum into the professionalisation of this unique form of research in Austria. The introduction of competitive, quality-assured processes for awarding funding, involving international peer reviews, has made a major contribution towards high-quality, innovative and internationally visible research characterised by a diverse output.

Survey results indicate that the Programme for the Development and Inclusion of the Arts (PEEK) has done a lot to drive forward the institutionalisation of arts-based research in Austria and has become a central element of the research done at the universities of the arts. At the same time, there are signs of substantial concentration effects indicating that some universities of the arts are highly dependent on the programme. Although universities of the arts made up between 50% and 80% of the projects submitted and funded across the board, other universities and a handful of specialised institutions have also benefited from the Programme for the Development and Inclusion of the Arts (PEEK), particularly in the fields of architecture and digitalisation.

The Programme for the Development and Inclusion of the Arts (PEEK) is one of a kind in the Austrian research landscape. Since it offers an alternative paradigm for research, it is not based solely on the hypothesis-driven scrutiny of assumptions or empirical findings or observations, but rather allows methods taken from the arts to be applied in an explorative way, often involving inter- and transdisciplinary perspectives.

The evaluation recommends that the Programme for the Development and Inclusion of the Arts (PEEK) be continued in the medium term and made mainstream in the long term, while also recognising its unique characteristics as a research paradigm in its own right. Rather than remaining restricted to a specific programme, arts-based research must be able to make use of other FWF instruments to an appropriate extent in the medium to long term. Alongside criticism of the review of project proposals and the amount of audit work associated with the Programme for the Development and Inclusion of the Arts (PEEK) – although programme implementation was found to be highly professional overall – recommendations also included improving the proposed budget, expanding the range of institutions submitting proposals through networking and communications activities, thereby making the submission process more flexible and integrating research better into teaching.

Lessons learned and results obtained from the concurrent survey on the "w-fFORTE Innovatorinnen" pilot

With *w-fFORTE Innovatorinnen* (w-fFORTE Female Innovators), the Federal Ministry of Labour and Economy (BMAW) aims to provide targeted support for women in location-specific research and innovation and raise their profile. The aim is to enable them to

283 See Austrian Science Fund (FWF) (2021): PEEK application guidelines, https://www.fwf.ac.at/fileadmin/files/Dokumente/Antragstellung/PEEK/ar_antragsrichtlinien.pdf

hone their focus on their own missions through workshops, "fireside chats", co-creation sessions and ongoing work on their own early-stage ideas. Highly skilled women are to be encouraged to develop their ideas, establish new network connections and achieve more creative freedom and professional advancement. The Austrian Research Promotion Agency (FFG) developed an innovative leadership and empowerment programme for this purpose in 2018 and 2019, which was first piloted with 21 female innovators between June 2020 and April 2021. WPZ Research conducted a concurrent survey[284] during the project's term geared towards gauging the effectiveness of the pilot and gathering evidence in favour of potentially continuing it.

The concurrent survey began in autumn 2020 and comprised two online questionnaires sent out to the female innovators as well as a concluding reflection workshop held together with the Austrian Research Promotion Agency (FFG) and the Federal Ministry for Digital and Economic Affairs (BMDW; now BMAW) in April 2021. By giving the concurrent survey their wholehearted support, all the innovators made a major contribution to the further development of the pilot and its quality assurance.

The participants appreciated the diversity and suitability of the formats. Two formats – "Lego" and "Mission Road Map" – were found to be particularly inspiring. Both enabled those taking part to expand their own ways of thinking and make time for reflection and visualisation but also to question their own opinions and views. "Implementation Coaching" was praised for being tailored, i.e. aligned closely to people's individual needs, while "Empowerment Coaching" was regarded as imbuing them with strength. The "*Meine Mission – Mein Auftritt*" (My Mission – My Presence) format helped the female innovators to strengthen their personal presence. All the formats used by *w-fFORTE Innovatorinnen* were considered to be highly beneficial, with many of the innovators stating that their personal viewpoint had now changed, i.e. that, in particular, they were now looking at their own idea from a broader perspective. The innovators have also become more aware of their own strengths, which has given them greater self-confidence. They said that the programme has made them more self-confidence in a work environment and honed their focus on the key points of their idea. Discussing their ideas with other women has helped them to try out new inputs and tools. The innovators have already put many of the skills that they learnt in the pilot to use in their day-to-day work. The success prompted the recommendation that the empowerment approach be rolled out as a standalone programme for promoting women and/or as a cross-cutting strategy for the FFG's whole funding portfolio.

Concluding evaluation of the Knowledge Transfer Centres and IPR Exploitation programme

The Knowledge Transfer Centres and IPR Exploitation funding programme was launched in 2013 by the Federal Ministry of Education, Science and Research (BMBWF) together with the Federal Ministry for Digital and Economic Affairs (BMDW; now BMAW) and implemented by Austria Wirtschaftsservice (aws) until 2018. This programme served to improve cooperation amongst universities and between universities and other research institutions as well as companies engaged in knowledge and technology transfer, strengthen strategic patent funding and, through prototype funding, make it easier to translate academic findings into day-to-day business operations and thus accelerate the exploitation of inventions incubated at universities. The programme comprised three modules: Module 1a – Regional Knowledge Transfer centres; Module 1b – thematic Knowledge Transfer Centre; Module 2 – Patent Funding; and Module 3 – Proof of Concept (PRIZE prototype funding).

284 http://repository.fteval.at/id/eprint/570

The concluding evaluation of the programme[285] covered its entire term, i.e. 2013–2018. The design of the programme as well as its implementation, its impact, the extent to which it achieved its objectives and the lessons learnt from it were assessed by means of an online survey of project participants, network analyses and in-depth interviews. Additional research has shown that no other countries have comparable programmes that provide targeted support to developing knowledge and technology transfer in higher education. Although there are numerous funding programmes, such as centres of excellence, that are focused on science-industry cooperation – including some of international renown – they are only indirectly related to transfer in the context of higher education development.

21 public universities signed consortium agreements to form a total of three regional knowledge transfer centres with others from the same area. This gave rise to the Knowledge Transfer Centre East, Knowledge Transfer Centre South and Knowledge Transfer Centre West. Project managers attached a great deal of importance to the establishment of strategic networks, followed by greater professionalism in handling intellectual property, identifying existing areas of potential, designing exploitation processes more effectively, and raising public awareness of knowledge and technology transfer. The networking between universities, the exchange of expertise and the creation and expansion of shared services are all very positive developments. The networking generated by the Knowledge Transfer Centres (WTZs) has had a lasting impact and has strengthened interdisciplinary collaboration. Overall, the Knowledge Transfer Centres have helped make the higher education and research area more closely aligned.

In addition, a thematic Knowledge Transfer Centre has been set up that has put a suitable framework in place for translating academic research into the development of active substances and diagnoses. This objective was achieved successfully with the establishment of the "wings4-innovation" Translational Research Centre.

The Austria Wirtschaftsservice (aws) accepted 91% of the funding applications for patents, while the number of patent funding grants disbursed for first and subsequent filings remained relatively constant. Most applications for patent funding were submitted in the life sciences (43%), chemistry (16%) and physics (12%).

As far as prototype funding was concerned, five PRIZE calls were carried out between 1 December 2013 and 31 December 2018, with €6.045 million being awarded. Most applications for prototype funding were submitted in the life sciences (41%), chemistry/energy technology (21%) and physics/nanotechnologies (12%). Achievements on the exploitation front have been especially positive, with 50% of all projects having been successfully exploited or being in the exploitation process within two years of funding being granted.

The Austria Wirtschaftsservice (aws) launched the three-year "Austrian Technology and Knowledge Transfer Programme" in 2019 with funding from the National Foundation for Research, Technology and Development (NFTE). This gave universities of applied sciences and certain other academic institutions more opportunities to collaborate while also making community building and the continuation of successful Knowledge Transfer Centres (WTZ) integral parts of the performance agreements for 2019–2021. A need to safeguard prototype funding in the relevant budgets was identified since this form of funding is regarded as unique in Austria and essential for exploiting technologies at universities.

AplusB Scale-up: interim evaluation

The AplusB Scale-up Programme was launched in 2016 as an evolution of the AplusB (Academia plus Business) Funding Programme, which was itself

285 https://www.bmbwf.gv.at/Themen/Forschung/Forschung-in-%C3%96sterreich/Services/Nationale-Kontaktstelle-f%C3%BCr-Wissenstransfer-und-Eigentumsrechte.html

launched in 2002. The aim of both programmes was and is to support enterprise formations with an academic background. In particular, AplusB Scale-up is intended to stimulate and bring about new research-, technology- and innovation-based ventures with high potential for growth from the academic sector. The programme is being administered by the Austria Wirtschaftsservice (aws) on behalf of the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK).

WPZ Research carried out an interim evaluation in 2021, focusing on the achievements and offerings of the individual incubators in terms of both raising awareness and training and coaching the start-up teams. For the purposes of the evaluation, an online survey was conducted amongst all start-ups that were being or had been supported by the AplusB Scale-up incubators. Network, regional and statistical analyses were also drawn up, and the whole process was then complemented and consolidated with interviews.

The interim evaluation shows that the incubators are already deploying a wide range of measures to raise awareness in a bid to increase the relevant target groups' knowledge of start-ups and their willingness to give it a go themselves. Workshops are a particularly popular event format, while there is also a lot of awareness of the promotion of women. In addition, the incubators have set up a very extensive programme of services and measures in terms of support for start-up teams and training/coaching that covers a broad range of topics. Most of these services and measures are tailored very specifically to the teams to be supported so that individual needs can be met as best possible, with experienced mentors on hand to help them.

The key finding from the interim evaluation is that the incubators have succeeded in establishing a very expedient and promising programme of services and measures that provides effective support to the potential start-ups in their early stages and gears them up for market entry. This suggests that most of the targets set in the aws programme document are being met.

According to the survey of start-up entrepreneurs and selected stakeholders, the recommendations for action are based on maintaining the programme's openness and flexibility, not least so that it can also incorporate specific regional characteristics and needs. For the future, it is suggested that strategies be developed for getting even closer to the interface between science and industry and especially to the transfer points of the actors engaged in research in order to leverage even more areas of potential through joint efforts and thus be in a position to play a role of greater systemic relevance. Against this background, a focus should also be placed on ensuring "room for manoeuvre" on the journey towards entrepreneurship.

Interim evaluation of the PPPI Toolbox funding programme

The aws IÖB-Toolbox funding programme is designed for public procurement officers and is geared towards supporting the planning and implementation of PPPI Challenges as an innovative market research instrument, while also helping to fund the delivery of specific innovative procurement projects. "PPPI – Public Procurement Promoting Innovation" is an innovation instigated by the Federal Ministry for Digital and Economic Affairs (BMDW, now BMAW) and the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) with the support of the Austria Wirtschaftsservice (aws). A total of €1.8 million from the Austria Fund was made available to the PPPI Toolbox programme in 2019–2020 (Phase 1). The innovation has been funded by the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) since 2021. In total, twenty-two transfer projects (funding products and/or services) and three "Prepare Projects" (funding external consultancy projects) have been carried out.

The programme was evaluated by Joanneum Research and the Austrian Institute of Technology (AIT)

in 2021 using interviews, data/document analysis and online surveys.[286] This interim assessment focused on the implementation of the programme and the contributions to the achievement of objectives/impact that it had demonstrably made up to that point.

Many of the objectives that were or are being pursued with a funded innovative solution, including improving/overhauling processes, workflows and techniques or improving/overhauling technical or manual equipment/infrastructure, had already been largely realised by the time the survey was done. Less surprisingly, the primarily technical and operational objectives were achieved faster than those that generally need longer to take effect (e.g. increasing the visibility of the organisation). Worthy of particular mention are the programme's contributions to creating the image of a role model and to improving products and services at the procurers' ends. The projects are helping to make the public sector more efficient, boosting sustainability and environmental compatibility, and strengthening the innovative potential of Austrian business and industry. For their part, suppliers have seen a positive sales trend, improvements in relevant skills areas, and a greater awareness and understanding of both R&D and innovation within their company.

The results of the evaluation suggest that there are deadweight effects in play. In terms of additionality, therefore, there is a need for more evidence – not least with regard to the role played by the COVID-19 pandemic. Future investigations should examine whether implementing a project without funding in an unchanged form or later on in time would actually have achieved the same amount of innovation intended for the funded project. The possibility of getting support from the toolbox for procurement activities where two or more institutions have a requirement for or interest in this should also be examined. The positive experience that respondents have had with external consultants makes it advisable to expand the network further and strengthen it by organising events. Not all the suppliers were able to be contacted for the evaluation, suggesting that new incentives are needed in order to improve monitoring, e.g. by documenting success stories. The 2021 special guidelines already pick up on a number of findings, including some outlined by the evaluation. These include: setting a clearer objective with a focus on climate action, environmental protection and digitalisation; formulating impact objectives; introducing impact indicators for assessing the extent to which objectives have been achieved; and setting out specifications for publishing descriptions of funded projects online.

Evaluation of the concept behind the TECXPORT initiative

The Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) launched the TECXPORT initiative in 2017 to support the transfer and export of technology in the Austrian economy. An event format known as the Austrian Technology Days (ATDs) encourages targeted networking between Austrian technology providers in specific fields of technology and partners and other interested parties (particularly with potential customers) in the target country. Austrian technology providers can apply for travel grants in order to attend an ATD. Finally, the TECXPORT platform was developed as part of the initiative to support the activities of intermediaries (primarily the employees with specialist responsibilities at Austria's foreign trade offices and embassies). Between 2017 and 2020, the initiative was funded from the Austria Fund under the aegis of the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK). The Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) has funded it from its own budgetary resources since 2021. The Austrian Research Promotion Agen-

286 https://repository.fteval.at/581/1/Bericht_IÖBToolbox_27092021.pdf

cy (FFG) has been tasked with running the initiative on the BMK's behalf.

Conducted by inspire research Beratungsges.m.b.H., the interim evaluation[287] covers the period from 2017 to 2020 and looks at the design of the programme, its implementation to date, its potential impact and its contributions to achieving the objectives that can already be discerned at the time of the evaluation. It drew on programme documents from the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) and the Austrian Research Promotion Agency (FFG) as well as interviews with Austrian technology providers, BMK technology attachés and economic delegations in other countries.

The results of the concept evaluation show that the TECXPORT initiative and its instruments complement the BMK's own additional funding and support mechanisms for the internationalisation of technology as well as the services provided by other key players in the Austrian funding and support landscape. The Austrian Technology Days' most important USP is the role played by the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) in opening doors for the Austrian technology providers taking part. The BMK's proactive role in preparing, hosting and following up the Austrian Technology Days (ATDs) events can give the participating Austrian technology firms effective access to (government) bodies in their target markets, forging contacts and building networks for launching technology exports. Its technology-focused showcasing of Austrian skills gives the TECXPORT platform a clear USP. The interviews confirmed that the strategic objective is expedient and that the TECXPORT platform already has the potential to support Austrian intermediaries and their partners abroad.

The recommendations indicate a need to sharpen the programme's focus in terms of its content and initiate a number of reforms in terms of handling. These include:

- For the ATDs, the BMK should continue to focus very clearly on its role of opening doors and on its support for specific needs (Austrian technology providers) in the target country. Areas such as energy, mobility, the environment, health, industrial technologies, aeronautics and aerospace, ICT, (urban) infrastructure and security are relevant in this regard.
- Travel grants should only be awarded where this makes strategic sense.
- The concept behind the platform needs to be honed further. It should be positioned clearly as a support instrument for Austrian intermediaries and developed further.
- The content of the services offered should be expanded, their profile raised and awareness of them increased.
- Future RTI partnerships should tie in with the FFG's existing experience and programmes and be aligned with the funding budgets available.
- In strategic terms, the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) should continue to prioritise partnerships in order to ensure synergy effects with other actors in the Austrian funding and support system for the institutionalisation of technology.
- Objectives and their respective indicators must be set. Monitoring should be expanded and made more systematic in order to aid governance and ongoing programme steering.

Evaluation of the COVID-19 investment premium

To stimulate the Austrian economy following the slowdown caused by the COVID-19 crisis, the Federal Ministry of Labour and Economy (BMAW, formerly BMDW) is funding new investment in the period from 1 August 2020 to 28 February 2025 (submission deadline 28 February 2021) to the tune of 7% or 14% for the priority areas of digitalisation, ecologisation

287 http://repository.fteval.at/id/eprint/580

and life sciences. The scheme is being handled by the Austria Wirtschaftsservice (aws). The projects submitted amount to total investment of €78.2 billion, for which a grant volume of €7.8 billion is envisaged.

The Federal Ministry for Digital and Economic Affairs (BMDW; now BMAW) tasked the Institute of Industrial Science (IWI) and Pöchhacker Innovation Consulting GmbH with evaluating the macro- and microeconomic consequences of the investment premium so that it could compare the costs of the set of instruments with their potential benefits.[288] The evaluation process ran from October 2020 to July 2021, i.e. both concurrently and after the submission deadline.

The range of methods employed included economic analyses and modelling calculations, online surveys of funding recipients, case studies prepared from in-depth interviews and an economic policy assessment of the short-, medium- and long-term impact.

Investments are being undertaken sooner and in higher volumes thanks to the instrument. From various multiplier perspectives, therefore, the funding is an important stimulus for the economic recovery from the COVID-19 pandemic and is also having an impact on the domestic market: the purchases triggered by the investment premium are mainly fuelling business within Austria.

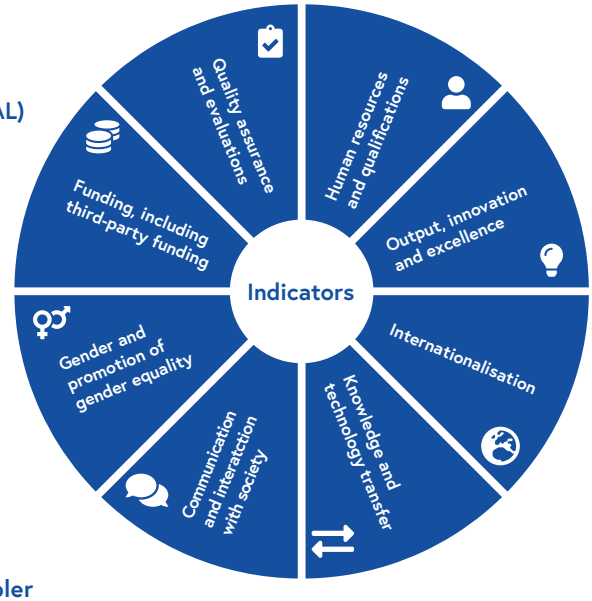
Much of the funding is going towards the ecologisation and digitalisation priority areas, thereby making it more affordable for funding recipients to take the necessary step towards becoming more environmentally sustainable and speeding up the digital transformation. It is the service sector in particular, which is generally ineligible for funding, that is showing a keen appetite for investing. Across the whole of the economy, the volume of investment backed by the investment premium is set to add an extra short- to medium-term production value of €83.4 billion and generate national value added of €40.6 billion over the entire funding period. This instrument is also making a significant contribution to employment security nationwide, with ten jobs being safeguarded by every €1 million in investment supported by the investment premium.

288 https://www.bmdw.gv.at/Services/Publikationen/Investitionspr%C3%A4mie.html

3. Monitoring in accordance with the Research Financing Act (FoFinaG): Central research and research funding institutions

Research institutions

- Austrian Institute of Technology GmbH (AIT)
- Institute of Science and Technology Austria (ISTA)
- Austrian Academy of Sciences (OeAW)
- Silicon Austria Labs GmbH (SAL)
- Ludwig Boltzmann Gesellschaft (LBG)



- Austria Wirtschaftsservice Gesellschaft mbH (aws)
- Christian Doppler Society (CDG)
- Austrian Science Fund (FWF)
- OeAD-GmbH (OeAD)
- Austrian Research Promotion Agency (FFG)

Research funding agencies

As outlined in Chapter 1, the Research Funding Amendment 2020 and the RTI Pact 2021–2023 are currently being implemented. The RTI Pact provides the framework for the performance and financing agreements concluded with the central institutions. Accordingly, the year 2021 was dominated by the preparation of the 2021–23 performance and financing agreements with the central research and research funding institutions pursuant to the Research Financing Act (FoFinaG). The key points of the three-year agreements with the individual institutions[289] are explained in Chapter 1.

The law provides for annual monitoring of the ten central institutions under Section 8 which states: "In accordance with Section 1(2), the federal ministers must report annually to the National Council within the framework of the Austrian Research and Technology Report as per Section 8(1) of the Research Organisation Act (FOG), Federal Law Gazette No. 341/1981."

The central research institutions and research funding institutions are listed in full in Section 3. The **research institutions** are:

1. Austrian Institute of Technology GmbH (AIT)
2. Institute of Science and Technology Austria (ISTA)
3. Austrian Academy of Sciences (OeAW)
4. Silicon Austria Labs GmbH (SAL)
5. Ludwig Boltzmann Gesellschaft (LBG) – Austrian Association for the Promotion of Scientific Research

The central **research funding institutions** are as follows:

1. Austria Wirtschaftsservice Gesellschaft mbH (aws)
2. Christian Doppler Research Association (CDG)
3. Austrian Science Fund (FWF)
4. OeAD-GmbH (OeAD)
5. Austrian Research Promotion Agency (FFG)

Although the Act did not come into force until the summer of 2020, the key factors had already been established beforehand, so that the Austrian Research and Technology Report 2020 mapped the ten central institutions for the first time based on a profile description and selected indicators that were developed jointly with the responsible federal ministries. The profiles of the various central institutions were further developed, harmonised and significantly streamlined in the 2021 report. A new indicator – "Communication and interaction with society" – was introduced, and the Austrian Research Promotion Agency (FFG) EU Performance Monitor and the Austrian Science Fund (FWF) statistics were used consistently as a source for the data on projects acquired in the ERC and FWF excellence programmes. The Ludwig Boltzmann Gesellschaft – Austrian Association for the Promotion of Scientific Research (LBG) was presented as a research institution for the first time.

This Austrian Research and Technology Report for 2022 builds on the model developed last year and includes the following further developments:

- The tables have been standardised further.
- Definitions have been adjusted and refined.
- Target values for 2023 have been defined together with the ministerial departments and stated by the ten institutions.

289 Silicon Austria Labs (SAL) is an exception; a performance agreement will only be concluded with them in the next funding period (2024-2026).

Agreeing on uniform target values proved a challenge, as the ten institutions set very different priorities and different target values are also defined in the performance agreements. The following indicators were chosen for the presentation of target values after liaising with the ministerial departments and the central institutions. A distinction was made here between research funding institutions and research institutions, and account was taken of the fact that not all indicators make equal sense for all institutions (for example, it only makes sense to gather information on publications from funded projects from the two research funding institutions the Christian Doppler Research Association (CDG) and the Austrian Science Fund (FWF)).

Table 3-1: Overview of target values

Research funding institutions		
Indicator	**2023 target value**	**Institutions**
Output, innovation and excellence	SMEs as a percentage of all companies	aws, FFG
	Publications from projects	FWF, CDG
	Number of consultations	aws, OeAD, FFG (in Austria and abroad)
	Patents applied for, consulting on patents	aws, FFG
	Funded projects in various institutions	OeAD
Internationalisation	Percentage of projects with international partners	FWF
Communication and interaction with society	Participants in interactive formats	OeAD
Gender and promotion of gender equality	Women in funded projects, female project leaders	aws (percentage of founders who are women), FWF (also: difference in the approval rate between women and men), CDG, OeAD, FFG

Research institutions		
Indicator	**2023 target value**	**Institutions**
Funding, including third-party funding	Third-party funds raised	AIT, ISTA (cash-in achieved), SAL, LBG
Human resources and qualifications	Theses completed	AIT, ISTA
Output, innovation and excellence	Publications	AIT, ISTA (publications with co-authors), SAL, LBG
Internationalisation	Number of Horizon Europe applications	OeAW
Communication and interaction with society	Number of different interactive formats	OeAW
Gender and promotion of gender equality	Percentage of women in management positions	AIT, ISTA, SAL, LBG (Glass Ceiling Index)

As in the previous year, the details on all central institutions follow a uniform structure:

- First the profile and the most important key figures on the institution as a whole are presented;
- This is followed by a comparison of key figures from 2020 and 2021 on the following indicators: i) financing and third-party resources, ii) quality assurance and evaluations, iii) human resources and qualifications, iv) output, innovation and excellence, v) internationalisation, vi) knowledge and technology transfer, vii) communication and interaction with society, and viii) gender and promotion of gender equality;
- Finally, special events from 2021 are presented along with a brief outlook on future projects and developments;
- Explanations of key terms and abbreviations can be found in Annex II.

The target values will be developed further and harmonised as far as possible in the coming years. Next year will see the addition of an eleventh central institution in the form of the new national competence centre GeoSphere Austria, the Federal Agency for Geology, Geophysics, Climatology and Meteorology (Bundesanstalt für Geologie, Geophysik, Klimatologie und Meteorologie). GeoSphere Austria has been formed by merging two federal agencies, the Geological Survey of Austria (GBA) and the Central Institute for Meteorology and Geodynamics (ZAMG), and is tasked with supplying key data for climate research and wellbeing.

3.1 Austrian Institute of Technology (AIT)

3.1.1 Profile and key figures

The Austrian Institute of Technology (AIT) holds a leading position in innovation in Austria and plays a key role at European level as the research and technology organisation focusing on the central infrastructure topics of the future. AIT's research and technological developments bring about fundamental innovations for the next generation of infrastructure technologies in the areas of Energy, Low-Emission Transport, Health & Bioresources, Digital Safety & Security, Vision, Automation & Control, and Technology Experience. These areas of scientific research are supplemented by skills in Innovation Systems & Policy. As a national and international network hub at the interface between scientific research institutions and industry, the Austrian Institute of Technology (AIT) enables innovation through its expertise in science and technology, market experience, tight customer relationships and outstanding research infrastructure and is thus strengthening Austria as a centre for research and production.

Key figures 2020 and 2021

	2020	2021
Total income in €1,000	161,252	179,059

Number of employees of the AIT	2020	2021
Employees (= headcount)	1,298	1,331
Full time equivalents (rounded)	1,149	1,178

Source: Austrian Institute of Technology (AIT).

3.1.2 Indicators for 2020 and 2021

Indicator 1: Funding, including third-party funding

Unlike the "key figures", all indicators in section 3.1.2 refer to the Austrian Institute of Technology (AIT) without including Seibersdorf Labor GmbH or Nuclear Engineering Seibersdorf GmbH.

	2020 in €1,000	2021 in €1,000	2023 targets (in €1,000)
Total operational income	130,253	135,985	
of which contributions from shareholders	48,923	50,801	
of which third-party funding	81,331	85,184	92,119
of which from non-EU countries and global organisations	1,113	1,694	
of which public	163	284	
of which private	949	1,410	
of which from the EU and European countries or organisations	26,014	26,901	
of which public	17,266	18,877	
of which private	8,748	8,024	
of which national and regional organisations	54,204	56,589	
of which public	31,447	32,106	
of which private	22,757	24,483	

Source: Austrian Institute of Technology (AIT).

Indicator 2: Quality assurance and evaluations

Evaluations of thematic and strategic orientation

The Austrian Institute of Technology (AIT) carries out an evaluation for each ongoing strategy period in line with its performance agreement and articles of association. Internationally composed evaluation panels are appointed according to a decision of the Supervisory Board. These panels are tasked with reviewing and evaluating the scientific quality and impact of research results, ensuring the international positioning and practical relevance of the centres' activities, and issuing position statements on strategic developments. The evaluation panels report to the Managing Directors, who pass the results on to the Supervisory Board and include them as a key factor in their development of the subsequent strategy. The most recent evaluation was performed in the second quarter of 2020, with the next planned for March/April 2023 in line with the three-year strategy cycle.

Institutional quality assurance measures

The quality management (QM) system is certified according to ISO 9001, and some organisational units additionally have ISO 13485 certification for medical devices or ISO 17025 accreditation as testing laboratories. Besides complying with legal requirements, the Austrian Institute of Technology (AIT) is also guided by QM regulations, economically optimal variants, social aspects, and safety and environmental factors. The Managing Directors draw up the quality policy and annual quality objectives and targets and thus bear overarching responsibility for quality within the institute. Staff at AIT work in accordance with established QM documents and strive for continuous improvement in order to achieve excellence and maximise customer satisfaction. Compliance with the requirements of the quality management system is monitored through both internal and external audits.

Indicator 3: Human resources and qualifications

Number of employees (including LKR Leichtmetallkompetenzzentrum Ranshofen GmbH (Competence Unit "Light Metals Technologies Ranshofen"))	2020			2021		
	m	f	Total	m	f	Total
Employees (= headcount)	741	338	1,079	765	337	1,102
of which at management level (Department Head, Division Head, General Management, Head of Staff Unit)	35	8	43	31	8	39
Full time equivalents (rounded)	673	279	952	691	277	968
of which at the management level	33	8	41	29	8	37

Number of PhD students	2020	2021	2023 target value
Number of theses completed	27	38	30*
Employees (= headcount)	185	182	
of which employed at the AIT	143	136	
of which in a structured training programme (doctoral schools, etc.)	42	46	

* The higher-than-expected number of theses completed in 2021 is due to the delays caused in 2020 by the COVID-19 pandemic. Experience from previous years suggests that the figure will stabilise again at pre-pandemic levels after 2021.

Source: Austrian Institute of Technology (AIT).

The following staff development measures were implemented in 2020 and 2021:

Recruiting and employer branding: Expansion of our external presence (career talks, digital career fairs), "gender initiative": women researchers as role models; onboarding: AIT onboarding app, internal landing page for new employees

Qualification: Re-evaluation of the training programme: incorporating gender- and diversity-oriented content; specific sales training on web-based selling and acquisition: focus on web-based sales calls, gender and diversity training initiative for managers; implementing a "lateral management" curriculum

Career development: implementing a PhD programme based on a new model; evaluating job profiles and career paths, adapting job profiles in line with gender equality criteria as well as project and management responsibility; first-ever AIT Female Leadership Development Programme

Organisational development: conducting the 2020 employee survey, focusing particularly on "new work" and resulting in the implementation of centre-specific measures

Indicator 4: Output, innovation and excellence

Scientific publications	2020	2021	2023 target value
Total publications	568	615	630
of which monographs and editions	20	12	
of which articles/papers in scientific journals, edited volumes and proceedings	548	603	
of which listed in WoS or Scopus	401*	300**	

* Updated value for evaluation date 24 January 2022.

** The figures for WoS for 2021 are only provisional since not all publications had yet been included in WoS at the time of the evaluation (24 January 2022).

Source: Austrian Institute of Technology (AIT).

Grants in excellence programmes of the European Research Council (ERC) and Austrian Science Fund (FWF)		2020	2021
ERC	Number	0	0
	Total funding approved in €1,000	-	-
Wittgenstein Award of the Austrian Science Fund (FWF)	Number	0	0
	Total funding approved in €1,000	-	-
Start Programme of the Austrian Science Fund (FWF)	Number	0	0
	Total funding approved in €1,000	-	-

Source: Austrian Science Fund (FWF) and Austrian Research Promotion Agency (FFG) EU Performance Monitor. The following formats are considered for the ERC: Starting Grants, Consolidator Grants and Advanced Grants. The figure is based on the year in which the contract was concluded.

Indicator 5: Internationalisation

	2020	2021
Share of international co-publications among all publications	59.4%*	60%**
Number of newly approved participations in Horizon 2020 and Horizon Europe programmes and initiatives	33	29
Total funding approved in €1,000	20,535	12,675

* Updated value for evaluation date 24 January 2022.

** The information for WoS for 2021 is only provisional since not all publications were included in WoS at the time of the evaluation (24 January 2022). The values stated refer to co-publications with at least one author from abroad as a proportion of the total number of publications in the WoS.

Source: Austrian Institute of Technology (AIT).

Central memberships in international umbrella organisations and networks, important internationalisation measures in 2020 and 2021:

Under the strategy being pursued by the Austrian Institute of Technology (AIT), national and international scientific networks are one way to strengthen and enhance core skills. The Austrian Institute of Technology (AIT) cultivates its scientific partnerships and PhD programmes on an on-going basis and is constantly working on expanding them. For instance, it is developing a transatlantic research partnership with Tufts University Boston. Researchers from the Austrian Institute of Technology (AIT) present their findings at international conferences and are members of numerous international project consortia and networks. EARTO, EARPA, ECSO, EERA, EFFRA, ECTRI, EHPA, EMVA, HLG on Innovation Policy, IEA WGs, IEEE Women in Engineering – Austria Section, EpoSS, AIOTI, EUREC and YEAR as well as EIT HEALTH and European Industrial Alliances (Battery, Clean Hydrogen) should be highlighted here.

Indicator 6: Knowledge and technology transfer

	2020	2021
Share of co-publications with industry and practice partners among all publications listed in WoS	40%*	37%**

IPR: Patents and exploitation activities	2020	2021
Number of patent applications	41	22
of which national	14	7
of which EU/EPC	13	7
of which non-EU countries	14	8
Issued patents	36	35
of which national	11	9
of which EU/EPC	19	11
of which non-EU countries	6	15
Exploitation spin-offs	2	1

* Updated value for evaluation date 24 January 2022.

** The figures for WoS for 2021 are only provisional since not all publications had yet been included in WoS at the time of the evaluation (24 January 2022). Note: the figures indicate the number of AIT publications in Web of Science in which the named types of organisations were involved as co-authors. Having several co-authors in a single publication will result in multiple citations.

Source: Austrian Institute of Technology (AIT).

Indicator 7: Communication and interaction with society

The following activities and formats for communicating and transferring knowledge as well as for engaging and addressing civil society actors were implemented in 2020 and 2021:

Formats for communicating and disseminating knowledge:

- Digital and social media channels as well as Austrian news agency APA OTS
- AIT blog and podcast
- Media partnerships
- AIT staff in the media and in panel discussions
- Lectures at national and international research institutions
- Appearances at international trade fairs
- Appearance at the City Intelligence Lab at Expo 2020 in Dubai
- Alpbach technology symposium
- Exhibition at the Ars Electronica Center on topics connected with the flagship region for energy
- Involvement in the Kinder UNI Tulln children's university
- Participation in Vienna's Daughters' Day

Examples of projects for engaging and addressing civil society actors:

- The Blockchain Grid project uses blockchain technology to enable users in local energy communities to share grid resources with one another and store or sell any surpluses generated to other community members. CLUE likewise involves local energy communities.
- CATRINA is studying gender- and diversity-specific factors influencing actions that demonstrate civil courage.
- #mypart is working together with schoolchildren to devise strategies for changing people's habits in the interests of mitigating climate change.

- Talk about IT! is developing and trialling business cases for incorporating gender equality and diversity into digitalisation.
- YouthCodes is exploring peer education approaches in raising awareness of mobility issues amongst young people.

Indicator 8: Gender and promotion of gender equality

Share of women in management positions by management level	2020	2021	2023 target value
Managing Directors	0%	0%	
Head of Center/Head of Administrative Area	9%	20%	
Principal Scientist	20%	14%	
*Glass Ceiling Index based on management levels**	1.68	1.49	
Percentage of women in project leader positions**	44%	48%	50%

* Calculated as the share of women among all employees/share of women in management positions. The following are considered management positions: Managing Director, Head of Centre, Head of Administrative Area, Principal Scientist.

** This figure relates to the percentage of female project leaders in relation to all employees on the *Science and Research Engineer/Expert Advice career path*. It does not include any employees on other career paths.

Source: Austrian Institute of Technology (AIT).

The following activities were implemented in 2020 and 2021 aimed at promoting gender equality:

Recruiting and employer branding: programmes aimed explicitly at recruiting female early stage researchers, comprehensive information services on gender activities and ensuring balanced selection processes, relaunching the AIT women's network with a series of events

Qualification and ongoing training: access to the company's training services for all employees irrespective of gender or working hours, mandatory training for different target groups and specific training for women in the organisation: introduction of the AIT Female Leadership Development Programme (modules, coaching, project work, institution-wide networking events and accompanying communication measures)

Compatibility of family and career: helping employees shape their personal work/life balance with a special focus on flexible working hours and teleworking; childcare during the holidays

Structural measures: adoption of the Gender Action Programme and Gender Equality Plan, establishment of a dedicated gender information area on the intranet for AIT staff, brochures and FAQs on gender issues, discussion forums both for women and for AIT management, AIT Gender Monitor

3.1.3 Special events in 2021 and outlook for the coming years

In line with its "Shareholder Vision 2030" and in its capacity as Austria's largest research and technology organisation (RTO), the Austrian Institute of Technology (AIT) is oriented towards technology development in the "Grand Challenges" with a focus on infrastructure topics of the future. Together with its customers and partners, the Austrian Institute of Technology (AIT) is harnessing the potential that new technologies present for innovations and is supporting business and society in the areas of digitalisation, decarbonisation and the consequences of climate change in particular.

Work on implementing the current strategy, "Research and Innovation for a Sustainable and Competitive Position in the Digital Age", got under way in 2021. In response to the new Research Financing Act, the planning and management processes and governance system at the Austrian Institute of Technology

(AIT) were aligned with the now three-year strategy cycle, and a new performance agreement was launched.

The AIT's strategic positioning was strengthened further through investments in state-of-the-art laboratory infrastructure, most notably the AIT Battery Laboratory, which is currently being enhanced with the addition of equipment for solid-state batteries, and the expansion of the Direct Current Laboratory – an extension to the existing infrastructure for electrical energy systems geared towards providing a major boost to DC innovations for industry.

The success of the AIT's integrated spin-off strategy, including restructuring the "Time to think big" entrepreneurship programme, was demonstrated in 2021 by no fewer than three companies being set up. The Austrian Institute of Technology (AIT) also achieved an outstanding second place in the "Non-university research institutions" category in the "Spin-Off Dashboard Austria 2021".[290]

3.2 Institute of Science and Technology Austria (ISTA)

3.2.1 Profile and key data

The Institute of Science and Technology Austria (ISTA) was established in 2006 by the Federal Government of Austria and the Government of Lower Austria. Its Klosterneuburg campus opened in 2009. The Institute serves as a centre for cutting-edge basic research in the natural, mathematical and computer sciences. The objectives of the Institute of Science and Technology Austria (ISTA) are to open up new fields of research and to ensure high-quality post-graduate education in the form of interdisciplinary PhD and postdoc programmes. Research, education and staff selection are internationally oriented; the working and teaching language is English. There will be around 150 research groups and a total of more than 2,000 employees on campus by 2036.

Key figures 2020 and 2021

	2020	2021
Total income in €1,000	94,648	85,002

Number of employees	2020			2021		
	m	f	Total	m	f	Total
Employees (= headcount)	479	382	861	520	415	935
Full time equivalents (rounded)	472	359	831	512	390	902

Source: ISTA.

290 Further information can be found in the AIT's Annual Financial Statement 2021: https://www.ait.ac.at/fileadmin/cmc/images/New_Presse/Jahresabschluss_und_Berichte/AIT_Jahresbericht-2021-EN-ES.pdf

3.2.2 Development of indicators

Indicator 1: Funding, including third-party funding

	2020 in €1,000	2021 in €1,000	2023 target (in €1,000)
Total income	94,648	85,002	
of which basic public funding from the federal government	63,499	53,106	
of which cash-in obtained for eligible third-party funds	20,575	21,638	21,500*
of which funding from the federal state of Lower Austria	2,383	2,822	
of which other sales revenues and other operating income	9,697	10,349	
of which from the release of investment grants	8,231	8,951	
of which third-party funding	19,069	18,725	
of which from non-EU countries and global organisations	2,518	2,926	
of which from the EU and European countries or organisations	12,062	10,783	
of which national and regional organisations	4,490	5,016	

* Owing to the significant fluctuations between individual years in the disbursement of third-party funds, the ISTA uses average figures over a longer period (three years), from which the target value is calculated.

Source: ISTA.

Indicator 2: Quality assurance and evaluations

Evaluations of thematic and strategic orientation

The Institute of Science and Technology Austria (ISTA) is managed by a number of executive bodies that perform specifically defined tasks. Various quality assurance instruments are used to measure its performance: the Board of Trustees and the Executive Committee oversee the development and strategic direction of the Institute, while the Scientific Board prepares proposals for the scientific orientation and for ensuring high performance. The development of the Institute undergoes regular evaluations, as stated in Section 5 (2) of the Federal Act Establishing the Institute of Science and Technology Austria. To date, one economic evaluation (2014-15) and three scientific evaluations (2011, 2015, 2019) have taken place, in which excellent development of the Institute was noted.

Institutional quality assurance measures

- Bottom-up recruitment strategy: prioritising excellent people over a particular research field. The recruitment strategy pursued by the Institute of Science and Technology Austria (ISTA) is based on excellence;
- Tenure-track system for long-term assurance of high scientific standards;
- Internal control system and risk management system as parts of the “Three Lines of Defense” corporate governance model.

The internal control system (1st Line of Defense) was implemented for central processes. The internal control system is tested and a report submitted to the management and the Audit Committee at least annually. The risk management system (2nd Line of Defense) pursues the goal of identifying and assessing significant risks in good time. Internal Audit forms the 3rd Line of Defense. The Board of Trustees and the Audit Committee are updated on the risk situation by management at least once a year.

Indicator 3: Human resources and qualifications

Number of employees	2020			2021		
	m	f	Total	m	f	Total
Employees (= headcount)	479	382	861	520	415	935
of which at the management level (faculty – professors and assistant professors, general management, division heads, unit heads)	62	20	82	67	21	88
Full time equivalents (rounded)	472	359	831	512	390	902
of which at the management level	62	20	82	67	20	87

Source: ISTA.

Number of PhD students	2020	2021	2023 target value
Number of theses completed	32	23	28
Employees (= headcount)	250	280	
of which employed at the ISTA	250	280	
of which women	106	121	122
of which in a structured training programme (doctoral schools, etc.)	250	280	

Source: ISTA.

The following staff development measures were implemented in 2020 and 2021:

- The staff development and career advancement plan drawn up as part of the 2021–2023 performance agreement is implemented on an ongoing basis.
- Target-group-specific training for the academic sector includes training in the areas of academic skills, technical skills, career development, training in grant applications and training in sharing standards of good research practice.
- Administrative employees and employees in the Scientific Service Units have access to a comprehensive continuing education and training programme as well as to specific training on the topic of leadership.

Indicator 4: Output, innovation and excellence

Scientific publications*	2020	2021	2023 target value
Monographs and editions	32	25	
Articles/papers in scientific journals, edited volumes and proceedings	376	434	
of which listed in WoS or Scopus	359	413	
Percentage of publications with at least one co-author affiliated elsewhere	>75%	90.3%	≥75%

* Setting a target value for the total number of publications would not be meaningful for the ISTA because the institution focuses on the quality rather than quantity of publications. Such an indicator would therefore give a misleading impression of the institution's actual publication output.

Source: ISTA.

Grants in excellence programmes of the European Research Council (ERC) and Austrian Science Fund (FWF)		2020	2021
ERC	Number	4	3
	Total funding approved in €1,000	6,455	6,145
Wittgenstein Award of the Austrian Science Fund (FWF)	Number	0	0
	Total funding approved in €1,000	-	-
Start Programme of the Austrian Science Fund (FWF)	Number	0	0
	Total funding approved in €1,000	-	-

Source: Austrian Science Fund (FWF) and Austrian Research Promotion Agency (FFG) EU Performance Monitor. The following formats are considered for the ERC: Starting Grants, Consolidator Grants and Advanced Grants. The figure is based on the year in which the contract was concluded.

Indicator 5: Internationalisation

	2020	2021
Share of international co-publications among all publications	81.6%	79.2%
Number of newly approved participations in Horizon 2020 and Horizon Europe programmes and initiatives (including ERC grants)	5	8
Total funding approved in €1,000	5,032	12,971

Source: ISTA.

Central memberships in international umbrella organisations and networks, important internationalisation measures in 2020 and 2021:

- Member of the BRIDGE network together with Rockefeller University (USA), the Francis Crick Institute (UK), the Weizmann Institute of Science (Israel) and the Okinawa Institute of Science and Technology (Japan).
- Participation in the IST-BRIDGE International Postdoctoral Program (1st call 2021).
- Participation in the Erasmus+ Staff Mobility Programme.
- The library is part of an international research infrastructure project with a focus on open access.
- Member of PRACE (Partnership for Advanced Computing in Europe).
- Research groups in the field of artificial intelligence are members of ELLIS (European Laboratory for Learning and Intelligent Systems).
- Member of the ALBA Network (https://www.alba.network/).

Indicator 6: Knowledge and technology transfer

	2020	2021
Share of co-publications with industry or practice partners among all publications	7.0%	10.7%

Patents and exploitation activities	2020	2021
Number of patent applications	10	7
Issued patents	0	0
Exploitation spin-offs	2	0

Source: ISTA.

Indicator 7: Communication and interaction with society

Events were held online wherever possible due to the ongoing COVID-19 pandemic.

- Public IST Lectures: internationally recognised top researchers present their work in terms that are generally comprehensible
- Science-Industry Talk (together with the Federation of Austrian Industries)
- IST Austria Science Talks: public lectures in German by researchers at the Institute of Science and Technology Austria (ISTA)
- TWIST Talk: series of lectures aimed at promoting discussions between industry, start-ups and the research community
- "Lange Nacht der Forschung" ("Long Night of Research") (online in 2020, cancelled in 2021)
- Science Education Day: annual knowledge-sharing event for teachers and researchers
- Zoom a Scientist: gets classes of schoolchildren talking to researchers

- Open Campus: largest science festival in Klosterneuburg; was able to be held on campus in September 2021, including the awards ceremony for the "Zukunft gestalten" ("Shaping the Future") competition for schools
- "Sommercampus 2021" ("Summer Campus 2021"): was able to be held in person; specific camps for primary school children and for pupils in the middle and upper cycles

Amongst the initiatives devised in response to the pandemic, the board game "Virusalarm in Bleibhausen" ("Virus Alert in Bleibhausen") was developed further in 2021.

Indicator 8: Gender and promotion of gender equality

Share of women in management positions by management level	2020	2021	2023 target value
All management levels*	24.4%	23.9%	24%
General management	0%	0%	
Division heads/unit heads	39.1%	43.5%	
Faculty (professors and assistant professors)	19.0%	17.0%	
*Glass Ceiling Index based on management levels***	1.82	1.86	

* The following are considered management positions: faculty (professors and assistant professors), general management, division heads and unit heads.

** Calculated as the share of women among all employees/share of women in management positions.

Source: ISTA.

Increasing the share of women is a key strategic focus for the Institute of Science and Technology Austria (ISTA), which is employing various measures to achieve this:

- Targeted scouting of female postdocs in awarded research institutes;
- A separate recruitment committee that searches specifically for appropriate female candidates for professorships and actively invites them to apply to the Institute of Science and Technology Austria (ISTA);
- Bias awareness training for professors as well as for managers in Administration and the Scientific Service Units;
- Expansion of the dual career concept in order to be able to take even greater account of the careers of partners of ISTA staff in the future;
- With the launch in 2021 of the "WoMen in Science: Change the World!" focus area, the Institute of Science and Technology Austria (ISTA) is highlighting the need for gender equality. The campaign features a range of activities including the WoMen in Science Day, a photo exhibition and a special edition of "Zoom a Scientist" just for girls;
- STEM fatale lecture series: successful women from the STEM disciplines (science, technology, engineering and mathematics) present their career paths and how they have managed to overcome challenges in their professional careers so far.

3.2.3 Special events in 2021 and outlook for the coming years

The continued success of researchers in acquiring funding from the European Research Council (ERC) represents another clear sign of excellence.

No fewer than 49 (72%) of the professorships on campus are held by *ERC grantees*. At 47%, the success rate for applications for *ERC Advanced, Consolidator* and *Starting Grants* is amongst the highest in the whole of Europe.

The new agreement in accordance with Art. 15a of the Austrian Federal Constitutional Law (B-VG) between the federal government and the federal state of Lower Austria was approved unanimously by the National Council and Federal Council in 2021, thus securing the institution's continued growth until 2036.

Also in 2021, the management team was strengthened with the appointment of two Vice Presidents for Science Education and Technology Transfer in order to allow society and industry to appreciate and benefit from the value of basic research.

The new Sunstone Building was likewise completed in 2021, and construction began on an additional laboratory building. A master plan for the continued expansion of the campus in the years to 2036 was devised, and the architectural competition for laboratory building 7 – the first of these new projects – has already been launched.

"IST cube", the risk fund initiated by ISTA, was endowed with €45 million by the European Investment Fund and private partners. The fund currently invests in 11 start-ups, several of which were born out of research conducted at the Institute of Science and Technology Austria (ISTA).[291]

3.3 Austrian Academy of Sciences (OeAW)

3.3.1 Profile and key data

"To promote science in every way" – that is the statutory mandate of the Austrian Academy of Sciences (OeAW), Austria's largest and most diverse non-university institution for basic research.

As a research performing organisation of 25 institutes in the area of humanities, social sciences and cultural studies (GSK) as well as in natural, life and technical sciences, the OeAW embraces pioneering research topics often on an interdisciplinary basis, taking an application-open approach while preserving our cultural heritage.

As a research funding organisation, the Austrian Academy of Sciences (OeAW) supports promising scientific talent, both intramurally through an attractive career model and throughout the entire Austrian research area by awarding grants and prizes.

As a national academy of sciences, OeAW is a learned society and dispenser of knowledge that also contributes the latest scientific findings to the public discourse from a multidisciplinary perspective.

The interaction of these areas under one umbrella creates synergies, dynamism and innovation potential for the benefit of science and society.

Key figures 2020 and 2021

Austrian Academy of Sciences (OeAW) as a whole	2020	2021
Total income in €1,000*	194,922	207,874

Number of employees at OeAW (including wholly-owned subsidiaries)	2020			2021		
	m	f	Total	m	f	Total
Employees (= headcount)	1,062	805	1,867	997	831	1,828
Full time equivalents (rounded)	897	637	1,534	851	656	1,507

* Total income does not include extraordinary income from the release of provisions or income from the disposal of fixed assets.

Source: Austrian Academy of Sciences (OeAW). The numbers for 2021 are preliminary values.

291 For more information, see the ISTA's Annual Report 2021: https://ista.ac.at/wp-content/uploads/2022/04/IST-Annual-Report-2021-WEB.pdf

3.3.2 Development of indicators

Devising target values for knowledge-oriented, application-open basic research poses a particular challenge. The Federal Ministry of Education, Science and Research (BMBWF) and the Austrian Academy of Sciences (OeAW) therefore agreed to devise plausible, meaningful indicators that could be used to carry out the target/actual comparison required by the Research Financing Act (FoFinaG) in a joint coordination process and establish them by mutual agreement. Corresponding information will thus be able to be presented in the Austrian Research and Technology Report (FTB), starting from next year's FTB.

Unlike the "key figures" listed above, all the following indicators apart from indicator 7 refer solely to the Austrian Academy of Sciences (OeAW) as a research performing organisation, i.e. excluding the learned society, fellowships and the commissioned area.

Indicator 1: Funding, including third-party funding

Austrian Academy of Sciences (OeAW) research performing organisation	2020 in €1,000	2021 in €1,000
Total income *	**173,249**	**182,925**
of which federal funds based on the OeAW/BMBWF performance agreement	100,463	111,730
of which other income (recharge of costs)	25,417	25,599
of which third-party funding**	47,369	45,596
of which global organisations and non-European countries or organisations	76	966
of which from the EU and European countries or organisations	15,134	17,392
of which public	15,134	17,392
of which private	0	0
of which national and regional organisations	32,159	27,238
of which public	32,154	27,227
of which from the National Foundation for Research, Technology and Development (NFTE) and the Austria Fund	8,458	3,020
of which private	6	11

* Total income does not include extraordinary income from the release of provisions or income from the disposal of fixed assets.

** Third-party funds are presented according to the time of receipt of payment and do not include accruals and deferrals.

Source: Austrian Academy of Sciences (OeAW). The numbers for 2021 are preliminary values.

Indicator 2: Quality assurance and evaluations

Evaluations conducted at the institute and programme level

Regular or special-purpose evaluations according to international standards provide crucial momentum for further development at the Austrian Academy of Sciences (OeAW) institutes and initiatives; results from the evaluations provide the starting point for decisions by the Executive Board on the institutes' development in coordination with the Research Committee and the Academy Council at the OeAW.

Evaluations at the institutes are carried out by international teams of high-level researchers, with the independence and expertise of these teams being the responsibility of the OeAW Research Committee, which includes Nobel Prize winners. Evaluation teams usually form an independent opinion of the situation on site. With the pandemic continuing into 2021, these kinds of evaluation at the institutes were not possible. Pilot projects were therefore launched, including at the Institute for Habsburg and Balkan Studies, to explore the possibilities and limitations of purely online evaluations.

Institutional quality assurance measures

In addition to evaluations, other measures designed in accordance with international standards ensure scientific quality on an on-going and transparent basis, e.g. through the filling of scientific (executive) positions or in ex ante and ex post project and programme monitoring. All quality assurance processes, which in 2021 led to target agreements being successfully concluded between the Executive Board and the individual institutes at the Austrian Academy of Sciences (OeAW), take into account specific aspects and dynamics of the respective research field as well as special institute missions, such as protecting cultural heritage or science-based policy consultancy.

In addition to scientific appropriateness, the administration at the Austrian Academy of Sciences (OeAW) is also guided by legal requirements, complies with the federal government's Public Corporate Governance Code (PCGK) to the extent applicable to it, and follows a risk and compliance management system, which is monitored by its Audit Committee as well as by an internal audit commissioned externally.

Indicator 3: Human resources and qualifications

Number of employees of the OeAW research performing organisation (incl. wholly-owned subsidiaries)	2020			2021		
	m	f	Total	m	f	Total
Employees (= headcount)	1,019	753	1,772	954	780	1,734
of which at the management level	122	51	173	117	55	172
Full time equivalents (rounded)	860	594	1,454	814	614	1,428
of which at the management level	111	47	158	104	51	155

Source: Austrian Academy of Sciences (OeAW).

Number of PhD students	2020	2021
Employees (= headcount)	316	327
of which employed at Austrian Academy of Sciences (OeAW) research institutions	293	277

Source: Austrian Academy of Sciences (OeAW).

The following staff development measures were implemented in 2020 and 2021:

The harmonisation and implementation of the OeAW's careers model and collective agreement have created an improved framework for transparent career development and staff planning based on career stages that can be compared internationally.

A mentoring scheme organised key skills workshops for the next generation of scientists for the sixth time. Knowledge transfer and strategic support for the mentees' career development play a crucial role, and these activities were supplemented by self-organised peer mentoring in 2021.

The Austrian Academy of Sciences (OeAW) offers tailor-made training measures such as Excellence-4GRANTed workshops for ERC aspirants or initial training sessions for project leaders in order to facilitate the acquisition of competitive projects with third-party funding.

The OeAW's extramural scholarship programmes that focus specifically on early-career researchers, such as Post-DocTrack, were continued successfully.

Indicator 4: Output, innovation and excellence

Number of scientific publications from projects of the OeAW research performing organisation*	2020	2021
Monographs and editions	61	59
Articles/papers in scientific journals, edited volumes and proceedings	1,767	1,832
of which listed in WoS or Scopus	1,329	1,469
of which published in other outstanding journals or by specialised publishers of the departments**	112	133

* From the OeAW's perspective, producing an overall total for such different types of publication as monographs and articles in specialist journals is not permitted from either a quantitative or a qualitative perspective as they have completely different characteristics, so no such total is provided.

** Since the WoS and Scopus indices do not fully represent publications in the humanities, social sciences and cultural studies (GSK), a further selection of indices was made with external international participation, as well as of outstanding publication bodies that are placed on an equal footing with the journals indexed in WoS/Scopus in the publication indicators of the Austrian Academy of Sciences (OeAW).

Source: Austrian Academy of Sciences (OeAW).

Projects acquired by OeAW research institutions in excellence programmes of the European Research Council (ERC) and Austrian Science Fund (FWF)		2020	2021
ERC	Number	3	5
	Total funding approved in €1,000	4,713	10,150
Wittgenstein Award of the Austrian Science Fund (FWF)	Number	0	0
	Total funding approved in €1,000	-	-
Start Programme of the Austrian Science Fund (FWF)	Number	0	0
	Total funding approved in €1,000	-	-

Source: Austrian Research Promotion Agency (FFG) EU Performance Monitor (ERC), Austrian Research Promotion Agency (FFG) (Start Programme). The following formats are considered for the ERC: Starting Grants, Consolidator Grants and Advanced Grants. The figure is based on the year in which the contract was concluded.

Besides the projects listed in the table, the Austrian Academy of Sciences (OeAW) was also involved in 2021 as the co-beneficiary in two other successful applications for ERC Advanced Grants. In addition, the OeAW obtained two Consolidator Grants in 2020, which were transferred to another research institution prior to project start, and participated as a co-beneficiary in one other successful Consolidator Grant application. The OeAW is now involved as a co-beneficiary in one of the Consolidator Grants included in the above table for 2020.

Indicator 5: Internationalisation

	2020	2021	2021–23 target
Share of international co-publications among all publications* listed in WoS in the reporting year	83.8%	80.6%	-
Number of newly approved participations by OeAW research institutions in Horizon 2020 and Horizon Europe programmes and initiatives	19	15	-
Total funding approved in €1,000	17,865	7,194	-
Number of Horizon Europe applications	-	63	-
cumulative for 2021–2023	-	-	200

* The following citable publication types are taken into account: articles, proceedings, papers, review articles, letters.

Source: Austrian Academy of Sciences (OeAW).

Central memberships in international umbrella organisations and networks, important internationalisation measures in 2020 and 2021:

The Austrian Academy of Sciences (OeAW) is involved in multilateral academy associations (e.g. ALLEA, EASAC, FEAM). Partnerships with science academies from 55 countries (including Israel, Canada, Croatia, Slovenia, Ukraine and the western Balkan region) enable the implementation of joint research activities

and scientific guest stays with minimum bureaucracy. The OeAW "Joint Excellence in Science and Humanities" mobility programme (JESH) facilitates cooperation between outstanding young researchers from abroad and Austria. A joint JESH call for proposals covering all 55 focus countries was organised in 2021, with an "outgoing" track included for the first time since 2017.

Memberships of the OeAW in international research alliances and infrastructures on behalf of the Republic of Austria are open to the entire Austrian research community; these are complemented by numerous research collaborations entered into autonomously with international players.

Indicator 6: Knowledge and technology transfer

	2020	2021
Share of co-publications with industry or practice partners among all publications listed in WoS	33.0%	31.4%

IPR: Patents and exploitation activities	2020	2021
Number of patent applications	30	30
of which national	0	0
of which EU/EPC	14	15
of which non-EU countries	16	15
Issued patents	14	6
of which national	2	0
of which EU/EPC	4	2
of which non-EU countries	8	4
Exploitation spin-offs	3	2
Licensing agreements	4	3
Options agreements	1	0
Sales agreements	2	3
Exploitation partners (companies, non-university research institutions)	7	8

Source: Austrian Academy of Sciences (OeAW).

Indicator 7: Communication and interaction with society

Active perception of the OeAW's role in society	2020	2021	2023 target value
Number of the OeAW's "Akademie im Klassenzimmer" ("Academy in the Classroom") talks given at secondary schools	3	4	20
Summer and winter school seminars as part of the Österreichische Studienstiftung (Austrian Academic Studies Foundation)	4	10	3

Source: Austrian Academy of Sciences (OeAW).

The following activities and formats for communicating and transferring knowledge as well as for engaging and addressing civil society actors were implemented in 2020 and 2021:

New knowledge continued to be generated and shared in a variety of ways at the Austrian Academy of Sciences (OeAW) in 2020 and 2021, including via exhibitions on Heldenplatz and at the Weltmuseum, the OeAW's contribution to the Vienna Children's University and the OeAW's public prize question. This sees people from all over the world submitting essays on a particular topic, most recently "What can science do in pandemics?". The OeAW's science comics were sent out to schools across Austria accompanied with a website with details of hands-on experiments and teaching materials.

The Österreichische Studienstiftung (Austrian Academic Studies Foundation), which provides intellec-

tual stimulation to gifted and talented secondary-school leavers and supports them during their studies, introduced a series of discussions with public figures in 2021 alongside its summer and winter schools and mentoring by established researchers.

Two video series – "Corona-Faktencheck" ("Coronavirus Fact Check") and "Was macht eigentlich…?" ("What do actually do?") – launched on the OeAW's YouTube channel in 2021. The OeAW's podcast was also continued successfully.

Due to the pandemic, in-person talks at schools had to be scaled back and many other events moved online.

Indicator 8: Gender and promotion of gender equality

Share of women in management positions by management level	2020	2021
Institute directors	28%	26%
Scientific directors	18%	31%
(Senior) group leaders	24%	28%
Junior group leaders	27%	22%
Administrative and technical management staff	37%	38%
Glass Ceiling Index based on management levels*	1.44	1.41

* Calculated as the share of women among all employees/share of women in management positions.

Source: Austrian Academy of Sciences (OeAW).

The following activities were implemented in 2020 and 2021 aimed at promoting gender equality:

The focus remains on reinforcing gender equality in order to embed it further within the institution as well as on improving the compatibility of science and private life. Following the introduction of "Academy and Child" in 2019, the concept was expanded into "Academy and Family" in 2020.

A repository of information on gender bias was made available to all evaluation committees at the Austrian Academy of Sciences (OeAW) in order to raise awareness of the issue.

The OeAW's new Equal Opportunities and Women's Advancement Plan entered into force in March 2021.

The hashtag #WomenInScience on the OeAW's Facebook page continued to draw attention to the achievements of women in research in the past and present in 2021.

The first "8ung auf Frauen" ("Take Note of Women") lecture was held in 2021. The series, which aims to showcase the work of female researchers, kicked off with OeAW archaeologist Barbara Horejs shining a new light on the "Neolithic Revolution" on International Women's Day.

Regular lectures on gender and diversity provide momentum for advancing gender equality; unfortunately, the lectures planned for 2021 had to be postponed to 2022 due to the COVID-19 pandemic.

3.3.3 Special events in 2021 and outlook

The development plan sets out the Academy's strategic objectives and the performance agreement corresponding measures that it will take, in each case over a three-year horizon. Both documents for 2021–2023 can be found at https://www.oeaw.ac.at/en/oeaw/academy/performance-reports-strategy.

Examples of research results from 2021

Archaeologists from the Austrian Academy of Sciences (OeAW) working in Saint Catherine's Monastery in the Sinai Peninsula discovered a previously unknown text from the time of Homer.

Data obtained by glacier researchers from the Austrian Academy of Sciences (OeAW) proves that the peaks of the eastern Alps had once been ice-free in the past 10,000 years.

An international team led by researchers from the Austrian Academy of Sciences (OeAW) and the University of Vienna created a 192-kilometre-long quantum-encrypted connection via underwater cable in the Mediterranean Sea as part of efforts to develop a tap-proof quantum internet.

The successful development of self-organising heart organoids at the Austrian Academy of Sciences (OeAW) is opening up new possibilities in the study of cardiovascular disease, congenital genetic defects and developmental disorders of the heart.

Under the direction of the Austrian Academy of Sciences (OeAW), a project entitled "Mutationsdynamik von SARS-CoV-2 in Österreich" ("Mutation Dynamics of SARS-CoV-2 in Austria") is investigating mutations of the virus that are in circulation in Austria in order to obtain a better molecular understanding of the biology behind SARS-CoV-2, how it is transmitted, and how mutations emerge in the population.

Outlook

A call for proposals has been launched for basic research projects on anti-Semitism in modern-day Austria. May 2022 will see the opening of the Academy Campus, which includes premises inside the former Austrian Postal Savings Bank building designed by Otto Wagner. This milestone in the OeAW's consolidation of its presence in the heart of Vienna will send out a signal for science and society. The OeAW is also celebrating its 175th anniversary.[292]

3.4 Silicon Austria Labs (SAL)

3.4.1 Profile and key data

Silicon Austria Labs (SAL) is a European research centre for electronics-based systems (EBSs). At the three locations of Graz, Linz and Villach, SAL conducts research along the entire EBS value chain, from basic to application-oriented research, from microelectronic components to intelligent systems. Thanks to innovations that add value at every stage, participating companies can secure unique competitive advantages on the world market. The cooperation model of Silicon Austria Labs (SAL) brings together key players from different areas to work on research projects in the areas of sensor systems, intelligent wireless systems, power electronics and embedded systems. SAL offers various models customised to the specific research requirements and the technology readiness level (TRL).

Key figures 2020 and 2021

	2020	2021
Total income in €1,000	21,840	32,163

Number of employees at SAL	2020			2021		
	m	f	Total	m	f	Total
Employees (= headcount)	136	52	188	191	60	251
Full time equivalents (rounded)	127	47	174	179	55	234

Source: SAL.

292 Further information can be found here: https://www.oeaw.ac.at/en/oeaw/academy/performance-reports-strategy

3.4.2 Development of indicators

Indicator 1: Funding, including third-party funding

	2020 in €1,000	2021 in €1,000	2023 target (in €1,000)
Total income	21,840	32,163	
of which contributions from shareholders	12,618	20,120	
of which third-party funding	9,222	12,043	25,200
of which from non-EU countries and global organisations	0	46	
of which public	0	46	
of which private	0	0	
of which from the EU and European countries or organisations	1,725	2,515	
of which public	635	1,252	
of which private	1,090	1,263	
of which national and regional organisations	7,497	9,482	
of which public	3,730	3,240	
of which private	3,767	6,242	

Source: SAL.

Indicator 2: Quality assurance and evaluations

Evaluations of thematic and strategic orientation

SAL's strategic focus is evaluated on a continuous basis by its general management and management board and adapted where required. Silicon Austria Labs (SAL) is also evaluated regularly at international level by the Austrian Research Promotion Agency (FFG). This focuses on the quality of the projects, the suitability of the project partners, utilisation and exploitation, as well as the topics of internationalisation and human resources. In addition to the external evaluation by the FFG, the research topics and strategies are also discussed regularly on SAL's Scientific Advisory Board and with the Scientific Board.

Institutional quality assurance measures

Silicon Austria Labs (SAL) developed the compliance, risk and process management aspects of its management system further in 2021. Its quality management system in accordance with ISO 9001:2015 was successfully recertified and migrated to a digital platform. The project-based "phase-gate" research process that was introduced in 2020 was enhanced and is subject to ongoing quality assurance. Compliance with the ISO standard and internal quality requirements is monitored through both internal and external audits. The research process will also be mapped in a quality-assured way from 2022 onwards and the stage set for digitalisation. In addition, Silicon Austria Labs (SAL) set up a risk management system in 2021, which has already become established on a digital platform. Making risk management digital will significantly improve risk prevention and the steering of measures.

Indicator 3: Human resources and qualifications

Number of employees	2020			2021		
	m	f	Total	m	f	Total
Employees (= headcount)	136	52	188	191	60	251
of which at the management level	26	3	29	19	3	22
Full time equivalents (rounded)	127	47	174	179	55	234
of which at the management level	25	3	28	18	3	21

Source: SAL.

Number of PhD students	2020	2021
Number of theses completed	2	1
Employees (= headcount)	26	34
of which employed at SAL	16	24
of which in a structured training programme (doctoral schools, etc.)	10	10

Source: SAL.

The following staff development measures were implemented in 2020 and 2021:

Current activities are focusing on **health promotion**, which the company believes merits greater attention due to the pandemic.

An **evaluation of employees' mental stress** was carried out in the final quarter (online questionnaires and "ABS" job assessment scale groups). Specific measures for improving employee satisfaction are currently being devised.

A company-wide agreement enabling staff to **work from home** is also being drafted.

Alongside job-specific training, an **online training catalogue** is being made available where staff can sign up for various measures. These range from regular training sessions (e.g. project seminars for researchers) and job-specific courses leading to a qualification right through to language seminars (German, English).

Indicator 4: Output, innovation and excellence

Scientific publications	2020	2021	2023 target value
Total publications	110	142	160
Monographs and editions	0	0	
Articles/papers in scientific journals, edited volumes and proceedings	110	142	
of which listed in WoS or Scopus	79	32	

Source: SAL.

Grants in excellence programmes of the European Research Council (ERC) and Austrian Science Fund (FWF)		2020	2021
ERC	Number	0	0
	Total funding approved in €1,000	-	-
Wittgenstein Award of the Austrian Science Fund (FWF)	Number	0	0
	Total funding approved in €1,000	-	-
Start Programme of the Austrian Science Fund (FWF)	Number	0	0
	Total funding approved in €1,000	-	-

Source: Austrian Research Promotion Agency (FFG) EU Performance Monitor (ERC), Austrian Research Promotion Agency (FFG) (Start Programme). The following formats are considered for the ERC: Starting Grants, Consolidator Grants and Advanced Grants. The figure is based on the year in which the contract was concluded.

Indicator 5: Internationalisation

	2020	2021
Share of international co-publications among all publications	37%	48%
Number of newly approved participations in Horizon 2021 and Horizon Europe programmes and initiatives (including ERC grants)	3	0
Total funding approved in €1,000	1,484	0

Source: SAL.

Central memberships in international umbrella organisations and networks, important internationalisation measures in 2020 and 2021:

Silicon Austria Labs (SAL) is a member of numerous Austrian and international networks, including the AMA (industry association for sensors and measurements), EpOSS (international network for smart systems and system integration), EPIC (European Photonics Industry Consortium) and MWS (MEMS World Summit). The company also uses LinkedIn to raise its international profile. SAL's international outlook is also reflected in its recruitment, with people from 40 different countries working at the company. It also drew up an internationalisation strategy in 2020 geared towards becoming one of the top five EBS research institutions in Europe in the medium term. One important step on this journey was the launch of the "Aeromic" Horizon 2020 project, for which Silicon Austria Labs (SAL) is the consortium leader.

Indicator 6: Knowledge and technology transfer

	2020	2021
Share of co-publications with industry or practice partners among all publications	35%	32%

Patents and exploitation activities	**2020**	**2021**
Number of patent applications	11	1
of which national	0	0
of which EU/EPC	0	1
of which non-EU countries	9	0
of which international (PCT)	2	0
Issued patents	10	8
of which national	0	0
of which EU/EPC	1	2
of which non-EU countries	9	6
Exploitation spin-offs	0	0

Source: SAL.

Indicator 7: Communication and interaction with society

The following activities and formats for communicating and transferring knowledge as well as for engaging and addressing civil society actors were implemented in 2020 and 2021:

The scientific and academic community was addressed through publications, articles in specialist journals, R&D results, poster sessions and participation in conferences. Long-term partnerships with other industry players and stakeholders were ensured through communication via the SAL newsletter, the SAL website and events (e.g. SAL roadshows in Carinthia and Styria). COVID-19 forced the postponement of some other events, most notably the SAL roadshows in Upper Austria, Vienna and St. Pölten, which are now to be held in 2022.

Silicon Austria Labs (SAL) pursues a multi-channel approach to address a wide audience, making use of press releases, media partnerships ("Die Macher", "Austria Innovativ", "Der Standard Forschung Spezial") and social media. The company is focusing on YouTube (e.g. with the "Superwomen in Science" video series) and LinkedIn, where it has already managed to attract over 5,000 followers through regular employer branding, job posts and project updates.

Being a member of clusters (e.g. Silicon Alps, Silicon Europe Cluster, AC Styria) and standardisation bodies (e.g. IEEE and GSMA) allows Silicon Austria Labs (SAL) to engage in direct dialogue with experts in order to raise its profile.

Indicator 8: Gender and promotion of gender equality

Share of women in management positions by management level	2020	2021	2023 target value
All management levels	10.4%	13.6%	18%
Management level 1 (general management)	0%	0%	
Management level 2	33%	33%	
Management level 3	9%	11%	
Glass Ceiling Index based on management levels*	2.67	1.75	

* Calculated as the share of women among all employees/share of women in all management positions.

Source: SAL.

The following activities were implemented in 2020 and 2021 aimed at promoting gender equality:

The central goals of the **gender equality policy** are to achieve a balanced ratio of men and women as well as to integrate gender and gender analysis within research content.

The SAL Gender Equality Plan (GEP) was finalised and published on the company's website in 2021. As well as maintaining existing measures (enhanced flexitime model, family and work measures, continuous professional development, etc.) and optimising them on an on-going basis, this plan describes the company's strategy, current activities and corresponding monitoring in detail.

The focus of this work lay on the following topics and areas:

Further developing the organisational culture

- Gender-neutral language
- Clear rules on dealing with gender-specific violence, including sexual harassment, bullying and bossing in the workplace and in business relationships
- Diversity and inclusion
- Survey on mental stress in the workplace

Work/life balance

- Four weeks' paternity leave
- Marginal employment during maternity leave
- Expanding working from home

Family & Work Audit (recertification valid until 2023)

- Ongoing analysis of measures and taking action to achieve objectives

3.4.3 Special events in 2021 and outlook

During the first half of the year, Silicon Austria Labs (SAL) took part in the Global Innovation Summit and made a presentation on "Tech for Green" together with an international panel. A SAL researcher working on sensor applications and her team won the 5E Contest for their "Sustainable Multifunctional Biface Sensor." Silicon Austria Labs (SAL) helped to organise the WFCS 2021 in Linz and took part in the UAR Innovation Network 360° with a keynote speech on 6G. A beyond-state-of-the-art Evatec CLUSTERLINE 200 production system was installed at the Villach site. The bilateral research partnership between Silicon Austria Labs (SAL) and the Italian research institute Fondazione Bruno Kessler launched in September. Another partnership, this time with the Virtual Vehicle Center, has also been agreed. The new premises at Science Park 4 in Linz were opened in October in the presence of leading figures from business, industry and politics, while the kick-off event for SAL DC was held in Pörtschach. Silicon Austria Labs (SAL) took part in EBSCON in November and hosted a roadshow in Klagenfurt. More of these roadshows in other federal states are planned for 2022, as is involvement in the "Lange Nacht der Forschung" ("Long Night of Research"). These activities are supplemented by regular press releases, news articles, LinkedIn posts and videos.

SAL's portfolio of applications will be expanded in a targeted manner in 2022, and efforts to make its enterprise services digital will be given added momentum by investing more in IT project management.[293]

3.5 Ludwig Boltzmann Gesellschaft (LBG) – Austrian Association for the Promotion of Scientific Research

3.5.1 Profile and key data

The Ludwig Boltzmann Gesellschaft (LBG) is a non-university research institution that currently operates seventeen institutes, one research group and two centres. The Ludwig Boltzmann Institutes (LBIs) are tasked with launching new areas of research relevant to society and conducting innovative research. With their expertise, the Open Innovation in Science Center and the Career Center support efforts to include society in science and promote researchers' continuing staff development.

Key figures 2020 and 2021

	2020	2021
Total budget for the research units in €1,000*	30,660	37,195

Number of employees at the Ludwig Boltzmann Gesellschaft	2020			2021		
	m	f	Total	m	f	Total
Employees (= headcount)	235	310	545	251	356	607
Full time equivalents (rounded)	133	190	323	137	223	360

Source: Ludwig Boltzmann Gesellschaft (LBG).

293 Further information can be found in the SAL Annual Report 2021: https://silicon-austria-labs.com/jahresbericht/

3.5.2 Development of indicators

Indicator 1: Funding, including third-party funding

	2020 in €1,000	2021 in €1,000	2023 target (in €1,000)
Total budget for the research units	30,660	37,195	
of which global budget*	9,082	10,638	
of which third-party funding**	21,578	26,557	24,300
of which from non-EU countries and global organisations	92	21	
of which from the EU and European countries or organisations	2,122	2,818	
of which national and regional organisations	19,364	23,718	
of which public***	15,898	18,412	
of which private	3,466	5,306	

* Includes funds from the federal government and the National Foundation for Research, Technology and Development (NFTE) to fund the basic costs of the institutes.

** Including dedicated partner financing in the institutions.

*** Includes funds from the National Foundation for Research, Technology and Development (NFTE) for the Ludwig Boltzmann Gesellschaft (LBG) Career Center and OIS Center.

Source: Ludwig Boltzmann Gesellschaft (LBG).

Indicator 2: Quality assurance and evaluations

Evaluations of thematic and strategic orientation

The research and development activities of the Ludwig Boltzmann Institutes (LBIs) are evaluated every three to four years as part of international peer review procedures. Independent external committees with relevant scientific and evaluation expertise are formed for this purpose, which rate the institutes to be peer-reviewed on a nine-level scale of 1–9; categories 1–3 represent the excellence range. These interim evaluations took place for five institutes in 2020 and for three in 2021. Five out of the eight institutes evaluated were within the excellence segment. The results of the evaluation form the basis for the decisions of the LBG Board of Directors to continue the Institute's funding.

Institutional quality assurance measures

Implementation of the research strategy of the Ludwig Boltzmann Gesellschaft (LBG) is supported by an international scientific advisory board. Performance agreements are agreed with the Federal Ministry of Education, Science and Research (BMBWF) within the course of implementing the Research Financing Act. A Scientific Advisory Board (SAB) exists for each research unit for the ongoing institutional quality assurance of the research and development activities, with each Board made up exclusively of international experts complemented by "experts by experience". There were 18 SABs in place in 2020 with 84 persons, with 19 SABs in 2021 with 88 persons.

The Ludwig Boltzmann Gesellschaft (LBG) expanded its efforts to institutionalise internal quality assurance further in 2021, primarily in the area of process management. A risk management system was established to improve corporate governance, while a company-wide compliance management system is currently being developed.

Indicator 3: Human resources and qualifications

Number of employees	2020			2021		
	m	f	Total	m	f	Total
Employees (= headcount)	235	310	545	251	356	607
of which at management level (institute heads, research group heads, centre heads, department heads, executive management, divisional management)	30	15	45	32	18	50
Full time equivalents (rounded)	133	190	323	137	223	360
of which at the management level	18	9	27	19	10	30

Source: Ludwig Boltzmann Gesellschaft (LBG).

Number of PhD students	2020	2021	2023 target value
Number of theses completed	18	15	15
Employees (= headcount)	149	187	
of which employed at the Ludwig Boltzmann Gesellschaft	73	83	
of which in a structured training programme (doctoral schools, etc.)	76	104	

Source: Ludwig Boltzmann Gesellschaft (LBG).

The following staff development measures were implemented in 2020 and 2021:

The LBG *Career Center* added courses in leadership and management in 2020, both via the Leading Researchers Program and a summer school for researchers as well as through the Leadership Academy Boltzmann, which supports senior managers in their role as leaders. The focus on entrepreneurship was made more professional via the "4 Fellowships 4 Entrepreneurs" special programme and the LBG Innovators' Road. The Career Center's programmes were also offered to the LBIs' university partners on a cooperative basis. As well as the winter school, which was held for the first time in 2020 and which teaches relevant skills in academic writing, the "Digital Transformation in Research" collaboration programme was launched in 2021.

Indicator 4: Output, innovation and excellence

Scientific publications	2020	2021	2023 target value
Total publications	661	656	600*
Monographs and editions	34	19	
Articles/papers in scientific journals, edited volumes and proceedings	627	637	
of which listed in WoS or Scopus	426	503	

* Three research units will be phased out by the end of 2023, meaning that the target value for 2023 is below the current figure.

Source: Ludwig Boltzmann Gesellschaft (LBG).

Grants in excellence programmes of the European Research Council (ERC) and Austrian Science Fund (FWF)		2020	2021
ERC	Number	0	0
	Total funding approved in €1,000	0	0
Wittgenstein Award of the Austrian Science Fund (FWF)	Number	0	0
	Total funding approved in €1,000	0	0
Start Programme of the Austrian Science Fund (FWF)	Number	0	0
	Total funding approved in €1,000	0	0

Source: Ludwig Boltzmann Gesellschaft (LBG).

Indicator 5: Internationalisation

	2020	2021
Share of international co-publications among all publications	N/A	54.3%
Number of newly approved participations in Horizon 2020 and Horizon Europe programmes and initiatives	2	3
Total funding approved in €1,000	528	505

Source: Ludwig Boltzmann Gesellschaft (LBG).

Central memberships in international umbrella organisations and networks, important internationalisation measures in 2020 and 2021:

As part of its third-party funding strategy, the Ludwig Boltzmann Gesellschaft (LBG) is a member of CROWDHELIX (crowdhelix.com), a professional platform for forming international project consortia under Horizon Europe, as well as the European Association of Research Managers and Administrators (earma.org), another network relevant to the EU Research Framework Programmes. The Ludwig Boltzmann Gesellschaft (LBG) is also a network partner of EIT Health Austria, one of the newly established "Regional Innovation Hubs". In the field of the digital humanities, the association is involved in the Time Machine Europe organisation (timemachine.eu) in the field of Digital Humanities and is a supporting member of Open Knowledge Maps (openknowledgemaps.org) as part of its focus on open innovation in science. The Boltzmann institutes and their researchers are involved in international scientific associations and networks in a variety of ways.

Indicator 6: Knowledge and technology transfer

	2020	2021
Share of co-publications with industry or practice partners among all publications	11%	13.6%

Patents and exploitation activities	**2020**	**2021**
Number of patent applications	4	4
of which national	0	2
of which EU/EPC	3	2
of which non-EU countries	1	0
Issued patents	0	0

Source: Ludwig Boltzmann Gesellschaft (LBG).

Indicator 7: Communication and interaction with society

The following activities and formats for communicating and transferring knowledge as well as for engaging and addressing civil society actors were implemented in 2020 and 2021:

The Ludwig Boltzmann Gesellschaft (LBG) operates its own competence centre for the involvement of civil society groups with the LBG Open Innovation in Science Center (OIS). Projects including the following were completed in 2020 and 2021:

- *LBI crowdsourcing on the topic of digital health and patient safety:* in a "have your say" format, the association was asked "What risks and damage caused by the coronavirus can we in society as a whole accept?"
- *OIS Impact Labs*: setting up two Impact Labs together with partners. The Impact Labs enable transdisciplinary research and involve society through skills training and practical projects.

- *Projects for patient and public involvement and engagement:* the OIS Center is supporting 11 projects that are including patients and non-academic specialists in the research process.
- VHS Urania panel discussion: various formats for enabling patients to actively help shape research were discussed with them directly.
- LBI Applied Diagnostics: empowering cancer patients during the COVID-19 crisis.

Indicator 8: Gender and promotion of gender equality

Share of women in management positions by management level in %	2020	2021	2023 target value
All management levels	33.3%	36%	
General management	50%	100%	
Institute management and research group management	29.7%	31.7%	
Centre management, divisional management and departmental management	50%	60%	
*Glass Ceiling Index based on management levels**	1.71	1.63	1.55

* Calculated as the share of women among all employees/share of women in management positions. The following are considered management positions: Executive management and divisional management, institute management and research group management, centre management and departmental management. The *Glass Ceiling Index* is explained in the definitions.

Source: Ludwig Boltzmann Gesellschaft (LBG).

The following activities were implemented in 2020 and 2021 aimed at promoting gender equality:
As one of Austria's most important research institutions, the Ludwig Boltzmann Gesellschaft (LBG) is committed to equal opportunities regardless of gender, a corporate culture that is sensitive to diversity aspects and raising awareness of related issues amongst all its staff. The association endeavours to incorporate skills that are as diverse as possible in its teams.

The groundwork for drawing up a gender equality plan (the LBG Gender Equality Plan) was laid in 2021. This will enable it to set out in concrete terms how gender equality is ensured: besides measures designed to improve the compatibility of family and career (certified as a "family-friendly employer" in 2020), the focus is also on using gender-neutral language, monitoring gender equality by analysing data and raising awareness of gender issues in recruitment and HR development. Guidelines for job interviews and staff on parental leave were also drawn up.

3.5.3 Special events in 2021 and outlook

The development plan for 2022–2026 was completed successfully in late June and, Building on this, the negotiations for the first performance agreement based on the Research Financing Act were conducted in order to secure funding for the Ludwig Boltzmann Gesellschaft (LBG) from the Federal Ministry of Education, Science and Research (BMBWF) in 2022 and 2023.

Four institute heads received a professorship. The LBI for Lung Vascular Research was able to expand its research with the addition of a doctoral programme obtained successfully together with the Medical University of Graz (MUG) and is to become part of the MUG's Cluster for Lung Research.

Two new OIS Impact Labs were set up in the LBG's OIS Center: "*The Future we want*" and "*Action for sustainable Future Hub*". The LBG's *Career Center* won the contract for the "*LBG Innovator's Road*" programme.

In line with the government programme, the Ludwig Boltzmann Gesellschaft (LBG) will be focusing on medical and healthcare research in the future. To this end, new LBIs similar to the Howard Hughes Medical

Institutes will be set up from 2023 onwards. These will work closely with universities and other partners to generate innovative research with an impact on society based on scientific excellence.

From 2022 onwards, clinical research groups will also be supported to improve training and research structures at hospitals, and the two centres will be evaluated.[294]

3.6 Austria Wirtschaftsservice Gesellschaft mbH (aws)

3.6.1 Profile and key data

The Austria Wirtschaftsservice GmbH (aws) is the federal promotional bank and central point of contact for the promotion of entrepreneurial growth and innovation. It supports companies from the initial idea through to international market success by granting low-interest loans, guarantees, grants and equity capital. The Austria Wirtschaftsservice (aws) also provides support related to the protection of intellectual property. It offers informational, advisory and other services to companies. The Austria Wirtschaftsservice (aws has played an important role in stabilising the country's economy since 2020 by managing the federal government's COVID-19 measures and the investment premium. The data for key figures and indicators covers aws's entire promotion and funding portfolio in each case (particularly budget chapters 33 and 34 and budget chapter 40).

Key figures 2020 and 2021

aws total not including COVID-19 assistance	2020	2021
Number of projects	8,020	9,720
Financing performance including liabilities in €1,000*	1,030,000	1,272,000
Present value in €1,000	128,000	287,000

Number of employees at aws	2020			2021		
	m	f	Total	m	f	Total
Employees (= headcount)	134	178	312	153	202	355
Full time equivalents (rounded)	125	152	277	125	177	321

COVID-19 assistance**	2020	2021
COVID-19 assistance – number of projects	73,230	245,290
COVID-19 assistance – financing performance in €1,000	5,735,000	6,584,000

* The financing performance is calculated as commitments assumed, volume of the credit or loan issued, amount of the grant awarded or established value of a consultation service.

** These include: the Austria Wirtschaftsservice (aws) investment premium, aws bridging guarantees, COVID-19 package for start-ups, NPO funds, fixed costs grants, comeback grants for film and TV productions.

Source: Austria Wirtschaftsservice (aws).

294 Further information can be found in the LBG Annual Report 2021: https://lbg.ac.at/download/

3.6.2 Development of indicators

Indicator 1: Funding, including third-party funding

Source of funds (not including COVID-19 assistance) (public funds and third-party funding, not including contributions from companies)	Financing performance	
	2020 in €1,000	2021 in €1,000
ERP Fund	600,000	600,000
Federal ministries acting as owners	182,000	366,000
BMK	6,000	25,000
BMDW (now BMAW)	176,000	341,000
BMNT	17,000	36,000
NFTE/Austria Fund	18,000	13,000
Regional governments	7,000	5,000
EU	10,000	18,000
Other (including third-party funding raised)*	196,000	234,000
Total	**1,030,000**	**1,272,000**

* The Other category relates entirely to funds of the Federal Ministry of Finance (BMF) (Guarantee Act).

Source: Austria Wirtschaftsservice (aws).

Indicator 2: Quality assurance and evaluations

Surveys of (potential) applicants and funded individuals

The aws has been conducting a systematic electronic survey of customers since 2013. An invitation to participate in the feedback is sent out a few weeks after funding has been approved or rejected. Six-monthly assessments of 250–300 applications in each case allow conclusions to be drawn on the quality of the funding services provided with respect to information, advice and procedures. The standardised questions are supplemented by verbal comments on experiences in the funding process and provide valuable information on potentials for improvement.

Evaluations of funding programmes, impact analyses

Evaluations are a key component of funding planning and implementation. An evaluation plan is also drawn up with the commissioning bodies when programme documents and guidelines are prepared. Typically, there will be interim evaluations, but at least there are regularly final evaluations before or shortly after the end of a programme's duration. External evaluation teams generally carry out the evaluation. The multiannual programme also provides for internal evaluations. A systematic survey that is representative of the monetary funding is conducted at three-yearly intervals – done most recently in 2019 and planned for 2022 – while internal evaluations are also conducted on selected topics, issues and programmes.

Evaluation and quality assurance concept; institutional quality assurance measures

The multiannual programme valid for the 2020–2022 period provides the conceptual framework for the systematic monitoring of customer satisfaction, service quality and the effectiveness of support measures. This defines recurring internal quality assurance activities which are intended to identify organisational, technical and thematic opportunities for improvement. It also sets out specifications for an annual evaluation plan which specifies topics and programmes for internal monitoring and evaluation and therefore complements the evaluation projects commissioned externally.

Indicator 3: Human resources and qualifications

	Headcount									
	Total		Women				Men			
	2020	2021	2020		2021		2020		2021	
	Number	Number	Number	%	Number	%	Number	%	Number	%
Support staff/student support	85	122	65	76	78	64	20	24	44	36
Experts	201	204	102	51	110	54	99	49	94	46
Management level 3 (team leaders)	18	22	8	44	11	50	10	56	11	50
Management level 2 (heads of department, staff and service units)	3	3	1	33	1	33	2	67	2	67
Management level 1 (managing directors)	5	4	2	40	2	50	3	60	2	50
Total	312	355	178		202		134		153	

	Full time equivalents (rounded)									
	Total		Women				Men			
	2020	2021	2020		2021		2020		2021	
	Number	Number	Number	%	Number	%	Number	%	Number	%
Support staff/student support	71	106	55	94	67	63	16	6	39	37
Experts	181	186	86	48	96	52	95	52	90	48
Management level 3 (team leaders)	18	22	8	44	11	50	10	56	11	50
Management level 2 (heads of department, staff and service units)	3	3	1	33	1	33	2	67	2	67
Management level 1 (managing directors)	5	4	2	40	2	50	3	60	2	50
Total	277	321	152		177		125		144	

Source: Austria Wirtschaftsservice (aws), figures include aws, erp funds, aws fund management.

The following staff development measures were implemented in 2020 and 2021:

A large part of the training was held virtually in 2021 as a result of the pandemic. In addition to the training focus "green aws", almost 100 additional employees were trained in operational funding processing (overview of funding products, funding guidelines, customer advice, funding processing procedures).

Indicator 4: Output, innovation and excellence

Projects and participations	2020		2021		2022 target
	Number	Share	Number	Share	Share
Funded projects	8,020*		9,720*		
Funded companies	4,990		6,400		
of which SMEs	4,880	98%	6,340	99%	95%*
of which enterprise formation	2,050	41%	2,660	42%	

* The slight decline is due mainly to changes in the portfolio of programmes (e.g "KMU.E-Commerce" ("SME.E-Commerce")).

Source: aws.

Time to contract and consultations	2020	2021	2022 target
Median processing time (time to contract) in days*			
aws guarantee	16	15	
aws programme for knowledge and technology transfer	7	8	
Seed/pre-seed funding	38	38	
Number of consultations for (potential) funding applicants**	~12,700	~12,400	~11,800***

* Not including COVID-19 assistance.

** Consultations conducted internally including consultations on COVID-19 assistance measures.

*** The slight decline is due mainly to changes in the portfolio of programmes, most notably COVID-19 assistance measures.

Source: Austria Wirtschaftsservice (aws).

Patents and licences	2020	2021	2022 TARGET*
Support with IP consulting and funding	460	484	340

* Taking account of the current budget specifications.

Source: Austria Wirtschaftsservice (aws).

Indicator 5: Internationalisation

Programmes with a particular focus on internationalisation	Approvals	
	Present value 2020 in €1,000	Present value 2021 in €1,000
Technology internationalisation	1,900	4,300
Global Incubator Network	500	500
Guarantees for internationalisation*	18,300	3,100

* Figures reflect financing performance (= guarantee obligations); the high level of financing performance for "Guarantees for internationalisation" was dominated by a small number of "major projects" in 2020.

Source: Austria Wirtschaftsservice (aws).

Central memberships in international umbrella organisations and networks, important internationalisation measures in 2020 and 2021:

- European Association of Guarantee Institutions (AECM)
- Network of European Financial Institutions for SMEs (NEFI)
- European Business Angel Network (EBAN)
- European Venture Fund Investors Network (EVFIN)
- Invest Europe

Indicator 6: Knowledge and technology transfer

Funding programmes and awards in the area of knowledge and technology transfer	2020		2021	
	Projects	Present value in €1,000	Projects	present value in €1,000
Impulse Programme for Transferring Knowledge and Technology in Austria	47	960	42	700
Innovative Youth	481	52	409	45
aws First	13	400	13	400
Austrian Phoenix Founders Award	180	20	205	20
AI Marketplace*	94	0	139	0
Wings4innovation	17	1,700	26	3,400

* AI Marketplace is an artificial intelligence (AI) platform that supports networking activities. It provides services but no commitments are made involving monetary funding.

Source: Austria Wirtschaftsservice (aws).

Indicator 7: Communication and interaction with society

The following activities and formats for communicating and transferring knowledge as well as for engaging and addressing civil society actors were implemented in 2020 and 2021:

The Austria Wirtschaftsservice (aws offered established formats such as "Innovative Youth" and "aws first" to teach STEM and start-up skills in the entrepreneurship sector. In the environment of the academic spin-offs, priorities in the area of creating sustainable exploitation strategies and knowledge valorisation were communicated to an interested public, including "World IP Day" and the "Phoenix" competition.

Indicator 8: Gender and promotion of gender equality

	2020		2021		2022 target
	Number	Share	Number	Share	Share
Women in funded projects	2,150	29%	2,537	29%	
Women Principal Investigators	1,933	30%	2,279	30%	>30%
Women founders	217	21%	258	21%	
Women on committees and juries					
aws Supervisory Board	7	47%	8	53%	
ERP Credit Committee (EKK)	1	8%	2	16%	
ERP Expert Committee on Tourism Industry	4	57%	3	43%	
ERP Expert Committee on Agriculture and Forestry	4	57%	3	43%	
ERP Expert Committee on Transport	3	43%	3	43%	
Juries of individualaws programmes					
Processing, Marketing and Development	4	36%	5	45%	
Film Industry Support Austria (FISA)	5	45%	7	64%	
Impulse	16	59%	18	64%	
Seed	6	29%	12	50%	
Gründung am Land (Rural Enterprise Formation)	2	40%	2	40%	

Source: Austria Wirtschaftsservice (aws).

Programmes/initiatives with gender or gender equality in their funding criteria:

Diversity in companies is included in the economic evaluations for all projects funded by the Austria Wirtschaftsservice (aws). The Austria Wirtschaftsservice (aws) multiannual programme 2020–2022 has also defined the topic of "sustainable growth" as an important field of action, with "diversity" as a priority here. The rules of funding programmes are set by the respective client. Gender aspects are incorporated as a funding criterion in a small number of programmes under the financing agreement for 2022 and 2023.

3.6.3 New initiatives and instruments for 2021 and outlook

New instruments and highlights in 2021

Like 2020, 2021 was also dominated by the COVID-19 pandemic and coronavirus assistance measures. As the federal promotional bank, the Austria Wirtschaftsservice (aws) provided active support to Austrian companies as they sought to make up for lost ground and business following the recession. The digitalisation steps that it had taken enabled the Austria Wirtschaftsservice (aws) to process a record number of applications. A total of 255,013 funding commitments were made, more than triple 2020's figures and over 50 times more than before the crisis. Financing performance also increased in 2021, up from its previous record of €6.8 billion to a new high of €7.8 billion. This equates to a rise of some 15% on 2020's record-breaking figure and a sevenfold increase on pre-crisis levels.

The implementation of the Research Financing Act and the RTI Pact were two main features of 2021. The funding agreement for 2022–2023 will bring several years of funding security for high-technology and innovation programmes for the first time. Steps have also been taken to optimise governance structures, which will give agencies more operational flexibility.

Outlook for the coming years

Innovations and growth are becoming more important once again, as the rapid economic recovery has shown. The Austria Wirtschaftsservice (aws) is well positioned with its core programmes consisting of loans, guarantees, grants, equity, coaching and networking services. It will be concentrating on the areas of digitalisation, sustainability and life sciences. The investment premium will be another focus for the Austria Wirtschaftsservice (aws) in the medium term. Companies have until February 2023 or, as appropriate, until 2025 to submit their invoices.[295]

3.7 Christian Doppler Research Association (CDG)

3.7.1 Profile and key data

The Christian Doppler Research Association (CDG) supports Christian Doppler Laboratories (CD Laboratories) at universities and non-university research institutions and Josef Ressel Centres (JR Centres) at universities of applied sciences. Around 50% of the CDG's funding programmes are financed through public funds (Federal Ministry of Labour and Economy (BMAW, formerly BMDW) and National Foundation for Research, Technology and Development (NFTE) as well as the Austria Fund) and another 50% by the CDG's member companies.

The funding is aimed at application-oriented basic research and boosts Austria both as a place for business and for science. By virtue of this essential bridging function that it performs between basic research and innovation, the Christian Doppler Research Association (CDG) is viewed internationally as a model of best practice. The Christian Doppler Research Association (CDG) also generates great benefit to society, as numerous CDG research units contribute to the implementation of the UN 2030 Agenda for Sustainable Development.

Key figures for 2020 and 2021

	2020	2021
Number of CD Laboratories	91	87
Number of JR Centres	17	15
Funding budget in €1,000	19,254	18,496

Office staff	2020			2021		
	m	f	Total	m	f	Total
Employees (= headcount)	5	13	18	7	12	19
Full time equivalents (rounded)	5	9	14	5	10	15

Note: Budgetary data for 2021 corresponds to the maximum budget framework since accounting data are not yet available.

Source: Christian Doppler Research Association (CDG). The decline is due to the funding from the National Foundation for Research, Technology and Development (NFTE) and the Austria Fund being discontinued in 2020.

295 Further information can be found in the Austria Wirtschaftsservice (aws) Performance Report 2021: https://www.aws.at/fileadmin/user_upload/Downloads/Sonstiges/2021_aws_Leistungsbericht_2021.pdf

3.7.2 Development of indicators

Indicator 1: Funding, including third-party funding

Source of funds (public funds and third-party funding, not including contributions from companies)	2020 in €1,000	2021 in €1,000
Federal funding	19,254	18,496
of which basic budget (BMDW; now BMAW)	11,612	11,362
of which from the National Foundation for Research, Technology and Development (NFTE) and the Austria Fund	7,642	7,134
Other funds (including third-party funding raised)	132	20
Total funding budget	**19,387**	**18,516**

Note: Budgetary data for 2021 corresponds to the maximum budget framework since accounting data are not yet available.

Source: Christian Doppler Research Association (CDG).

Indicator 2: Quality assurance and evaluations

Surveys of (potential) applicants and funded individuals

Surveys of the funded CD Laboratories/JR Centres are conducted in the framework of the programme evaluations (e.g. Alt et al., 2017): Kombinierte Programmevaluierung der Christian Doppler Labors und Josef Ressel Zentren 2016).

Evaluations of funding programmes, impact analyses

An analysis carried out in 2021 (SciVal based on Scopus (>50 million publications) and the data from five of the world's largest patent offices) confirms that the publications from the CDG's research units have the highest values internationally in terms of patent relevance (out of 1,000 publications, 265 are cited in patents) and in the number of joint publications by science and industry. In addition, around 40% of the publications appear in the top 10% of journals in the respective discipline.

The impact of the CDG's funding programmes is analysed as part of comprehensive programme evaluations (e.g. Alt et al., 2017).

Evaluation and quality assurance concept; institutional quality assurance measures

The Scientific Board of the Christian Doppler Research Association (CDG) ensures scientific quality based on a multi-stage, international peer review process as part of its funding decision and interim evaluations during the term of the CDG research units.

The Christian Doppler Research Association (CDG) has an internal control system (ICS), a data protection manual and a of compliance guideline for institutional quality assurance purposes. This ensures the security and cost-effectiveness of all operational processes and compliance with the prescribed business guidelines and statutory regulations.

CDG's business activities are also regularly audited by independent external institutions. CDG is a member of the Austrian Agency for Research Integrity (OeAWI) and the Austrian Platform for Research and Technology Policy Evaluation (fteval).

Indicator 3: Human resources and qualifications

Office staff	Headcount									
	Total		Women				Men			
	2020	2021	2020		2021		2020		2021	
	Number	Number	Number	%	Number	%	Number	%	Number	%
Support staff	5	5	4	80	4	80	1	20	1	20
Experts	10	11	7	70	6	55	3	30	5	45
Management level	3	3	2	67	2	67	1	33	1	33
Total	18	19	13	72	12	63	5	28	7	37

Office staff	Full time equivalents (rounded)									
	Total		Women				Men			
	2020	2021	2020		2021		2020		2021	
	Number	Number	Number	%	Number	%	Number	%	Number	%
Support staff	3	3	3	100	3	100	0	0	0	0
Experts	8	9	4	51	5	56	4	49	4	44
Management level	3	3	2	66	2	67	1	34	1	33
Total	14	15	9	64	10	67	5	36	5	33

Source: Christian Doppler Research Association (CDG).

Staff development at the Christian Doppler Research Association (CDG) is subject to a continuous process of enhancement, with training programmes that are important for the growth of the organisation (e.g. digitalisation, GDPR, compliance training) and that are both defined for the respective function and adapted to the individual.

Indicator 4: Output, innovation and excellence

participations	2020	2021
Participating companies	189	189
of which SMEs	38	42
Universities	14	14
Non-university research institutions	1	1
Universities of applied sciences	10	9
Foreign universities	0	2

Source: Christian Doppler Research Association (CDG).

Time to contract and consultations	2020	2021
Time to contract for applications without revisions in days	197	202
Time to contract for applications with revisions in days	349	312
Number of consultations for (potential) funding applicants	31	49

Source: Christian Doppler Research Association (CDG).

Funded individuals	2020	2021
Total	1,161	1,194
of which women	428	470
of which men	733	724
Percentage of women amongst the individuals funded	37%	39%

Source: Christian Doppler Research Association (CDG).

Number of scientific publications from the funded projects	2020	2021	2023 target value
Monographs and editions	1	2	
Articles/papers in scientific journals, edited volumes and proceedings	647	748	
Total	648	750	
Publications per €1 million of public funding	33.7	40.5	>30*

* The 2023 target value is below the current value for 2021. The reason is that both the quality and number of publications are currently very high (40% of publications are in the top 10% of journals). Simply increasing the quantity would not say anything about the quality. Delayed effects from COVID-19 may also be a factor.

Source: Christian Doppler Research Association (CDG).

Patents and records of invention	2020	2021
Patents applied for	N/A	N/A
Granted patents	17	9
Records of invention submitted to the university/university of applied sciences/ research institution	28	33

Source: Christian Doppler Research Association (CDG).

Indicator 5: Internationalisation

	2020		2021	
	Number	in %	Number	in %
Projects with international partners	46	43	45	44
Participating companies located abroad	55	29	50	26

Source: Christian Doppler Research Association (CDG).

CD Laboratories can also be established at foreign universities/research institutions. In addition, CD Laboratories offer the option of operating one or more of their modules at a foreign location. A domestic CD Laboratory may also engage foreign company partners. Some 45% of publications from the research units receiving funding arise as a result of international collaboration.

Indicator 6: Knowledge and technology transfer

	2020	2021
Total funding volume in €1,000	36,824	35,863
of which cooperation between science/industry	36,824	35,863
Share in %	100%	100%

Source: Christian Doppler Research Association (CDG). Note: Budgetary data for 2021 corresponds to the maximum budget framework since accounting data are not yet available.

Indicator 7: Communication and interaction with society

The opening of CD Laboratories and JR Centres was used for networking and public relations activities. This process takes place in close collaboration with the PR departments of the respective universities or universities of applied sciences.

Success stories from the perspective of the corporate partners are developed and disseminated in close cooperation with the respective companies.

Overall, the research topics of the Christian Doppler Research Association (CDG) are covered in around 250 reports in the printed media each year. The CDG's activities are also made accessible to a wide audience via numerous social media posts.

The CDG Prize for Research and Innovation has been awarded every year since 2020, likewise generating significant audience attention.

The CDG is a member of the Open Science Association and Uni.PR.

Indicator 8: Gender and promotion of gender equality

	2020		2021		2023 target value
	Number	Share	Number	Share	Share
Funded projects					
Women in CD Laboratories and JR Centres	428	37%	466	40%	>35%**
Female heads of CD Laboratories and JR Centres	17	15%	17	16%	
Evaluation committees and reviews					
Women on permanent evaluation committees and advisory councils	13	30%	12	27%	
Reviews conducted by women	10	12%	13	16%	

* Provisional, not yet finalised data Funding recipients may still supply information retrospectively.

** The 2023 target value is below the current figure for 2021. This is because, despite programmes designed to promote women, the percentage of women varies considerably from field to field (e.g. life sciences compared to materials sciences), and the bottom-up design of the programmes results in a natural fluctuation in the number of CD Laboratories and JR Centres for each field. The total percentage of women may therefore fluctuate.

Source: Christian Doppler Research Association (CDG).

3.7.3 New initiatives and instruments for 2021 and outlook for the coming years

New instruments and highlights in 2021

The 2021 CDG Prize for Research and Innovation was awarded to Prof. Stefan Pirker from the University of Linz (JKU) for his work on particulate flows. Besides corporate partners, who will be able to achieve significant efficiency gains in production by applying the results of this research, the methods – which are available as open-source programs – are also being used by dozens of universities and research centres. NASA is using them to study the movement of the Curiosity Mars rover, while bedload flows are being calculated in the seas off Florida, and the models from the CD Laboratory can also be used to calculate the aerosols that people breathe out and thus to model the spread of viruses amongst flows of pedestrians.

Overall, around 20 CDG research units were busy working on issues from the fields of digitalisation and life sciences in 2021 that are helping either to overcome the COVID-19 crisis directly or to avoid similar crises in the future or make these more manageable.

Outlook for the coming years

All in all, the CDG model continues to enjoy a high level of popularity among both the scientific community and industry. Assuming that the Future Austria Fund supplies sufficient funding in good time, this makes it possible to anticipate further growth in the number of research units over the next few years.[296]

296 Further facts and figures can be found at https://www.cdg.ac.at/en/about-us/facts-and-figures-on-the-christian-doppler-model

3.8 Austrian Science Fund (FWF)

3.8.1 Profile and key figures

The Austrian Science Fund (FWF) is Austria's leading organisation for the bottom-up promotion of basic research as well as artistic-scientific research. In a selective international peer review process, the Austrian Science Fund (FWF) supports researchers and ideas that are pioneering by virtue of their scientific quality. The findings obtained from this research are strengthening Austria as a research nation and laying a broad basis for improving our ability to tackle future challenges facing society.

Investments in basic research that are funded via the Austrian Science Fund (FWF) are exerting a significant leverage effect in the knowledge and innovation sector. Basic research built on strong foundations is attracting the most talented minds and thus expertise, strengthening Austria's economic clout over the long term.

Key figures 2020 and 2021

	2020	2021
Funding budget in €1,000	255,479	270,017
of which new or extended projects (amount of new approvals)	243,618	256,078
Number of approved research projects	708	732
Number of individuals funded via funds from Austrian Science Fund	4,343	4,458

Staff FWF office	2020			2021		
	m	f	Total	m	f	Total
Employees (= headcount)	36	91	127	36	102	138
Full time equivalents (rounded)	33	76	108	32	87	119

Source: Austrian Science Fund (FWF).

3.8.2 Development of indicators

Indicator 1: Funding, including third-party funding

Source of funds	2020 in €1,000	2021 in €1,000
Federal funding	253,503	265,222
of which basic budget (Federal Ministry of Education, Science and Research (BMBWF)	222,831	234,022
of which from the National Foundation for Research, Technology and Development (NFTE) and the Austria Fund	30,671	31,200
Regional governments	923	2,251
EU	7	1,152
Other (including third-party funding raised)	1,046	1,392
Total	**255,479**	**270,017**

Source: Austrian Science Fund (FWF).

Indicator 2: Quality assurance and evaluations

Surveys of (potential) applicants and funded individuals

The scientific community is surveyed on various aspects of the Austrian Science Fund (FWF) procedure, funding programmes and research agendas every ten years. These surveys are carried out based on calls for proposals by international institutions. The last survey was conducted in 2013 by the (former) Institute for Research Information and Quality Assurance (Berlin) (now the German Centre for Higher Education Research and Science Studies – DZHW).[297]

Surveys among Principal Investigators are conducted on an on-going basis as part of final project reports aimed at evaluating various aspects of application submission, project management and support and supervision from the Austrian Science Fund (FWF).[298]

Evaluations of funding programmes, impact analyses

Evaluations of funding programmes are assigned by default to independent and proven experts based on transparent selection procedures and defined criteria. They follow the Austrian Science Fund (FWF) rules on the quality and transparency of evaluations, studies and research policy services as well as the standards of the Austrian Platform for Research and Technology Policy Evaluation (fteval) for this process. Evaluations are scheduled at appropriate intervals after the programmes have started and for their duration and are freely accessible following publication.

The programme evaluations represent the central impact analyses. In addition to these, cross-programme impact analyses are carried out by international institutions approximately every ten years.

Evaluation and quality assurance concept; institutional quality assurance measures

The Austrian Science Fund (FWF) has a systematic internal quality assurance system (IQS) enshrined within the institution. This defines the responsibilities and authorities of FWF staff and ensures the resources required. A recurrent management review is also implemented on the suitability, adequacy and effectiveness of the international quality assurance system.

The internal quality assurance system of FWF is designed as a combination of elements involving risk management, process management, internal control system, compliance management and internal auditing with the goal of managing and monitoring the company. The expansion and further development of this overarching holistic system takes place in compliance with the requirements of the Research and Technology Promotion Act (FTFG) and the Federal Public Corporate Governance Code.

297 See Neufeld (2014).

298 See the "Final Report Survey: From Application to Final Reporting – Feedback to the FWF", https://www.fwf.ac.at/en/research-funding/decision-making-procedure-evaluation/final-report-survey

Indicator 3: Human resources and qualifications

Office staff	Headcount									
	Total		Women				Men			
	2020	2021	2020		2021		2020		2021	
	Number	Number	Number	%	Number	%	Number	%	Number	%
Support staff	67	74	53	79	58	78	14	21	16	22
Experts	47	49	31	66	36	73	16	34	13	27
Management level	13	15	7	54	8	53	6	46	7	47
Total	127	138	91	72	102	74	36	28	36	26

Office staff	Full time equivalents (rounded)									
	Total		Women				Men			
	2020	2021	2020		2021		2020		2021	
	Number	Number	Number	%	Number	%	Number	%	Number	%
Support staff	53	59	42	79	47	79	11	21	12	21
Experts	42	45	27	63	32	71	16	37	13	29
Management level	13	15	7	54	8	52	6	46	7	48
Total	108	119	76	70	87	73	33	30	32	27

Source: Austrian Science Fund (FWF).

As an expert organisation and because of its funding activities, the Austrian Science Fund (FWF) is very aware of the importance of having well-qualified employees. In order to ensure that the FWF's quality standards, which are supported by its employees, are lived and further developed, the FWF invests in training and continuing education for its staff. An annual budget is available to the departments for this purpose. Most staff development activities were moved online in 2020 and 2021 due to the pandemic, pushing the associated costs down slightly.

Indicator 4: Output, innovation and excellence

Funded projects (new approvals)	2020		2021	
	Number	€1,000	Number	€1,000
Total	708	243,619	732	256,078
of which universities*	599	209,224	605	215,431
of which universities of applied sciences	11	3,618	8	4,261
of which non-university research facilities**	98	30,777	119	36,386

* Including private universities.
** Including research facilities abroad.

Source: Austrian Science Fund (FWF).

Funded individuals	2020	2021
Total	819	850
of which women	280	304
of which men	539	546
of which diverse	-	-

Source: Austrian Science Fund (FWF).

Time to contract* and consultations	2020	2021
Time to contract programme for stand-alone projects in days	157	176
Time to contract for international mobility (Schrödinger and Meitner programmes) in days	126	139
Number of consultations for (potential) funding applicants		
Total	**45**	**47**
of which coaching workshops	4	3
of which information events	23	44
of which Proposers' Days	18	0

* Period between receipt of the application by the Austrian Science Fund (FWF) and the decision on funding. It generally only takes a few days after that for the funding agreement to be issued.

Source: Austrian Science Fund (FWF).

Scientific publications from the funded projects*	2020	2021	2023 target value
Monographs and editions	52	101	
Articles/papers in scientific journals, edited volumes and proceedings	4,756	5,634	
of which listed in WoS or Scopus	N/A	N/A	
Total	**4,808**	**5,735**	**>5,000**
Publications per €1 million of public funding	**18.8**	**21.2**	

* Information from final project reports received in the respective year.

Source: Austrian Science Fund (FWF).

Patents and records of invention*	2020	2021
Patents applied for	N/A	N/A
Granted patents	8	11
Records of invention submitted to the university/university of applied sciences/ research institution	N/A	N/A

* Information from final project reports received in the respective year.

Source: Austrian Science Fund (FWF).

Indicator 5: Internationalisation

	2020		2021		2023 target values
	Number	in %	Number	in %	in %
Projects with international partners	1,871	75	1,918	74	>74
Individuals involved located abroad	7,992	53	6,764	48	

Source: Austrian Science Fund (FWF).

Bilateral and multilateral agreements with foreign research funding institutions (these are existing agreements; it does not mean that there is an option for submitting projects or that projects receive funding every year)

		2020	2021
Within Europe	Multilateral	• 10 ERA net participations • Cooperation in the DACH region (Austria, Germany, Switzerland) • CEUS – Central European Science Partnership (Austria, Czechia, Poland, Slovenia)	• 9 ERA net participations • Weave* (Belgium, Czechia, Germany, Luxembourg, Poland, Slovenia, Switzerland) • European Biodiversity Partnership "Biodiversa+" • Water4All
	Bilateral	• Belgium / Flanders • Germany • France • Italy / South Tyrol • Luxembourg • Poland • Russia • Switzerland • Slovenia • Czechia • Hungary	• France • Italy / South Tyrol • Russia • Hungary
Beyond Europe	Multilateral	• Belmont Forum	• Belmont Forum
	Bilateral	• China • India • Israel • Japan • South Korea • Taiwan • USA	• China • India • Israel • Japan • South Korea • Taiwan • USA

* Weave is a network of European research funding organisations geared towards funding international research projects on a collaborative basis.
Source: Austrian Science Fund (FWF).

The Austrian Science Fund (FWF) is involved in various international networks and activities and plays a leading role in some of these. The main ones are:

- Science Europe (scienceeurope.org)
  - High level policy network on cross-border collaboration
  - Weave Task Force
  - Monitoring Cross-Border Collaboration Task Force
  - Working Group on Open Science
  - Working Group on Research Culture
- Global Research Council (globalresearchcouncil.org)
- ERC Programme Committee (national expert);
- Twinning Project with the Shota Rustaveli National Science Foundation of Georgia
- Research on Research Institute (researchonresearch.org)
- Cooperation with ETH Zurich on analysis of the Austrian Science Fund (FWF) decision-making process
- GRANteD (granted-project.eu)
- Research Integrity (sops4ri.eu)
- cOAlition S (coalition-s.org)
- OA2020 (oa2020.org)
- OECD National Experts on Science and Technology Indicators

Indicator 6: Knowledge and technology transfer

Funding programmes in the area of knowledge and technology transfer	2020		2021	
	Projects	Total funding approved in €1,000	Projects	Total funding approved in €1,000
Clinical Research programme (KLIF)*	16	5,506	18	5,964
Weiss Prize	1	296	3	399
Netidee SCIENCE	1	396	1	246
Projects of the Herzfelder Foundation	1	115	7	2,565
Methods to replace animal testing	-	-	6	1,553
ASMET Research Award	1	369	-	-
Quantum Research and Technology programme (QFTE)	2	604	-	-

	2020		2021	
	Approvals in €1,000	Proportion of all approvals (%)	Approvals in €1,000	Proportion of all approvals (%)
All funding from the cooperation between science/industry	**7.287**	**3.0**	**10,728**	**4.2**

* Commercial companies are not permitted to have a direct interest in the results of the projects. Co-funders are not permitted to act as sponsors for the purposes of the ICH GCP regulations.

Source: Austrian Science Fund (FWF).

Indicator 7: Communication and interaction with society

The Austrian Science Fund (FWF) promotes communication and interaction with society on several levels: firstly, at the level of its programme portfolio with specific funding offers that enable researchers to expand their dialogue with society. These include the "Science Communication Programme", the "Top Citizen Science" funding programme and the transdisciplinary #ConnectingMinds programme. Secondly, the Austrian Science Fund (FWF) undertakes numerous communication and dialogue measures in its capacity as an institution to communicate the impact of its basic research. Together with partners, for instance, the Austrian Science Fund (FWF) organised "Am Puls" in 2021, a regular series of nationwide dialogues on research topics relevant to society. The online magazine scilog.fwf.ac.at uses background reports, interviews, podcasts and videos to present the latest research findings in an easily accessible format and introduces the general public to Austria's leading researchers. The Austrian Science Fund (FWF) also continued its science communication activities in partnership with other actors from the field of science in 2021, including the online campaign uninteressant.at run by Universities Austria (uniko).

Indicator 8: Gender and promotion of gender equality

	2020		2021		2023 target value
	Number	Share in %	Number	Share in %	Share in %
Women in funded projects					
Women project employees	2,034	47	2,099	47	
Women Principal Investigators	232	33	248	34	>33
Women on committees					
Executive Board	3	60	3	60	
Supervisory Board	8	80	8	80	
Assembly of Delegates	22	38	24	41	
FWF Board	25	39	28	44	
International Strategic Advisory Board	4	50	4	50	
Women on Programme Juries					
START-/Wittgenstein Jury	5	42	5	38	
PEEK (Programme for Arts-based Research) Board	3	50	3	50	
WissKomm Jury (Science Communication Programme Jury)	3	50	3	50	
doc.funds programme Jury	7	50	7	50	
Young Independent Researcher Group Jury	4	44	4	40	
1000 Ideas programme Jury	9	45	6	33	
Reviews conducted by women	1,251	26	1,586	28	
Difference in approval rate between women and men	-2.2 % points		-1.3 % points		+/-2.0 % points

Source: Austrian Science Fund (FWF).

Programmes/initiatives with gender or gender equality in their funding criteria:
Gender and gender-related aspects must be included in the project description for all programmes except in a few cases (excerpt from the application guidelines): "All potential sex and gender-related components in the planned project: How are these integrated into the research approach?" These topics must be briefly addressed in a separate section of the project description, even if the applicants believe that the project does not contain any components of this type. There are a few exceptions, including the Wittgenstein Award, as there is no need to submit a project description here and nominations are instead submitted by third parties. Team makeup is one of the funding criteria for research groups and Special Research Programmes.

3.8.3 New initiatives and instruments for 2021 and outlook

Signing the three-year financing agreement for the years to 2023 provides the Austrian Science Fund (FWF) with several years of planning security for the first time. A total of €806 million for pioneering basic research represents a 27% increase in the funding budget compared to the past three years.

In partnership with the Federal Ministry of Education, Science and Research (BMBWF), the Austrian Science Fund (FWF) opened a new chapter in research funding in 2021 with the launch of the "excellent=austria" (e=a) excellence initiative, an integral part of the financing agreement. Austria's research facilities were able to submit applications on an unprecedented scale as part of the first e=a funding scheme, entitled "Clusters of Excellence". At the end of 2021, there were 35 consortia in the approval process, with the first clusters to begin in 2023. The call for applications for the second funding scheme, "Emerging Fields", is due to open in 2022.

Since April 2021, highly skilled postdocs have also been able to make use of an improved offering for supporting their academic career with the ESPRIT programme, another part of the financing agreement. ESPRIT has replaced the Meitner and Firnberg programmes and offers an increased funding budget, longer project terms and the option of submitting applications at any time. The Austrian Science Fund (FWF) is also focusing particularly on promoting women.

On the initiative of the Federal Ministry of Education, Science and Research (BMBWF), Austria is using funds from the EU's "NextGenerationEU" Recovery and Resilience Plan to invest €107 million in expanding quantum research and quantum technologies. The "Quantum Austria" funding initiative runs from 2021 to 2026 and is being implemented by the Austrian Science Fund (FWF) working closely with the Austrian Research Promotion Agency (FFG). About €32 million will be at the FWF's disposal throughout the project term.[299]

3.9 OeAD-GmbH

3.9.1 Profile and key data

The OeAD-GmbH became Austria's Agency for Education and Internationalisation on 1 January 2021. The new name is explained by the expansion of its scope into the school and educational sectors. In addition to its core mission of supporting the internationalisation of educational institutions through mobility and project funding, OeAD also supports and initiates innovations in education, teaching and research through targeted interventions.

Besides its head office in Vienna, the OeAD also has seven regional offices at Austrian higher education sites, five cooperation offices in Eastern and South Eastern Europe with an educational focus and cooperation offices in Lviv and Shanghai that focus on science. OeAD-Wohnraumverwaltungs-GmbH is a subsidiary of OeAD that provides accommodation in student dormitories and OeAD guest houses for approximately 12,000 international students, researchers and professors each year.

Key figures for 2020 and 2021

	2020	2021
Total funding budget, disbursements in €1,000	50,548	53,725

Number of employees	2020			2021		
	m	f	Total	m	f	Total
Employees (= headcount)	75	194	269	83	221	304
Full time equivalents (rounded)	59	154	213	62	186	248

Source: OeAD-GmbH.

The increase in the key figures in 2021 is mainly down to the integration of the youth section of Erasmus+ and the assumption of project management duties for "Digital Learning", which forms part of the Austrian federal government's eight-point digitalisation plan.

299 For more information, see the Austrian Science Fund (FWF) Annual Report 2021: https://www.fwf.ac.at/fileadmin/files/Dokumente/Ueber_den_FWF/Publikationen/FWF-Jahresberichte/fwf-annual-report-2021.pdf

3.9.2 Indicators for 2020 and 2021

The Federal Ministry of Education, Science and Research (BMBWF) federal funds involve those research-related activities that are financed from budget chapter 31 "Global Budget 31.03" of the federal budget. This primarily includes incoming and outgoing scholarship programmes, initiatives with our neighbouring countries Hungary, Czechia and Slovakia, the lectureship programme, scientific/technical cooperation, international research cooperation and measures for internationalisation, the support of university networks with Southeast Asia, China and African countries as well as two newly added programmes: Children's and Youth Universities and "Sparkling Science".

Indicator 1: Funding, including third-party funding

	2020 in €1,000	2021 in €1,000
Total research-related funding (all income relevant to research from federal funds and third-party funding)	11,774	14,339
of which Federal Ministry of Education, Science and Research federal funds (approvals)	10,374	12,860
of which other federal funds (Austrian Development Agency; disbursements)	800	632
of which others (third-party funding, e.g. Indonesia, Pakistan; disbursements)	600	847

Source: OeAD-GmbH.

The increase is due to the fact that The financing agreement concluded between the Federal Ministry of Education, Science and Research (BMBWF) and the OeAD for the first time for 2021 to 2023 has increased the amount of funding and the Children's and Youth Universities programme has been added to the portfolio.

Indicator 2: Quality assurance and evaluations

Surveys of (potential) applicants and funded individuals

Scholarship holders are surveyed regularly on the progress of their study or research activities and on the OeAD's services. Among other things, these surveys provide information on levels of satisfaction with the way that the OeAD is implementing the programme. On a scale of 1 to 4 (1: very good; 4: unsatisfactory), these surveys have scored between 1.1 and 1.5 for overall satisfaction with the individual programmes.

Evaluations of funding programmes, impact analyses

The results of the evaluation commissioned by the Federal Ministry of Education, Science and Research (BMBWF) (Ecker et al., 2022) have been released. The evaluation reaffirms the added value that these programmes bring, particularly in terms of the "great flexibility" of the programmes, their importance to researchers' further academic careers, follow-up activities, skills acquisition, and the role that many funded individuals play as multipliers.

Evaluation and quality assurance concept; institutional quality assurance measures

The quality management system at the OeAD-GmbH has been certified according to ISO 9001 for over 15 years. Compliance with the requirements of the quality management system is monitored through annual internal and external audits, most recently via a recertification audit by TÜV-Nord on 1 and 2 December 2021.

Indicator 3: Human resources and qualifications

The headcount stated refers only to those research-related activities that are financed from budget chapter 31 of the "global budget 31.03" of the federal budget.

Office staff	Headcount									
	Total		Women				Men			
	2020	2021	2020		2021		2020		2021	
	Number	Number	Number	%	Number	%	Number	%	Number	%
Support staff	4	6	4	100	6	100	0	0	0	0
Experts	28	31	23	82	27	87	5	18	4	13
Management level	3	3	2	67	2	67	1	33	1	33
Total	**35**	**40**	**29**		**35**		**6**		**5**	

Office staff	Full time equivalents (rounded)									
	Total		Women				Men			
	2020	2021	2020		2021		2020		2021	
	Number	Number	Number	%	Number	%	Number	%	Number	%
Support staff	3	4	3	100	4	100	0	0	0	0
Experts	20	24	16	82	22	91	4	18	2	9
Management level	2	2	2	100	2	100	0	0	0	0
Total	**25**	**30**	**21**		**28**		**4**		**2**	

Source: OeAD-GmbH.

The increase in staff numbers reported is mainly due to taking over responsibility for the two new programmes Children's and Youth Universities and "Sparkling Science".

The majority of employees continued to work from home in 2021 due to the COVID-19 pandemic. "Reboarding" measures were carried out and new staff integrated in autumn 2021, when the pandemic permitted this to a limited extent.

The OeAD's extensive range of training courses, focusing particularly on organising and running online and hybrid events, was delivered as planned, with most sessions being held online.

Indicator 4: Output, innovation and excellence

Only those projects and individuals are shown here that are financed from budget chapter 31 of the "Global Budget 31.03" of the federal budget.

	2020		2021		2023 target values	
	Number	Share	Number	Share	Number	Share
Funded projects	629		415		650	
of which at universities	449	71%	266	64%	450	69%
of which at universities of applied sciences	21	3%	19	5%	20	3%
of which at other institutions	159	25%	130	31%	180	28%
Funded individuals	1,298		1,604		2,000	
of which men	558	43%	773	48%	1,000	50%
of which women	740	57%	831	52%	1,000	50%

Source: OeAD-GmbH.

The number of funded projects, many of which support international mobility, fell sharply in 2021 due to COVID-19. By contrast, the number of funded individuals increased as a result of a sharp rise in mobility placements from the 2021/2022 winter semester onwards. These climbed by nearly 25% compared with 2020, a year dominated by the COVID-19 pandemic.

Time to contract and consultations	2020	2021	2023 target values
Time to contract in days*	90 to 180	90 to 180	
Enquiries answered	5,000	5,300	5,000
Number of consultations under the law on foreign nationals	1,800	2,404	2,200

* The average processing time is defined from the end of the application deadline to the signing of the contract or the issuing of the scholarship.

Source: OeAD-GmbH.

The increase by a third in the number of consultations under the law on foreign nationals was also caused by the COVID-19 pandemic, which made the situation very complicated for students and researchers entering the country.

Indicator 5: Internationalisation

Nearly all programmes financed from budget chapter 31 of the "Global Budget 31.03" of the federal budget are per se internationalisation programmes in the field of science and research. This applies both to the mobility programmes (1,604 individuals on mobility placements who studied or conducted research in another country in 2021) and to 415 cooperation projects, with international cooperation the main focus of each of these.

The OeAD is involved in the European EURAXESS initiative financed from Horizon 2020 and is a member of the Academic Cooperation Association, the European umbrella organisation for education and science agencies.

Indicator 6: Knowledge and technology transfer

OeAD-GmbH's scholarship and cooperation programmes involve a knowledge and technology transfer, even though this is not stated as an explicit funding programme objective for many of the programmes.

Indicator 7: Communication and interaction with society

Various measures are implemented in the field of public science aimed at promoting science communication for children and young people both inside and outside of schools and building up expertise in citizen science. The objective is to create opportunities for cooperation between research institutions, schools and society.

The OeAD organised all kinds of different networking opportunities and exchange forums aimed at expanding the citizen science research approach in the scientific community.

Supporting the activities of the Children's and Youth Universities helps to promote science communication outside schools. The services offered to schools include the easily accessible Young Science Ambassadors initiative. This scheme saw researchers make a total of three in-person and forty-four virtual visits and hold eight topic-based online workshops in schools in 2021. Applications for the follow-up research funding programme, "Sparkling Science", were invited in 2021 for the first time. There were 168 projects submitted in all, with some 30 expected to be able to start from autumn 2022 onwards (total funding of €9.5 million is available). The "Citizen Science Award" research competition, which has been held annually since 2015 (over 3,100 people participated in 2021), also contributed significantly to science communication.

Participants in the following projects	2020	2021	2023 target values
Children's and Youth Universities (initiatives funded)	18	18	20
"Sparkling Science" (funded partnerships between institutions; funding does not start until 2022)			115
Citizen Science Award (individuals involved)	2,100	3,117	2,500

Source: OeAD-GmbH.

Indicator 8: Gender and promotion of gender equality

	2020		2021		2023 target value
	Number	Share	Number	Share	Share
Funded individuals	1,298		1,604		
of which men	558	43%	773	48%	
of which women	740	57%	831	52%	50%
Women on evaluation committees and as reviewer					
Juries, evaluating bodies (recorded from 2021 onwards)			19	46%	
Reviews (recorded from 2021 onwards)			241	35%	
Supervisory Board	5	42%	5	42%	
Strategy Advisory Board	3	38%	3	38%	
Total	**8**	**40%**	**268**	**36%**	

Source: OeAD-GmbH.

3.9.3 New initiatives and instruments for 2021 and outlook

New instruments and highlights in 2021 and outlook

The OeAD's programmes, particularly the promotion of international mobility and cooperation, continued to be severely affected by the COVID-19 pandemic in 2021 and were only able to be maintained by taking a flexible approach to research stays and projects being interrupted, postponed or extended. The 2021/22 winter semester saw mobility numbers increase again for the first time in quite a while, and this trend may well be amplified in the next academic year as a result of a "catching-up process" for international study and research visits that were not able to take place.

The conclusion of the financing agreement between the Federal Ministry of Education, Science and Research (BMBWF) and the OeAD for 2021 to 2023 meant that a multi-year horizon for planning content and three year's of financial security were contractually agreed for the first time in the OeAD's 60-year history. The financing agreement also includes the new programmes: the Children's and Youth Universities and "Sparkling Science". These cover the areas of science communication and interaction with society in particular and are contributing to a significant increase in the OeAD's funding volume. 2021 saw the completion of the first round of selection for APPEAR, the science and research cooperation programme with developing countries. This means that the winning projects and the disbursement of funding will begin on schedule in 2022.[300]

300 Further information can be found in the OeAD Annual Report 2021: https://oead.at/en/the-oead/downloads#c44555

3.10 Austrian Research Promotion Agency (FFG)

3.10.1 Profile and key data

The Austrian Research Promotion Agency (FFG) considers itself to be the central agency for the promotion of research, innovation and digitalisation in Austria. It is the implementation partner of the federal government in its strategies to strengthen Austria's position as a research and innovation location in global competition and in coordinating the specific strategies needed to achieve this.

The FFG offers a highly diverse programme portfolio with this core function. In addition to funding RTI projects and further developing infrastructures and institutions, the Austrian Research Promotion Agency (FFG) also addresses the development of human potential.

As well as implementing research and innovation programmes for the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK), the Federal Ministry of Labour and Economy (BMAW), the Federal Ministry of Education, Science and Research (BMBWF) and the Federal Ministry of Agriculture, Regions and Tourism (BMLRT), the Austrian Research Promotion Agency (FFG) is also the implementation partner for the Climate and Energy Fund (KLIEN) and most Austrian federal states.

Lastly, the Austrian Research Promotion Agency (FFG) supports companies and research institutions in participating in international research and technology partnerships and reviews applications for the research premium.

Key figures for 2020 and 2021

Austrian Research Promotion Agency (FFG) total not including broadband	2020	2021
Number of projects	3,917	4,977
Participations	5,748	7,828
Stakeholders	3,479	4,884
Funding including liabilities in €1,000	572,411	737,679
Present value in €1,000	461,948	640,131
Disbursements in €1,000	540,318	572,681

Employees	2020			2021		
	m	f	Total	m	f	Total
Employees (headcount)	142	215	357	158	213	371
Full time equivalents (rounded)	135	188	323	145	186	332

Broadband	2020	2021
Number of projects	318	304
Present value in €1,000	283,192	183,596
Disbursements in €1,000	122,599	108,394

Source: Austrian Research Promotion Agency (FFG).

3.10.2 Indicators for 2020 and 2021

Indicator 1: Funding, including third-party funding

Source of funds (not including commissioned projects or broadband) (public funds and third-party funding, not including contributions from companies)	Present values within the scope of contractual commitments in €1,000	
	2020	2021
Federal ministries acting as owners	344,873	494,421
BMK	315,293	415,756
BMAW (formerly BMDW)	29,580	78,664
BMBWF	549	1,507
BMLRT	14,723	12,564
NFTE/Austria Fund	35,081	49,248
Climate and Energy Fund (KLIEN)	42,054	57,121
Regional governments	8,522	13,365
EU	11,699	7,811
Other	4,447	4,095
Total	461,948	640,131

Source: Austrian Research Promotion Agency (FFG).

Indicator 2: Quality assurance and evaluations

Surveys of (potential) applicants and funded individuals

Ongoing surveys of applicants and funding recipients:

- Annual telephone survey on overall satisfaction with all Austrian Research Promotion Agency (FFG) services (processes, familiarity with services, the Agency's support with services, new topics such as support in the COVID-19 crisis or sustainability, etc.);
- Prompt online surveys on satisfaction with project support, the application process or preparation of the contract, with questions focusing on satisfaction with the application, effort, comprehensibility of requirements, etc. and analysis of the results within the course of process management;
- As required: focus groups for improvement projects in order to involve customers properly, particularly when it comes to developing applications or processing methods further;
- The opportunity to make suggestions at any time.

Evaluations of funding programmes, impact analyses

The Austrian Research Promotion Agency (FFG) funding is subject to regular evaluations in accordance with the evaluation plan defined in the relevant programme document. The clients are usually the respective programme owners. Within its own funding area, the Austrian Research Promotion Agency (FFG) commissions evaluations itself (e.g. in the case of funding offers financed by the National Foundation for Research, Technology and Development (NFTE) or the Austria Fund).

The FFG commissions an annual survey of the companies and research institutions receiving funding regarding the impact of the funded projects. Each survey is carried out four years after the relevant funded RTI projects have been completed, focusing particularly on the cost-effective use of project results. The survey covers funded RTI projects from the various programmes and areas. The results are published on a regular basis.

Evaluation and quality assurance concept; institutional quality assurance measures

The Austrian Research Promotion Agency (FFG) works with a process management system that provides for essential and risk-oriented controls. The entire system is supported and implemented by managers and employees. This ensures that the objectives are achieved, the tasks are carried out transparently and efficiently and by the people with the defined functions, and that careful use of resources is guaranteed. The functions for compliance management and risk management and the continuous performance of internal audits represent the essential cornerstones. This is embedded in constant monitoring based on follow-up checks and monitoring of measures in order to optimise all processes further in addition to the continuous improvement process.

Indicator 3: Human resources and qualifications

FFG staff	Headcount									
	Total		Women				Men			
	2020	2021	2020		2021		2020		2021	
	Number	Number	Number	%	Number	%	Number	%	Number	%
Support staff	67	61	51	76	49	80	16	24%	12	20
Experts	245	261	142	58	141	54	103	42%	120	46
Management level 3 (team leaders)	30	34	15	50	16	47	15	50%	18	53
Management level 2 (divisional management)	13	13	6	46	6	46	7	54%	7	54
Management level 1 (managing directors)	2	2	1	50	1	50	1	50%	1	50
Total	357	371	215	60	213	57	142	40%	158	43

FFG staff	Full time equivalents (rounded)									
	Total		Women				Men			
	2020	2021	2020		2021		2020		2021	
	Number	Number	Number	%	Number	%	Number	%	Number	%
Support staff	57	53	45	79	42	80	12	21	10	20
Experts	223	232	123	55	122	53	101	45	110	47
Management level 3 (team leaders)	28	29	14	49	13	47	14	51	15	53
Management level 2 (heads of department, staff and service units)	13	16	6	45	7	44	7	55	9	56
Management level 1 (managing directors)	2	2	1	50	1	50	1	50	1	50
Total	323	332	188	58	186	56	135	42	145	44

Source: Austrian Research Promotion Agency (FFG).

The following staff development measures were implemented in 2020 and 2021:

The FFG's salary scheme was reissued in 2020, and its introduction was accompanied by specific staff development measures. The training courses offered in 2021 continued to focus on developing skills in introducing and handling new digital technologies (e.g. digital tools in meetings, hosting digital meetings). In the training area, the creation of own e-learning content was established as of 2019 with an even greater focus on this in 2020 and 2021. This means that training can be carried out internally in a time-efficient and quality-assured manner. Staff development measures in 2021 focused on being proactive in tackling challenges and opportunities presented by the digital transformation (e.g. digital leadership).

Indicator 4: Output, innovation and excellence

Projects and participations	2020		2021		2023 target values
	Number	Share	Number	Share	
Funded projects	**3,917**		**4,977**		
Participation in projects, total	**5,748**	**100%**	7,828	100%	
Business enterprises	3,282	57%	4,888	63%	
of which SMEs	2,342	41%	3,729	48%	42%
Research institutions	874	15%	964	12%	
Higher education institutions	814	14%	1,096	14%	
Intermediaries and others	778	14%	880	11%	

Source: Austrian Research Promotion Agency (FFG).

Processing time (time to contract), median values in days

Funding offer	2020	2021
FFG total	38	22
of which as examples		
Bottom-up programmes*	61	77
Small-scale programmes**	7	8
Research premium	40	38

* Includes all funding offers that are implemented within the scope of the General Programme document: General Programme Classic, Early Stage, Impact Innovation.

** Mainly includes the internships and the Innovation Voucher.

Source: Austrian Research Promotion Agency (FFG).

Number of consultations for (potential) funding applicants	2020	2021	2023 target values
Funded nationally by the Austrian Research Promotion Agency (FFG)	10,167	10,928	10,000–11,000
Consultations within the scope of the EIP mandate	6,600	5,906	6,000

Source: Austrian Research Promotion Agency (FFG).

Patents and licences	2020	2021	2023 target values
Patents applied for*	524	505	500–525
Granted patents	N/A	N/A	
Licensing agreements	N/A	N/A	

* Total of: patent applications from funded projects up to four years after the end of the project (impact monitoring 2021) plus patent applications from the Patent Vouchers concluded in 2021.

Source: Austrian Research Promotion Agency (FFG), Austrian Institute for SME Research (impact monitoring).

Indicator 5: Internationalisation

	2020		2021	
	Number	in %	Number	in %
Projects with international partners	263	12%	256	10%
Participating companies located abroad	68	3%	209	4%

Source: Austrian Research Promotion Agency (FFG).

	Approvals	
	Present value 2020 in €1,000	Present value 2021 in €1,000
Article 185: AAL	3,702	3,674
Article 185: Eurostars	5,203	4,815
Eranet EU co-funded	2,326	904
Eranet not EU co-funded	11,985	5,663
Eureka	3,337	2,255
Joint Programming Initiatives	549	3,999
Joint Technology Initiatives	11,844	11,829
Other transnational projects	4,259	1,000
Total	**43,205**	**34,139**

Source: Austrian Research Promotion Agency (FFG).

Participations of the Austrian Research Promotion Agency (FFG) in Horizon 2020 and Horizon Europe

Pillar	Instrument	Number of projects 2020	Number of projects 2021
Excellent Science	CSA		
Excellent Science	ERA-NET-Cofund		1
Industrial Leadership	CSA	1	
Industrial Leadership	ERA-NET-Cofund	1	
Industrial Leadership	H2021-EEN-SGA	1	
Industrial Leadership	LS-CSA	1	
Societal Challenges	CSA		
Societal Challenges	ERA-NET-Cofund		
Spreading excellence and widening participation	CSA		
Science with and for Society	CSA	1	
Total		**5**	**1**

Source: Austrian Research Promotion Agency (FFG).

Central memberships in international umbrella organisations and networks, important internationalisation measures in 2020 and 2021:

- Member of TAFTIE, the European Network of Innovation Agencies. The Austrian Research Promotion Agency (FFG) runs the TAFTIE Academy on TAFTIE's behalf and has led a working group on the topic of "experimental approaches" since 2019
- Partner in the Innovation Growth Lab (IGL)
- Partner in the Enterprise Europe Network
- Agentur für Luft- und Raumfahrt (Aeronautics and Space Agency): Partner in UNO COPOUS (UN Committee on the Peaceful Uses of Outer Space), the IAA (International Academy of Astronautics), associate member of NEREUS (Network of European Regions using Space Technologies) and COSPAR (Committee on Space Research)
- Member of the International Astronautical Federation (IAF) and founding member of ESPI (European Space Policy Institute) with its head office in Vienna

Indicator 6: Knowledge and technology transfer

Funding programmes* in the area of knowledge and technology transfer

TOP 12* by funding volume	2020		2021	
	Projects	Present value in €1,000	Projects	Present value in €1,000
COMET	5	16,676	17	94,562
BASIS	151	30,782	178	35,448
Energy Research (e!MISSION)	31	27,457	42	36,340
Mobility of the Future (MdZ)	43	25,358	44	26,304
Production for the Future	33	20,871	28	22,851
ENERGIE DER ZUKUNFT (ENERGY FOR THE FUTURE)	24	9,245	73	26,071
BRIDGE	55	15,391	70	19,435
ICT of the Future	19	12,274	25	14,067
TAKE OFF	14	12,324	22	11,664
Flagship Projects eMobility	5	7,985	12	12,284
KIRAS	19	8,656	17	7,124
Emergency Call	19	14,411		

	2020		2021	
	Present value in €1,000	Share of total present value	Present value in €1,000	Share of total present value
All funding from the cooperation between science/industry	233,929	52%	349,432	55%

* Cooperation at the interface between science and industry is promoted in the majority of Austrian Research Promotion Agency (FFG) programmes. The programmes listed represent an excerpt, ranked according to the average funding volume from the last two reporting years. Formats for first-time applicants, such as the Innovation Voucher - (2021: 181 Innovation Vouchers, €1,810 thousand) are also important.

Source: Austrian Research Promotion Agency (FFG).

Indicator 7: Communication and interaction with society

Communication and interaction with society are supported in a variety of ways as part of funded projects, primarily through innovation laboratories. The following activities are examples. Take Off: AirLabs innovation laboratory (https://www.ffg.at/airlabs-austria) – establishing and operating a drone test infrastructure

Mobility of the Future (MdZ): involving users systematically in five mobility laboratories

Energy region flagship: The Green Energy Lab is conducting extensive stakeholder processes, the results of which are being made available to specific innovation and implementation projects (https://greenenergylab.at/)

Smart Cities LiLA4Green – a living lab for creating green-blue infrastructure in the Smart City Vienna, focusing particularly on smart participation with innovative methods taken from the social sciences

Benefit: the 2021 call for proposals on the topic of "Care and support at home" shone the spotlight once again on various groups of end users (https://www.ffg.at/benefit/AS2021-Leitprojekt)

Indicator 8: Gender and promotion of gender equality

	2020		2021		2023 target values
	Number	Share	Number	Share	
Women in funded projects					
FTEs based on audited reports	1,114	17.8%	1,240	17.8%	
Women project leaders*	1,291	23%	1,403	22%	>25%
Women on committees and juries					
Austrian Research Promotion Agency (FFG) Supervisory Board	8	53%	8	53%	
Bridge Advisory Board	4	25%	4	25%	
Advisory Committee for the General Programmes	7	32%	8	36%	
Reviews conducted by women	**1,728**	**33%**	**1,914**	**35%**	

* Note: refers to all participations with individuals named personally. If no project lead function is recorded, the evaluation is based on the gender of the technical contact person.

Source: Austrian Research Promotion Agency (FFG).

Funding with gender or gender equality as a criterion:

Gender equality is enshrined as the funding criteria in almost all programmes run by the Austrian Research Promotion Agency (FFG) – this relates both to the composition of the project team and to the project content.

Funding programmes with a particular focus on gender:

- The "Talents" funding priority (Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK)) promotes equal opportunities in companies and applied research as well as early stage researchers, children and young people from kindergarten age.
- INNOVATORINNEN ("FEMALE INNOVATORS", formerly w-fFORTE, Federal Ministry of Labour and Economy (BMAW)) raises the profile of women in influential R&I roles and hones female researchers' career skills.
- With its innovation network projects, Laura Bassi 4.0 is aimed at women and companies that want to shape digitalisation based on equal opportunities.
- Research partnerships – industry-related PhDs: 50% of funds for projects by female PhDs

3.10.3 New initiatives and instruments for 2021 and outlook

New instruments and highlights in 2021

The Austrian Research Promotion Agency (FFG) had an extra €88 million in its budget in 2021 as part of the climate protection stimulus package.

The most important areas of focus were:

- Cross-programme innovation promotion initiatives for sustainable production and economic management: Green Frontrunner, Green Production, circular economy. Client: Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK)
- Digital Innovation Hubs (DIHs): Promoting the establishment of six hubs and ongoing networking activities. Client: Federal Ministry of Labour and Economy (BMWA, formerly BMDW)
- Think.Wood. Launch of the Austrian Wood Initiative to strengthen the timber industry. Client: Federal Ministry of Agriculture, Regions and Tourism (BMLRT)
- Launch of two IPCEIs: Microelectronics (ME) and Batteries (EuBatIn). Clients: Federal Ministry for Cli-

mate Action, Environment, Energy, Mobility, Innovation and Technology (BMK), Federal Ministry of Labour and Economy (BMAW, formerly BMDW)
- Launch of the Broadband 2030 initiative

New governance: the current steering model, i.e. via individual programmes, is being replaced by multi-year financing agreements as part of the implementation of the Research Financing Act. The foundations for the contracts were laid in 2021 and entered into force at the start of 2022.

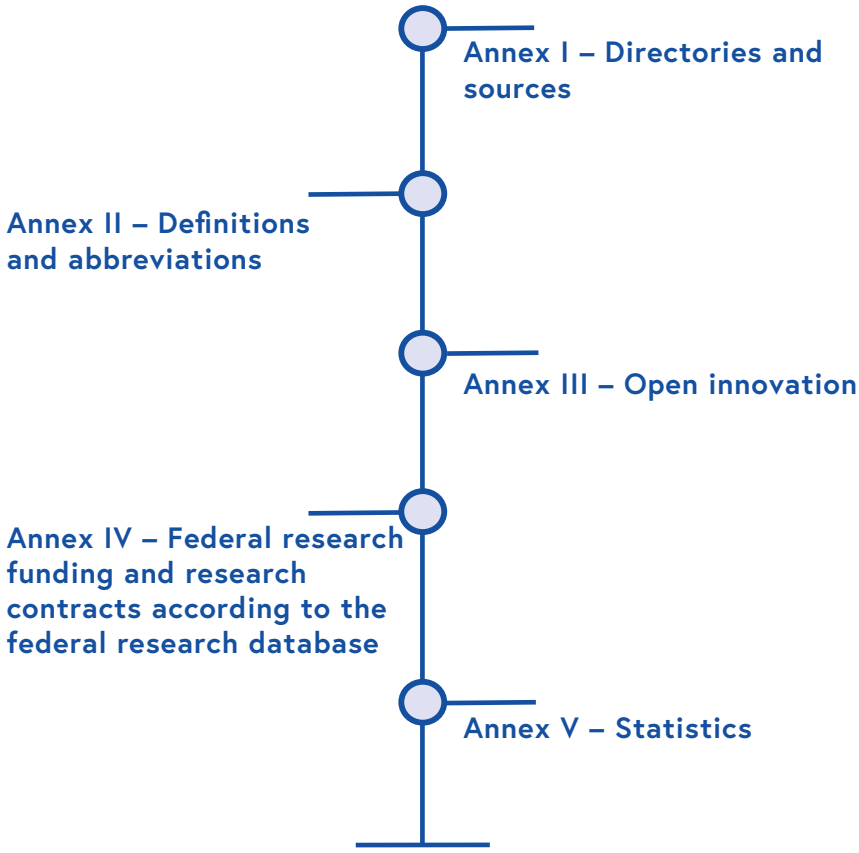
Outlook for the coming years

The funding on offer is set to be increased significantly in two areas over the coming years: reinforcing the scientific and technological foundations for key topics and further developing the underlying infrastructure. The most important new programmes are:

- Focus on Life Sciences. Client: Federal Ministry of Labour and Economy (BMAW, formerly BMDW)
- Mobility Transition, Energy Transition, Circular Economy, Climate-Neutral City Client: Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK)
- Quantum Austria: expanding quantum research in respect of initial applications and transfer to commercial use
- IPCEIs: Microelectronics II and Hydrogen
- Zero-Emission Buses, Commercial Vehicles and Charging Infrastructure[301]

301 Further information can be found in the Austrian Research Promotion Agency (FFG) Annual Report 2021: https://www.ffg.at/publikationen#jahresbericht

Annexes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Bibliography

Abramov, R.A., Sokolov, M S. (2017): Current challenges and competitive advantages of national innovation systems (NIS) of the countries-participants of the Union State up to 2030; Journal of Advanced Research in Law and Economics, 8(4), 1031-1039.

acatech (2020a): acatech HORIZONTE: Quantentechnologien (Quantum technologies), Munich. https://www.acatech.de/publikation/acatech-horizonte-quantentechnologie/

acatech (2020b): acatech IMPULS: Innovationspotenziale der Quantentechnologien der zweiten Generation (Innovation potentials of second generation quantum technologies), Munich. https://www.acatech.de/publikation/innovationspotenziale-der-quantentechnologien/

AIT (2018): Strategische Analyse der Möglichkeiten zur stärkeren Industrialisierung der Ergebnisse der österreichischen Quantenforschung (Strategic analysis of the possibilities for greater industrialisation based on the results of Austrian quantum research), Vienna. https://www.bmk.gv.at/themen/innovation/publikationen/ikt/quantentechnologie.html

AIT (2019): Quantentechnologien und Quantenkryptographie – Eine Management Einführung (Quantum technologies and quantum cryptography – a management introduction), Vienna. https://www.researchgate.net/publication/335715005_Quantentechnologien_und_Quantenkryptographie_-_Eine_Management_Einfuhrung

AI Watch (2022): National strategies on Artificial Intelligence. https://knowledge4policy.ec.europa.eu/ai-watch/national-strategies-artificial-intelligence_en

Alt, R., Berrer, H., Borrmann, J., Brunner, P., Dolle, B., Helmenstein, C., Jöchle, J., Pirker, J., Pohl, P., Popko, J., Schmidl, M., Schneider, H. (2017): Kombinierte Programmevaluierung der Christian Doppler Labors und Josef Ressel Zentren 2016 (Combined programme evaluation of the Christian Doppler Laboratories and Josef Ressel Centres 2016). Vienna.

Bennetot Pruvot, E., Estermann, T. (2021): Next Generation EU: What do National Recovery and Resilience Plans hold for universities? European University Association (EUA) Briefing, Brussels, October 2021.

Binder, D., Dibiasi, A., Schubert, N., Zaussinger, S. (2021): Entwicklungen im MINT-Bereich an Hochschulen und am Arbeitsmarkt, Studie im Auftrag des BMBWF (Developments in the STEM sector at higher education institutions and on the labour market, study commissioned by the BMBWF), Vienna.

Bitkom (2020): Bedeutung von High Performance Computing im Unternehmen (Importance of high-performance computing in companies), Berlin. https://www.bitkom.org/sites/default/files/2020-10/20201001_high_performance_computing_im_unternehmen.pdf

BMBF (2021): Hoch- und Höchstleistungsrechnen für das digitale Zeitalter – Forschung und Investitionen zum High-Performance-Computing (High-performance computing for the digital age – research and investment in high-performance computing), Bonn. https://bmbf-prod.bmbfcluster.de/upload_filestore/pub/Hoch_und_Hoechstleistungsrechnen_fuer_das_digitale_Zeitalter.pdf

BMBWF, BMK, BMDW (2021): Austrian Research and Technology Report 2021. Report of the Austrian federal government to the National Council in accordance with Section 8 (2) of the Research Organisation Act (FOG) on the position and the needs of research, technology and innovation in Austria https://www.bmbwf.gv.at/Themen/Forschung/Forschung-in-%C3%96sterreich/Services/FTB.html

BMDW (2020): IPCEI – Important Projects of Common European Interest. https://www.bmaw.gv.at/Themen/Wirtschaftsstandort-Oesterreich/IPCEI.html

BMDW (2021): IPCEI Life Sciences. Call for expressions of interest. Invitation to submit detailed project descriptions from 24 June 2021. https://www.bmdw.gv.at/dam/bmdwgvat/content/Themen/Wirtschaftsstandort-%C3%96sterreich/IPCEI/IPCEI-Life-Science_Interessensbekundung.pdf

BMF (2021): Austrian Recovery and Resilience Plan 2020–2026, April 2021, Vienna.

BMK (2020a): IPCEI Microelectronics II. https://www.bmk.gv.at/themen/innovation/internationales/ipcei/angestrebte_teilnahmen/me2.html

BMK (2020b): IPCEI Low CO2 Emissions Industry. Call for expressions of interest of 2 October 2020. https://www.bmk.gv.at/dam/jcr:c93c3b31-7b48-4509-b511-5c13e65dfa74/IPCEI_Interessensbekundung_LCI_ua.pdf

BMK (2021a): IPCEI FAQ. https://www.bmk.gv.at/dam/jcr:a23ac974-2100-46eb-9eec-18d258ce21ec/ipcei_faq_v2.pdf

BMK (2021b): IPCEI Hydrogen. https://www.bmk.gv.at/themen/innovation/internationales/ipcei/angestrebte_teilnahmen/h2.html

BMK (2021c): Die österreichische Kreislaufwirtschaft: Österreich auf dem Weg zu einer nachhaltigen und zirkulären Gesellschaft. (The Austrian circular economy: Austria on its way to becoming a sustainable and circular society). Review draft, Vienna.

BMK (2021d): Leuchttürme der Bioökonomie in Österreich (Lighthouses of the bioeconomy in Austria), Vienna.

BMK (2021e): The RTI initiative "Circular Economy": Austria on its way to becoming a circular society. First call for proposals, Vienna.

BMK (2021f): AI.AT. Media. AI and the Austrian Media Sector: Mapping the Landscape, Setting a Course, Vienna.

BMK and BMDW (2021a): IPCEI Hydrogen. Einladung zur Abgabe detaillierter Projektbeschreibungen vom 17. Mai 2021. (Invitation to submit detailed project descriptions from 17 May 2021.) https://www.bmk.gv.at/dam/jcr:1a21b5c4-5a7d-481b-a82e-6c0a7f616a56/ipcei_einladung_hydrogen.pdf

BMK and BMDW (2021b): IPCEI Mikroelektronik II. Einladung zur Abgabe detaillierter Projektbeschreibungen – 10. Juni 2021. (IPCEI Microelectronics II. invitation to submit detailed project descriptions – 10 June 2021.) https://www.bmdw.gv.at/dam/bmdwgvat/content/Themen/Wirtschaftsstandort-%C3%96sterreich/IPCEI/Aufruf-zur-Einreichunge-IPCEI-ME-II.pdf

BMK and BMDW (2021c): Strategie der Bundesregierung für Künstliche Intelligenz: Artificial Intelligence Mission Austria 2030 (Strategy of the Federal Government for Artificial Intelligence: Artificial Intelligence Mission Austria 2030) (AIM AT 2030), Vienna.

BMNT and BMVIT (2018): #mission2030: Die österreichische Klima- und Energiestrategie (The Austrian Climate and Energy Strategy), Vienna.

Boon, W., Edler, J. (2018): Demand, challenges and innovation. Making sense of new trends in innovation policy, Sci. Public Policy, 45 (4), pp. 435-447 https://www.researchgate.net/publication/326718429_Demand_challenges_and_innovation_Making_sense_of_new_trends_in_innovation_policy

Bornmann, L., Haunschild, R., Scheidsteger, T., Ettl, C. (2019): Quantum technology – a bibliometric analysis of a maturing research field, Max Planck Society. https://figshare.com/articles/preprint/Quantum_technology_a_bibliometric_analysis_of_a_maturing_research_field/9731327

Bundesgesetz über die Finanzierung von Forschung, Technologie und Innovation (Forschungsfinanzierungsgesetz – FoFinaG) Federal Act on the Financing of Research, Technology and Innovation (Research Financing Act – FoFinaG), StF: Federal Law Gazette I No. 75/2020.

Bundesregierung der Republik Österreich (2020a): FTI-Strategie 2030: Strategie der Bundesregierung für Forschung, Technologie und Innovation (RTI strategy 2030: strategy for research, technology and innovation of the Austrian Federal Government), Vienna. https://www.bundeskanzleramt.gv.at/dam/jcr:1683d201-f973-4405-8b40-39dded2c8be3/FTI_strategie.pdf

Bundesregierung der Republik Österreich (2020b): FTI-Pakt 2021–2023 (RTI Pact 2021–2023), Vienna.

Dachs, B., Weber, M. (2022): National recovery packages, innovation, and transformation. Studie im Auftrag des Rats für Forschung und Technologieentwicklung (Study commissioned by the Council for Research and Technology Development), Vienna.

DIN and DKE (2020): Deutsche Normungsroadmap Künstliche Intelligenz, DIN e.V. & DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN and VDE (German Standardisation Roadmap Artificial Intelligence, DIN e.V. & DKE German DIN and VDE Commission for Electrical, Electronic & Information Technologies), Berlin and Frankfurt am Main.

Ecker, B. and Gogola, G. (2021): Knowledge Transfer Centres and IPR Exploitation 2013–2018: Concluding evaluation of the programme. Study commissioned by aws, Vienna.

ESIR (2020): Protect, prepare and transform Europe: Recovery and resilience post COVID-19, Expert group on the economic and societal impact of research and innovation (ESIR), Brussels.

Eurofound (2021): European Working Conditions Survey 2021. https://www.eurofound.europa.eu/de/surveys/european-working-conditions-surveys/european-working-conditions-survey-2021

European Commission (2014): Criteria for the analysis of the compatibility with the internal market of State aid to promote the execution of important projects of common European interest. Communication 2014/C 188/02. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52014XC0620%2801%29

European Commission (2018): Mission-oriented Research and Innovation Policy: A RISE Perspective. Luxembourg: Publications Office of the European Union.

European Commission (2019): State aid: Commission approves €3.2 billion public funding for pan-European research and innovation project of seven Member States on all segments of the battery value chain. https://ec.europa.eu/commission/presscorner/detail/es/ip_19_6705

European Commission (2020): Strategic foresight: Charting the course towards a more resilient Europe. https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX:52020DC0493

European Commission (2020a): Weißbuch zur Künstlichen Intelligenz – ein europäisches Konzept für Exzellenz und Vertrauen. (White Paper on Artificial Intelligence: a European approach to excellence and trust.)

European Commission (2020b): Bericht über die Auswirkungen künstlicher Intelligenz, des Internets der Dinge und der Robotik in Hinblick auf Sicherheit und Haftung (Report on safety and liability implications of AI, the Internet of Things and Robotics), Brussels, 19.02.2020.

European Commission (2020c): Report from the Commission to the European Parliament, the Council and the European Economic and Social Committee. Report on safety and liability implications of AI, the Internet of Things and Robotics, Brussels.

European Commission (2021a): European Research Council Funding. https://erc.europa.eu/funding/

European Commission (2021b): European Research Council Statistics. https://erc.europa.eu/projects-figures/statistics

European Commission (2021c): European Innovation Scoreboard 2021 Methodology Report. Luxembourg: Publications Office of the European Union. https://ec.europa.eu/docsroom/documents/45971

European Commission (2021d): European Innovation Scoreboard 2021. Main Report. Luxembourg: Publications Office of the European Union. https://ec.europa.eu/docsroom/documents/46013

European Commission (2021e): The Digital Economy and Society Index Report 2021. https://ec.europa.eu/digital-single-market/en/digital-economy-and-society-index-desi

European Commission (2021f): The Digital Economy and Society Index (DESI) 2021: DESI methodological note. https://ec.europa.eu/newsroom/dae/redirection/document/80560

European Commission (2021g): Digital Economy and Society Index (DESI) 2021: Austria. Country Profile. https://ec.europa.eu/newsroom/dae/redirection/document/80487

European Commission (2021h): Quantum Flagship. https://qt.eu/about-quantum-flagship/

European Commission (2021i): Digital Exonomy and Society Index. Indicators. https://digital-agenda-data.eu/datasets/desi/indicators#desi-dimensions

European Commission (2021j): Europäischer Grüner Deal. (European Green Deal.) https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_de

European Commission (2021k): Strategic Foresight. https://ec.europa.eu/info/strategy/strategic-planning/strategic-foresight_en

European Commission (2021l): Resilience dashboards for the social and economic, green, digital, and geopolitical dimensions. https://ec.europa.eu/info/sites/default/files/dashboard_report_20211129_en.pdf

European Commission (2021m): Kriterien für die Würdigung der Vereinbarkeit von staatlichen Beihilfen zur Förderung wichtiger Vorhaben von gemeinsamem europäischem Interesse mit dem Binnenmarkt. (Criteria for the analysis of the compatibility with the internal market of State aid to promote the execution of important projects of common European interest.) Communication 2021/C 528/02. https://eur-lex.europa.eu/legal-content/DE/TXT/PDF/?uri=OJ:JOC_2021_528_R_0002&from=EN

European Commission (2021n): State aid: Commission adopts revised state aid rules on Important Projects of Common European Interest. https://ec.europa.eu/commission/presscorner/detail/de/IP_21_6245

European Commission (2021o): State aid: Commission approves €2.9 billion public support by twelve Member States for a second Pan-European research and innovation project along the entire battery value chain. https://ec.europa.eu/commission/presscorner/detail/de/IP_21_226

European Commission (2021p): Horizon Europe: Work Programme 2021–2022, 7. Digital, Industry and Space (European Commission Decision C(2021)9128 of 15 December 2021). https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/wp-call/2021-2022/wp-7-digital-industry-and-space_horizon-2021-2022_en.pdf

European Commission (2021q): Neue Vorschriften für künstliche Intelligenz – Fragen und Antworten (New rules for Artificial Intelligence – Questions and Answers), Brussels, 21 April 2021.

European Commission (2021r): Proposal for a regulation of the European Parliament and the Council on machinery products, Brussels, 21 April 2021.

European Commission (2021s): Vorschlag für eine Verordnung des Europäischen Parlaments und des Rates zur Festlegung harmonisierter Vorschriften für künstliche Intelligenz (Proposal for a Regulation of the European Parliament laying down harmonised rules on Artificial Intelligence), Brussels.

European Commission (2022a): Commission Communication on a European strategy for universities. https://education.ec.europa.eu/document/commission-communication-on-a-european-strategy-for-universities

European Commission (2022b): Europäischer Aufbauplan. (European Recovery Plan.) https://ec.europa.eu/info/strategy/recovery-plan-europe_de

European Parliament (2021): Circular economy: definition, importance and benefits. https://www.europarl.europa.eu/news/en/headlines/priorities/circular-economy/20151201STO05603/circular-economy-definition-importance-and-benefits

European Patent Office (2021): https://worldwide.espacenet.com/

European Union (2021): Regulation (EU) 2021/241 of the European Parliament and of the Council establishing a Recovery and Recovery and Resilience Facility. L_2021057DE.01001701.xml (europa.eu)

European Quantum Flagship (2020): Strategic Research Agenda, Brussels, Düsseldorf, February 2020. https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=65402

Eurostat (2021a): Eurostat Database. https://ec.europa.eu/eurostat/data/database

Eurostat (2021b): Data browser. Internet of things – use. https://ec.europa.eu/eurostat/databrowser/view/isoc_iiot_use/

Eurostat (2021c): Data browser. Internet of things – barriers to use. https://ec.europa.eu/eurostat/databrowser/product/page/ISOC_IIOT_BX

Feichtinger, G., Kettner-Marx, C., Kletzan-Slamanig, D., Köppl, A., Meyer, I., Sinabell, F., Sommer, M. (2021): Key Indicators of Climate Change and the Energy Sector in 2021. Special Topic: Environmental and Climate Actions in Austria's Recovery and Resilience Plan, WIFO monthly reports 7/2021, p. 513-530.

FFG (2021a): Climate technologies: Start von großer europäischer Batterie-Initiative mit entscheidender österreichischer Beteiligung (Launch of major European battery initiative with decisive Austrian participation). https://www.ffg.at/news/klimatechnologien-start-von-grosser-europaeischer-batterie-initiative-mit-entscheidender

FFG (2021b): Launch of microelectronics: Österreich tritt größter europäischer Initiative bei und setzt auf Schlüsseltechnologien (Austria joins largest European initiative and focuses on key technologies). https://www.ffg.at/news/mikroelektronik-startschuss-oesterreich-tritt-groesster-europaeischer-initiative-bei-und-setzt

FFG (2021c): IPCEI – Important Project of common European interest 2021. https://www.ffg.at/ipcei-important-projects-common-european-interest

Fraunhofer (2021a): Quantentechnologien – für ein wettbewerbsfähiges und technologisch souveränes Europa (Quantum technologies – for a competitive and technologically sovereign Europe), Berlin. https://www.fraunhofer.de/content/dam/zv/de/ueber-fraunhofer/wissenschaftspolitik/Positionen/politikpapiere-btw21/Politik-Papier%20Quantentechnologien.pdf

Fraunhofer (2021b): High-Performance Computing (HPC): Hochleistungsrechnen als Grundlage für eine leistungsstarke und souveräne Wirtschaft (High-performance computing as the basis of a powerful and sovereign economy), Berlin. https://www.fraunhofer.de/content/dam/zv/de/ueber-fraunhofer/wissenschaftspolitik/Positionen/politikpapiere-btw21/Politik-Papier%20HPC.pdf

Friesenbichler, K. S., Janger, J., Kügler, A., & Reinstaller, A. (2020): Auswirkungen der Covid-19-Pandemie auf die Forschungs- und Innovationsaktivität. (Impact of the COVID-19 pandemic on research and innovation activity.) Austrian Institute of Economic Research (WIFO).

Hartmann, E. A., Engelhardt, S. v., Hering, M., Wangler, L., und Birner, N. (2014): Der iit-Innovationsfähigkeitsindikator: Ein neuer Blick auf die Voraussetzungen von Innovationen. Working Paper of the Institute for Innovation and Technology (The iit Innovation Capability Indicator: a fresh look at the prerequisites for innovation). iit-Perspektive No. 16.

Hekkert, M. P., Janssen, M. J., Wesseling, J. (2020): Mission-oriented innovation systems, Environmental Innovation and Societal Transitions 34, pp. 76-79, ISSN 2210-4224, https://doi.org/10.1016/j.eist.2019.11.011

High-Level Steering Committee, Quantum Technologies Flagship (2017): Final Report. https://era.gv.at/public/documents/3365/Finalreport.pdf

High-Level Expert Group on Artificial Intelligence (2019): Ethics guidelines for trustworthy AI. https://wayback.archive-it.org/12090/20210728013426/https:/digital-strategy.ec.europa.eu/en/library/ethics-guidelines-trustworthy-ai

Hirsch, J. E. (2005): An index to quantify an individual's scientific research output. PNAS, 102(46), 16569–16572.

Horbach, J., Rammer, C. (2020): Circular economy innovations, growth and employment at the firm level: Empirical Evidence from Germany. Journal of Industrial Ecology, 24(3). https://doi.org/10.1111/jiec.12977

iit (2019): Quantentechnologien – Ein internationaler Vergleich bei Zahlen zu Publikationen und Patentanmeldungen (Quantum technologies – an international comparison in figures on publications and patent applications), Berlin. https://www.iit-berlin.de/iit-docs/5068c5d904b54f889880182fe9c1a1e4_WEB_2019_12_16_iit-perspektive_Nr_48.pdf

IMD World Competitiveness Center (2021): IMD World Talent Ranking 2021. https://www.imd.org/centers/world-competitiveness-center/rankings/world-talent-competitiveness/

IPCEI Batteries (2022): Technology Fields. https://www.ipcei-batteries.eu/technology-fields

IPCEI on Microelectronics (2022): Project Structure. https://www.ipcei-me.eu/what-is/project-structure/

ITA and AIT (2021): Foresight and technology assessment: Monitoring of future topics for the Austrian Parliament, report version November 2021, Vienna. https://www.parlament.gv.at/ZUSD/FTA/FTA-Monitoringbericht_gesamt_November_2021.pdf; https://www.parlament.gv.at/ZUSD/FTA/090_quanten_zukunft.pdf

Kattel, R., Mazzucato, M. (2018): Mission-oriented innovation policy and dynamic capabilities in the public sector, Ind. Corp. Public Policy, 27 (5), pp. 787-801.

Kaufmann, J., Petzlberger, K. (2022): Potenziale vertrauenswürdiger KI für die Digitalisierung in Österreich: Mit Fokus auf die Bereiche Produktion, Mobilität und Gesundheit (Potentials of trustworthy AI for digitalisation in Austria: with a focus on the areas of production, mobility and health), Policy Insight No. 1, Vienna, KMU Forschung Austria.

Keuschnigg, C., Sardadvar, S. (2019): Wagniskapital zur Finanzierung von Innovation und Wachstum, Studie des WPZ und der WPZ Research im Auftrag des Rates für Forschung und Technologieentwicklung (Venture Capital for Financing Innovation and Growth, study commissioned by WPZ and WPZ Research on behalf of the Council for Research and Technology Development).

Köppl, A., Schleicher, S. (2019): Material Use: The Next Challenge to Climate Policy, Intereconomics, 54(6), 338-341.

Marcher, A., Wieser, H. (2022): Potenziale vertrauenswürdiger KI für den Klimaschutz in Österreich: Handlungsoptionen für die Unternehmensförderung (Potentials of trustworthy AI for climate protection in Austria: Options for business promotion), Policy Insight No. 2, Vienna, KMU Forschung Austria.

Marshall, A. (1890): Principles of Economics. London, Macmillan.

Neufeld, J. (2014): FWF Scientists Survey 2013. Executive Summary. Berlin, Institut für Forschungsinformation und Qualitätssicherung – iFQ (Institute for Research Information and Quality Assurance). http://doi.org/10.5281/zenodo.17855.

OECD (2018): Frascati Manual 2015: Leitlinien für die Erhebung und Meldung von Daten über Forschung und experimentelle Entwicklung (Guidelines for Collecting and Reporting Data on Research and Experimental Development.) OECD Publishing, Paris. https://doi.org/10.1787/9789264291638-de

OECD (2019): Empfehlung des Rats zu künstlicher Intelligenz (Recommendation of the Council on Artificial Intelligence), OECD, Paris. https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0449.

OECD (2020a): Keeping the Internet Up and Running in Times of Crisis, OECD, Paris. https://www.oecd.org/coronavirus/policy-responses/keeping-the-internet-up-and-running-in-times-of-crisis-4017c4c9/

OECD (2020b): Digital Transformation in the Age of COVID-19: Building Resilience and Bridging Divides, Digital Economy Outlook 2020 Supplement, OECD, Paris. www.oecd.org/digital/digital-economy-outlook-covid.pdf

OECD (2020c): The Digitalisation of Science, Technology and Innovation: Key Developments and Policies. OECD Publishing, Paris. https://doi.org/10.1787/b9e4a2c0-en

OECD (2021a): Education at a Glance 2021: OECD Indicators. OECD Publishing, Paris. https://www.oecd.org/education/education-at-a-glance-19991487.htm/?refcode=20190209ig

OECD (2021b): OECD.Stat. Main Science and Technology Indicators. https://stats.oecd.org/

OECD (2021c): Gross domestic spending on R&D (indicator). https://doi.org/10.1787/d8b068b4-en

OECD (2021d): Triadic patent families (indicator). https://doi.org/10.1787/6a8d10f4-en

OECD (2022): OECD AI Policy Observatory. https://oecd.ai/en/countries-and-initiatives

ÖAW, ITA und AIT (2021): Foresight and technology assessment: Monitoring of future topics for the Austrian Parliament. Report version: May 2021. Project Report No. ITA-AIT-14. http://epub.oeaw.ac.at/ita/ita-projektberichte/ITA-AIT-14.pdf//epub.oeaw.ac.at/ita/ita-projektberichte/ITA-AIT-14.pdf

Pichler, R. (2021): The Research Financing Act: Neue Regelungsstrukturen in der Forschungsfinanzierung des Bundes (New regulatory structures in federal government research funding), in: Werner Hauser (Hg.): Hochschulrecht, Jahrbuch 2021 (Higher Education Legislation, Yearbook 2021), Vienna/Graz, pp. 307-326.

Polt, W., Schuch, K., Weber, M., Dall, E., Unger, M., Salamon, N. (2019): Debating Impact and Mission-Orientation of R&I Policies, fteval Journal for Research and Technology Policy Evaluation 47, DOI: 10.22163/fteval.2019.322

Prem, E., Ruhland, S. (2019): Artificial Intelligence (AI) Potenzial Österreich: Zahlen, Daten, Fakten, eine Annäherung auf Basis wirtschaftsstatistischer Analysen (Austria's artificial intelligence potential: figures, data, facts. An approximation based on economic statistical analyses), Vienna.

QUANTERA (2020): Quantum Technologies: Public Policies in Europe. https://quantera.eu/wp-content/uploads/2021/11/quantum_technologies_80221-1.pdf

Rat der Europäischen Kommission (Council of the European Commission) (2021): Durchführungsbeschluss des Rates zur Billigung der Bewertung des Aufbau- und Resilienzplans Österreichs (Council Implementing Decision on the approval of the assessment of the recovery and resilience plan for Austria), Brussels, 6 July 2021. https://www.parlament.gv.at/PAKT/EU/XXVII/EU/06/78/EU_67886/imfname_11080310.pdf

Reinstaller, A. (2022): Kräftiger Anstieg der Innovationsausgaben österreichischer Unternehmen im zweiten Jahr der COVID-19-Pandemie (Strong increase in innovation spending by Austrian companies in the second year of the COVID-19 pandemic), WIFO monthly reports 3/2002, 165-174

Reiter, M., Forstner, S., Garstenauer, V., Hofer, H., Molnárová, Z., Paterson, I. (2021): Macroeconomic assessment of the Austrian Recovery and Resilience Plan, IHS Research Report. https://irihs.ihs.ac.at/id/eprint/5831/1/ihs-report-2021-reiter-forstner-garstenauer-hofer-molnarova-paterson-austrian-recovery-resilience-plan.pdf

Schwaag Serger, S., Weber, M., Dachs, B., Kivimaa, P., Lazarevic, D., Lukkarinen, J., Stenberg, L., Johansson, D. (2022): Transformative innovation policy and the recovery and resilience packages in Austria, Finland and Sweden, presentation held at the OECD-Vinnova Workshop on STI policy goals, Feb 7 – 8, 2022.

Scimago Journal & Country Rank (2021): Country Rankings. https://www.scimagojr.com/countryrank.php

Scopus (2021): https://www.scopus.com/

Statistik Austria (2021): Volkswirtschaftliche Gesamtrechnungen (National Accounts) 1995–2020. Vienna, Verlag Österreich. Vienna, Verlag Österreich.

Szczepanski, M. (2019): Economic impacts of artificial intelligence (AI). European Parliamentary Research Service (PE 637.967). https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/637967/EPRS_BRI(2019)637967_EN.pdf

The Growth Lab at Harvard University (2021): The Atlas of Economic Complexity. http://www.atlas.cid.harvard.edu/rankings

Times Higher Education (2021a): Times Higher Education World University Rankings 2022. https://www.timeshighereducation.com/world-university-rankings/2022/world-ranking#!/page/0/length/100/sort_by/rank/sort_order/asc/cols/stats

Times Higher Education (2021b): Times Higher Education Young University Rankings 2021.https://www.timeshighereducation.com/world-university-rankings/2021/young-university-rankings#!/page/0/length/-1/sort_by/rank/sort_order/asc/cols/stats

Travagnin, M. (2019): Patent analysis of selected quantum technologies. ISBN 978-92-79-98120-3, doi:10.2760/938284, JRC115251. https://publications.jrc.ec.europa.eu/repository/bitstream/JRC115251/patent_analysis_of_selected_quantum_technologies_1.pdf

UNESCO (2021): UNESCO Institute for Statistics. http://data.uis.unesco.org/

United Nations (2020): The fourth industrial revolution combatting COVID-19: The role of smart and sustainable cities. Expert Group Meeting on "*Socially just transition towards sustainable development: The role of digital technologies on social development and well-being of all*". UNDESA / Division for Inclusive Social Development, in collaboration with UNCTAD and ITU. https://www.un.org/development/desa/dspd/wp-content/uploads/sites/22/2020/09/Maysoun-Ibrahim_4IR-and-SCs-in-the-Time-of-COVID19.pdf

United Nations (2021): Technology and Innovation Report 2021. Catching technological waves: Innovation with equity. Geneva: United Nations Conference on Trade and Development. Technology and Innovation Report 2021 | UNCTAD

Wieser, H, Kaufmann, P., Brunner, P., Haider, W., Hochreiter, H., Knoll, N., Koch, L., Kubeczko, K., Reitschuler, G., Sardadvar, S., Schuch, K., & Steyer, M. (2021): Environmental impacts of the RTI measures: Herausforderungen und Ansätze für die Evaluierungspraxis (Challenges and Approaches for Evaluation Practice), fteval Journal for Research and Technology Policy Evaluation, 52, pp. 36-46.

WIPO (2021): The Global Innovation Index 2021: Tracking Innovation through the COVID-19 Crisis. Geneva: World Intellectual Property Organization. https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2021.pdf

World Economic Forum (2019): How the future of computing can make or break the AI revolution. https://www.weforum.org/agenda/2019/06/how-the-future-of-computing-can-make-or-break-the-ai-revolution/

Data sources

EUROSTAT Database[302]: The statistical office of the European Union provides country comparisons using official data on various topics. In addition to data from EU member states, information on leading non-EU economies, such as the USA, is also included for some indicators.

Resilience Dashboard[303]: The Resilience Dashboard of the European Commission's Joint Research Center has been presenting the relative resilience capacities and weaknesses of European and non-European countries since 2021. Various indicators from the four areas "social and economic", "green", "digital" and "geopolitical" are collected and summarised in (sub-)indices.

Global Innovation Index 2021 (GII)[304]: This ranking is published annually by the United Nations' World Intellectual Property Organization (WIPO). Between 2013-2020, the GII was published together with the French business school INSEAD and Cornell University. Since 2021, the GII has been published by the World Intellectual Property Organization (WIPO) in cooperation with the Portulans Institute, various companies and academic network partners and the GII Advisory Board. In 2021, 132 economies are compared both on the overall index and in terms of more detailed indicators of innovation system inputs and outputs.

Digital Economy and Society Index (DESI) Report 2021[305]: The Digital Economy and Society Index (DESI) is published periodically by the European Commission. The following four areas of the DESI are evaluated in this report: connectivity, human capital, integration of digital technology by enterprises and digital public services.

European Innovation Scoreboard 2021 (EIS)[306]: The European Innovation Scoreboard analyses and compares the innovation performance of EU member states as well as other European and non-European countries.

OECD – Main Science and Technology Indicators: The OECD publishes important indicators on a wide range of topics in its database,[307] including industry, education, energy and transport as well as research and development.

Education at a Glance 2021[308]: In its "Education at a Glance" report, the Organisation for Economic Co-operation and Development (OECD) publishes an annual compilation of education indicators for the purposes of international comparison, Focusing on participation in education, graduate ratios, investment in education and teaching/learning settings.

The Atlas of Economic Complexity[309]: Produced by Harvard University, the Atlas of Economic Complexity features an economic complexity index. Calculated on the basis of foreign trade data, the index reflects the knowledge-intensity of products and the processes required to produce these products.

Scimago Journal & Country Ranks[310]: The Scimago Journal & Country Rank database is a portal that can be accessed by the general public and that also provides users with indicators of academic and scientific publications.

Scopus[311]: Scopus is a fee-based literature database that also enables advanced searches and bibliometric analyses.

IMD World Talent Ranking[312]: In its "Talent Ranking", the IMD World Competitiveness Center of the IMD business school – International Institute for Management Development presents the development of skills and the retention as well as the international attractiveness of and for highly-skilled workers.

Readiness for Frontier Technologies Index 2021[313]: The *United Nations Technology and Innovation Report 2021* provides a comparative analysis of the ability to apply future technologies. The Readiness for Frontier Technologies Index measures a country's ability to use, adopt and adapt frontier technologies and is composed of five pillars: ICT decployment, skills, R&D activity, industrial activity and access to finance.

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302 See Eurostat (2020).
303 See European Commission (2021d).
304 See World Intellectual Property Organization (WIPO) (2021).
305 See European Commission (2021a).
306 See European Commission (2021b); European Commission (2021c).
307 See OECD (2021b).
308 See OECD (2021a).
309 See The Growth Lab at Harvard University (2021).
310 See Scimago Journal & Country Rank (2021).
311 See Scopus (2021).
312 See IMD World Competitiveness Center (2021).
313 See United Nations (2021).

Annex II – Definitions and abbreviations

Definitions from the monitoring activities in accordance with the Research Financing Act (FoFinaG):

Time to Contract: The time to contract is the period between the receipt of an application by the research funding organisation and the finalisation (sending) of the contract to the grant recipient. Deviating definitions are explained in footnotes.

Third-party funds: The third-party funds of the research institutions include both revenue from customers (private and public) and funding raised. Funds of the National Foundation for Research, Technology and Development (NFTE) and the Austria Fund are also included in third-party funds, but other income from the onward charging of costs by charging for services, or funding from the Public Employment Service Austria (AMS) and research premiums is not.

Grants: The volumes of the projects acquired by the research institutions are also stated as total funding approved ("awarded"). Only those projects newly acquired in the relevant reporting year are shown and not the ongoing projects, in order to avoid double counting.

Funding budget: The research funding agencies use various terms to describe their funding or financing performance. For the purposes of the Research and Technology Report, approvals and commitments are reported at their present value.

Total income: The total income corresponds to the sales revenue and other operational income according to investment and financial controlling as per the Austrian Commercial Code (UGB).

Glass Ceiling Index: According to the She Figures, this index compares the percentage of women as a share of all employees with the percentage of women in management positions. [314] The Index can take all values between zero and infinity. A value below 1 means that women are relatively overrepresented in management positions, a value above 1 means that women are underrepresented. The higher the value, the greater the level of underrepresentation.

Global budget: The Austrian global budget or the basic funding of the research institutions refers to all grants from the owners/shareholders/supervisors that have not already been earmarked (frequently based on a performance agreement). The institutions allocate the basic funding themselves.

Employees are white-collar workers, freelancers, leased staff, persons in marginal employment, but not employees on leave, employees on temporary contracts or work and service contracts.

NFTE and Austria Fund: National Foundation for Research, Technology and Development (NFTE) and the Austria Fund.

Practice partners: Practice partners are cooperation partners that are important for the implementation but do not belong to the "industry", such as service companies, hospitals, regional authorities, NGOs.

Publications: The publications only include scientific publications (not project reports, etc.) that have undergone a quality assurance procedure (peer review). All publications have a "persistent identifier" such as a DOI or ISSN and have been published in scientific journals, edited volumes, proceedings or monographs. Publications with multiple authors are evaluated as"whole counts"(i.e. the publication as a whole is attributed to each author).

Reporting dates: All budget figures and employee headcounts are recorded as of 31 December of the relevant reporting year.

The **Technology Readiness Level (TRL)** is a scale used to assess the state of development of new technologies based on a systematic analysis. It indicates how advanced a technology is on a scale of 1 to 9. TRL 1 refers to basic research that is still very far from application, TRL 9 to technologies that have already been successfully implemented.

FTE: Full time equivalents, rounded.

WoS and Scopus: The Web of Science (formerly ISI, Web of Knowledge) is a multidisciplinary database run by Clarivate Analytics which lists scientific publications with their citations. Scopus is a similar database from Elsevier with bibliographic references to scientific literature. Scopus contains more entries and also covers non-natural science disciplines on a broader basis. Nevertheless, research organisations were given the option of presenting their publications in accordance with Scopus or WoS.

314 See European Commission (2019e).

Country codes

Country	Code	Country	Code	Country	Code
Australia	AUS	Finland	FIN	Netherlands	NLD
Austria	AUT	France	FRA	New Zealand	NZL
Belgium	BEL	Great Britain	GBR	Poland	POL
Bulgaria	BGR	Greece	GRC	Portugal	PRT
Brazil	BRA	Croatia	HRV	Romania	ROU
Switzerland	CHE	Hungary	HUN	Russia	RUS
Chile	CHL	Ireland	IRL	Slovakia	SVK
China	CHN	Israel	ISR	Slovenia	SVN
Cyprus	CYP	Italy	ITA	Sweden	SWE
Czechia	CZE	Lithuania	LTU	Turkey	TUR
Germany	DEU	Luxembourg	LUX	United States	USA
Denmark	DNK	Latvia	LVA	South Africa	ZAF
Spain	ESP	Mexico	MEX		
Estonia	EST	Malta	MLT		

Abbreviations

ACT	Austrian Centre of Transformation
AECM	European Association of Guarantee Institutions
AI	Artificial intelligence
AIM	Austrian Institute of Management
AIOTI	Alliance IoT Innovation
AIT	Austrian Institute of Technology
ALLEA	All European Academies
ALTAI	Assessment List for Trustworthy Artificial Intelligence
AMA	Association for Sensors and Measurement
AMDC	Austria Microdata Center
APA	Austrian Press Agency
APART	Austrian Programme for Advanced Research and Technology
AplusB	Academia plus Business
AQT	Alpine Quantum Technologies
ARP	Recovery and Resilience Plan (RRP)
ATD	Austrian Technology Days
aws	Austrian Federal Promotional Bank
BKA	Bundeskanzleramt (Austrian Federal Chancellery)
BMAW	Bundesministerium für Arbeit und Wirtschaft (Federal Ministry of Labour and Economics)
BMBWF	Bundesministerium für Bildung, Wissenschaft und Forschung (Federal Ministry of Education, Science and Research)
BMDW	Bundesministerium für Digitalisierung und Wirtschaftsstandort (Austrian Federal Ministry for Digital and Economic Affairs)
BMF	Bundesministerium für Finanzen (Austrian Federal Ministry of Finance)
BMK	Bundesministerium für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie (Austrian Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology)
BMLRT	Bundesministerium für Landwirtschaft, Regionen und Tourismus (Austrian Federal Ministry of Agriculture, Regions and Tourism)
BMNT	Bundesministerium für Nachhaltigkeit und Tourismus (Austrian Federal Ministry for Sustainability and Tourism)
BOKU	Universität für Bodenkultur Wien (University of Natural Resources and Life Sciences Vienna)
CCCA	Climate Change Center Austria
CD Laboratories	Christian Doppler Laboratories
CDG	Christian Doppler Forschungsgesellschaft (Christian Doppler Research Association)
CEN	European Committee for Standardization
CENELEC	European Committee for Electrotechnical Standardization
CERN	European Organisation for Nuclear Research
CEUS	Central European Science Partnership
COE	Clusters of Excellence
COSPAR	Committee on Space Research
CPC Codes	Cooperative Patent Classification Codes
DACH region	Germany, Austria, Switzerland
DeGEval	Deutsche Gesellschaft für Evaluation (German Evaluation Society)
DESI	Digital Economy and Society Index
DHZW	Deutsches Zentrum für Hochschul- und Wissenschaftsforschung (German Centre for Higher Education Research and Science Studies)

DIN	Deutsches Institut für Normung e.V. (German Institute for Standardization)
DK	Doktoratskolleg (Doctoral Programme)
DKE	Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE (German DIN and VDE Commission for Electrical, Electronic & Information Technologies)
EAD	Ethically Aligned Design
EARPA	European Automotive Research Partners Association
EARTO	European Association of Research and Technology Organisations
EASAC	European Academies Science Advisory Council
EBAN	European Business Angel Network
EBS	Electronics-based systems
EBSCON	Electronic Based Systems Conference
ECI	Economic Complexity Index
ECPAIS	Ethics Certification Program for Autonomous and Intelligent Systems
ECSO	European Cyber Security Organisation
ECTRI	European Conference of Transport Research Institutes
EEK	Entwicklung und Erschließung der Künste (Advancement and Appreciation of the Arts)
EERA	European Energy Research Alliance
EFFRA	European Factories of the Future Research Association
EHPA	European Heat Pump Association
EIC	European Innovation Council
EIS	European Innovation Scoreboard
EIT	European Institute of Innovation and Technology
EKK	ERP Kredit Kommission (ERP Credit Committee)
ELLIS	European Laboratory for Learning and Intelligent Systems
EMBL	European Molecular Biology Laboratory
EMVA	European Machine Vision Association
EPC	European Patent Convention
EPI	European Processor Initiative
EPIC	European Photonics Industry Consortium
EPO	European Patent Office
EPoSS	European Technology Platform on Smart Systems Integration
ERA	European Research Area
ERC	European Research Council
ESO	European Southern Observatory
ESPI	European Space Policy Institute
ESRF	European Synchrotron Radiation Facility
EURATOM	European Atomic Energy Community
EUREC	The Association of European Renewable Energy Research
EuroHPC	European High Performance Computing Joint Undertaking
EuroQCI	European Quantum Communication Infrastructure
EuroQCS	European Quantum Computing and Simulation
EVFIN	European Venture Fund Investors Network
EWCS	European Work Condition Survey
FEAM	Federation of European Academies of Medicine
FEEI	Association of the Austrian Electrical and Electronics Industries
FET	Future and Emerging Technologies
FFG	Österreichische Forschungsförderungsgesellschaft mbH (Austrian Research Promotion Agency)
FID	First Industrial Development
FIW	Forschungsplattform Internationale Wirtschaft (International Economy Research Platform)
FoFinaG	Forschungsfinanzierungsgesetz (Research Financing Act)
FOG	Forschungsorganisationsgesetz (Research Organisation Act)
FTB	Forschungs- und Technologiebericht (Austrian Research and Technology Report)
FTE	Full Time Equivalent
fteval	Austrian Platform for Research and Technology Policy Evaluation
FTFG	Forschungs- und Technologieförderungsgesetz (Research and Technology Promotion Act)
FWF	Fonds zur Förderung der wissenschaftlichen Forschung (Austrian Science Fund)
GB	Global budget
GBA	Geologische Bundesanstalt (Geological Survey of Austria)
GBER	General Block Exemption Regulation
GCP	Good Clinical Practice
GDP	Gross domestic product
GDPR	General Data Protection Regulation
GEP	Gender Equality Plan
GF	Geschäftsführung (General management)
GII	Global Innovation Index
GRP	Gross regional product
GSA	GeoSphere Austria, Federal Agency for Geology, Geophysics, Climatology and Meteorology
GSK	Geistes-, Sozial- und Kulturwissenschaften (Humanities, social sciences and cultural studies)
HLG	High Level Group
HPC	High-Performance Computing
HSRM	Hochschulraum-Strukturmittel (Higher education sector structural funds)
IAA	International Academy of Astronautics
IAF	International Astronautical Federation
ICS	Internal Control System
ICT	Information and Communication Technologies
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IIASA	International Institute for Applied Systems Analysis
IMD	Institute for Management Development
IoT	Internet of Things

IP/IPR	Intellectual Property/Intellectual Property Rights
IPCEI	Important Projects of Common European Interest
IPCEI EuBatIn	IPCEI European Battery Innovation
ISO	International Organization for Standardization
ISTA	Institute of Science and Technology Austria
IWI	Industriewissenschaftliches Institut (Institute of Industrial Science)
JESH	Joint Excellence in Science and Humanities
JKU	Johannes Kepler University Linz
JPO	Japan Patent Office
JR Centre	Josef Ressel Centre
KIC	Knowledge and Innovation Communities
KLIF	Klinische Forschung (clinical research)
LBG	Ludwig Boltzmann Gesellschaft (LBG) – Austrian Association for the Promotion of Scientific Research
LBI	Ludwig Boltzmann Institute
LCI	Low CO2 Emissions Industry
LV	Leistungsvereinbarungen (Performance agreements)
MaaS	Mobility as a Service
Med. Univ.	Medical University
MSCA	Marie-Skłodowska-Curie-Actions
MUG	Medical University of Graz
NCP-IP	National Contact Point for Knowledge Transfer and Intellectual Property
NEFI	Network of European Financial Institutions for SMEs
NEREUS	Network of European Regions using Space Technologies
NFTE	Nationalstiftung für Forschung, Technologie und Entwicklung (National Foundation for Research, Technology and Development)
NGEU	NextGenerationEU
NRP	National Reform Programme
Ö-Fonds	Österreichfonds (Austria Fund)
OeAD	Österreichischer Austauschdienst (Agency for Education and Internationalisation)
OeAW	Österreichische Akademie der Wissenschaften (Austrian Academy of Sciences)
OeAWI	Österreichische Agentur für wissenschaftliche Integrität (Austrian Agency for Research Integrity)
OECD	Organisation for Economic Co-operation and Development
OIS	Open Innovation in Science
PCGK	Public Corporate Governance Kodex (Public Corporate Governance Code)
PCT	Patent Cooperation Treaty
PEEK	Programme for the Development and Inclusion of the Arts
PIA 2030	Platform Internet Infrastructure Austria 2030
PPPI	Public Procurement Promoting Innovation
PRACE	Partnership for Advanced Computing in Europe
QFTE	Quantum Science and Technology
QKD	Quantum Key Distribution
QM	Quality Assurance Management
QT	Quantum Technology
R&D	Research and Development
R&I	Research and Innovation
RDI	Research, Development and Innovation
RRF	Recovery and Resilience Facility
RTD	Research, Technology and Development
RTI	Research, Technology and Innovation
RTO	Research and Technology Organisation
SAB	Scientific Advisory Board
SAL	Silicon Austria Labs GmbH
SDGs	Sustainable Development Goals
SFR	Strategic Foresight Report
SIP	Special Investment Programme
SMEs	Small and medium-sized enterprises
STEM	Science, Technology, Engineering and Mathematics
TFEU	Treaty on the Functioning of the European Union
THE Ranking	Times Higher Education World University Ranking
TRL	Technology Readiness Level
TU	University of Technology
UG	Untergliederung (Budget chapter)
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
USPTO	United States Patent and Trademark Office
VEN	Vienna Evaluation Network
VHS	Volkshochschule (adult education centre)
VSC	Vienna Scientific Cluster
VWA	Vorwissenschaftliche Arbeit (pre-scientific paper)
WEF	World Economic Forum
WFA	Wirkungsorientierte Folgenabschätzung (Outcome-oriented impact assessment)
WFCS	International Conference on Factory Communication Systems
WMO	World Meteorological Organization
WoS	Web of Science
WoSt	Wirkungsorientierte Steuerung (outcome-oriented control)
WTR	World Talent Ranking
WTZ	Wissenstransferzentrum (Knowledge Transfer Centre)
ZAMG	Zentralanstalt für Meteorologie und Geodynamik (The Central Institute for Meteorology and Geodynamics)
ZSI	Zentrum für Soziale Innovation GmbH (Centre for Social Innovation)

Annex III – Open Innovation

		Measure 1	Measure 2	Measure 3	Measure 4	Measure 5	Measure 6
		Building Open Innovation and experimental spaces	Embed Open Innovation elements in 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 match-making 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		FFG, BMK – Regional Talents BMBWF, BMAW – Innovative Youth	ISB – Handout on the topic of promoting innovation expertise and educational innovations			LBG – Open Innovation in Science (OIS) Impact Labs
Action area 2	Formation of heterogeneous Open Innovation networks and partnerships across all disciplines, industries and organisations	BMK – Innovation lab AirLabs Austria FFG, KLIEN – Flagship region for energy FFG – Energy.Free.Room	Innovation Foundation for Education – Innovation Network for Teachers and School Management Bodies	IÖB, BMAW, BMK – Innovation platform	FFG, BMAW – Laura Bassi 4.0 BMK – Innovation platform AAL Austria ISB – Innovation labs for education (promotion of the establishment of 5 innovation labs)	LBG – Priority Setting Database BMBWF – Research infrastructure database MCI – Digital Innovation Hub West ISB – Map of educational innovations	
Action area 3	Mobilisation of resources and creation of the framework conditions for Open Innovation	FFG – Innovation workshops FFG, BMK – Innovation labs	FFG – Innovation labs for education	FFG, BMLRT – REGIONAL.DIGITAL.INNOVATIV		BMK – Open4Innovation platform	LBG – Open Innovation in Science Impact Model and reflection instruments

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 crowd work	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, higher education institutions, 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
			Salzburg – Competence Centre for Open Innovation UAS Kufstein – INNoCamp	Austrian Patent Office – Training and events	Austrian Patent Office – Open Data Initiative FWF – Top Citizen Science (TCS) funding initiative	Austrian Patent Office – Raising awareness of exploitation strategies aws (ncp-ip) – Web Guide fair-open-innovation	BMBWF & BMK – Information & communication work via the official Open Innovation website (www.openinnovation.gv.at) BMBWF & BMK – Focus on networking with OI in workshops UAS St. Pölten – SMARTUP Initiative
FFG, BMAW – Focus on Open Innovation in the COIN networks CDG – CD Laboratories and JR Centres	BMK – AAL test regions FFG, BMK – Talents – FEMtech research projects		FFG, BMAW – Focus on Open Innovation in the COIN networks	FFG, BMAW – INNOVATORINNEN (FEMALE INNOVATORS) Leadership	BMK – "e-genius" open content platform FWF – #ConnectingMinds		BMK – Information & communication work within the scope of the Open4Innovation platform
CDG – Partnership in Research IHS – RiConfigure – democratising innovation	FFG, BMK – Innovation labs FFG – Involve end-users in the General Programme FFG – Fast Track Digital	aws (ncp-ip) – Web Guide OI Toolbox (www.fair-open-innovation.at)	Salzburg – Competence Centre for Open Innovation Austrian Patent Office – Professional search service for SMEs	Universities, BMBWF – Implementation of the OANA recommendations on Open Access BMK – Provision of research results of funded projects (Open4Innovation – Platform) BMBWF – AT2OA Austrian Transition to Open Access BMBWF – e-infrastructures Austria BMBWF – Open Education Austria BMBWF – Portfolio Showroom	FWF – Open Access for research data		

Annex IV - Federal research funding and research contracts according to the federal research database

The database for research funding and contracts (B_f.dat)[315] for the federal government has been in place since 1975, and was set up by the former Federal Ministry of Science and Research as a "documentation of facts by the federal government". Today, the database is maintained by the Federal Ministry of Education, Science and Research (BMBWF). The mandatory reporting of the ministerial departments to the relevant Science Minister is recorded in the Research Organisation Act (FOG), Federal Law Gazette No. 341/1981 as amended. In 2008, it was changed to a database to which all ministerial departments 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 field of activity. The federal research database has also been accessible to the public since 1 June 2016, providing the latest overview of the projects funded by the federal ministries. With regard to the relevant reporting year, the database contains ongoing, newly approved as well as already completed R&D contracts and grants, their overall funding volume and actual funds paid in the reporting year. All in all, this gives an up-to-date picture of directly commissioned R&D studies, assessments, evaluations, grants and the like, along with their funding by the federal government.

The federal research database thus contributes to transparency in the allocation of public funds and to the presentation of the overall picture of research funding in Austria. In total, the volume of research contracts and funding directly commissioned by the ministerial departments is relatively small, especially when compared to the university budgets and the resources of the research funding agencies (for details, see the overview of the federal government's use of research-related funds in Annex V). The amounts can therefore be considered supplementary information in the sense of providing maximum transparency and completeness.

Figure A-1 provides an overview of the R&D projects entered in the B_f.dat by the ministerial departments. The percentage share of R&D projects per ministerial department (on the left side of the figure) and the percentage share of total funding (on the right side of the figure) are shown here. The data in the B_f.dat reveal that a total of 426 R&D projects were funded in 2021 with a volume of €448.83 million. This figure also includes the global institutional funding. In total, approximately 85% of the funds were paid out as global funding to research institutions in 2021. Subtracting this from the total disbursement volume in 2021, the remaining funding amount is €69.79 million, which is €4.92 million or 7.6% higher than in 2020. It must be noted that this funding amount for each reporting year is usually a partial amount for an ongoing or completed project and this is subject to annual fluctuations depending on the progress of the respective projects.

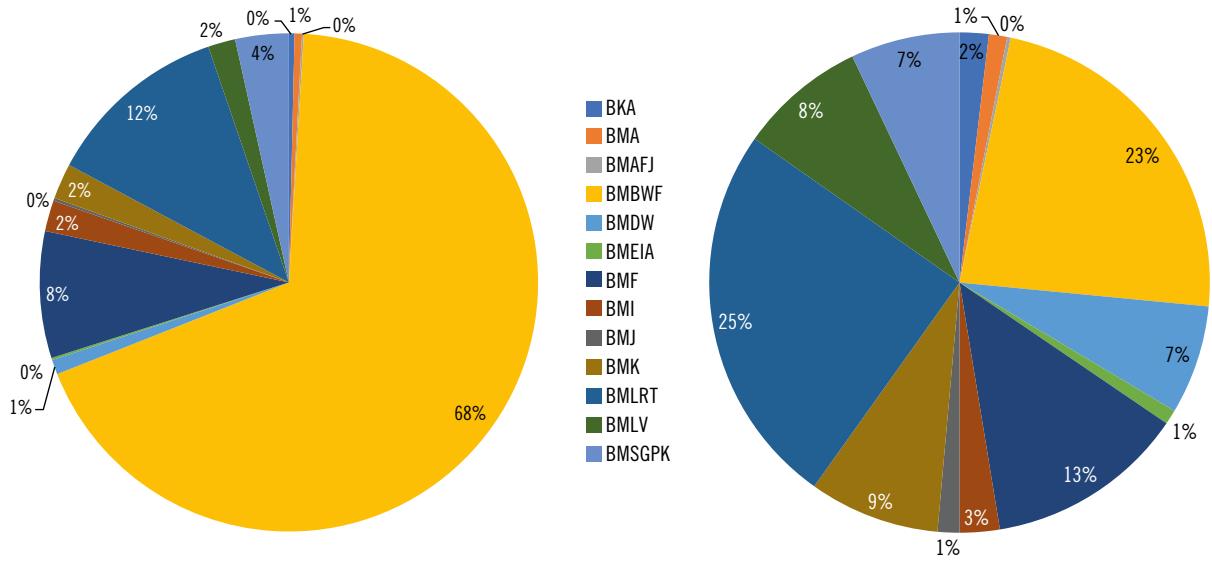
In 2021, as it was in the previous year, the Federal Ministry of Education, Science and Research (BMBWF) was the ministerial department with the largest share of funding amounts (see Figure A-1): 68% of the R&D projects (excluding global financing) were allocated to the BMBWF. In contrast, at 23.2% the BMBWF is slightly behind the Federal Ministry of Agriculture, Regions and Tourism (BMLRT) in terms of the number of R&D projects[316]. Entries and funding amounts have remained almost constant for the BMBWF compared to 2020. The funding cases decreased by 41 percentage points, but the amounts of the funding increased by 0.3 percentage points. In terms of the number of RTI contracts and grants, the

315 www.bmbwf.gv.at/bfdat-public

316 There is a possibility of double counting due to projects being shared amongst the ministries.

BMLRT was even 1.64 percentage points higher than the BMBWF; in terms of funding amounts the BMLRT follows in second place after the BMBWF, with 12%. It should be noted that the reason the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) had a comparatively small percentage (2.3%) was that most of the R&D funds were outsourced to the federal funding agencies Austrian Research Promotion Agency (FFG) and Austria Wirtschaftsservice (aws).

Fig. A-1: Ongoing and completed R&D projects and funding (Fig. left) and funding amounts in 2021 (Fig. right), by ministerial department



Source: Federal Ministry of Education, Science and Research (BMBWF), Federal research database B_f.dat. Graphic: WPZ Research.

Annex V – Statistics

Funding of gross domestic expenditure on R&D[317] (Tables A-1 and A-2)

According to an estimate by Statistics Austria, more than €14.1 billion are expected to be spent in Austria in 2022 on research and experimental development (R&D). This means that the R&D intensity – i.e. the share of R&D expenditure in nominal gross domestic product (GDP) – will rise from 3.21% in 2021 to 3.26%. The nominal increase of the total Austrian R&D expenditures from 2021 to 2022 is estimated at 9.3% and is thus higher than the forecast increase of the nominal gross domestic product (GDP) of 7.5%. Over the past two decades, domestic expenditure on research and development has risen sharply: In 2012, the R&D intensity was still 2.91%; in 2002 it lay at 2.07%.

In 2022, companies in Austria are expected to spend around €7.3 billion on research and thus finance around half of R&D expenditure (51%). The R&D funding of the company also includes funding via the research premium, which is estimated by the Federal Ministry of Finance (BMF) at €1 billion for 2022. The government sector will account for around €4.7 billion, or 33%, of total R&D funding, with the federal government accounting for almost €3.9 billion (28%), making it the most important source of finance. Around €600 million will be financed by the regional governments. Other public institutions – such as local governments, chambers, higher education institutions or social insurance institutions – will contribute around €215 million. Foreign sources, mainly foreign firms, are expected to finance research in Austria in the amount of approximately €2.2 billion.

The estimates and year-end closing data of the federal and the regional governments, current economic forecasts and theresults of the most recent R&D survey were all taken into account in estimating the Austrian gross domestic expenditure on R&D in 2022.

However, the estimates for the year 2022 are subject to particular uncertainty with regard to the further development of the COVID-19 crisis and the entire global economy as a result of the war in Ukraine.

Federal R&D expenditure in 2022

The tables "Federal expenditure on research and research promotion" show the total research-related expenditure of the federal government, which includes the research-related shares of the contributions to international organisations. The source is the "Detailed overview of research-related appropriation of federal funds" in the R&D supplement to the Federal Finances Act (BFG) 2022 (Part a and Part b). In terms of methodology, this is in line with the internationally applied "GBARD" concept[318] which, in contrast to the domestic concept, includes the 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 the OECD.

In 2022, the following socio-economic objectives (each as a share of total funding) will account for the largest share of federal expenditure on research and research promotion:

317 Statistics Austria usually creates an annual "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 Cash Flow Budgets and Cash Flow Statements of the federal and regional governments). Within the context of the global estimate, retroactive revisions or updates are made to reflect the latest data. The funding for expenditure on research and experimental development carried out in Austria is presented in accordance with the definitions of the Frascati Manual, which is valid around the world (OECD, EU) and thus ensures international comparability.

318 GBARD: Government Budget Allocations for Research and Development.

- Promotion of general knowledge advancement: 28.1%
- Promotion of trade, commerce, and industry: 26.5%
- Promotion of the health care system: 19.6%
- Promotion of social and socio-economic development: 5.6%
- Promotion of research covering the earth, the seas, the atmosphere, and space: 4.4%
- Promotion of energy production, storage and distribution: 4.2%

R&D expenditure of the regional governments

The research funding by the regional governments shown as a subtotal in Table A-1 is listed from the regional government budget-based estimates of R&D expenditure and financial statements as reported by the offices of the regional governments. The R&D expenditures of the regional hospitals are estimated annually by Statistics Austria according to a methodology agreed with the offices of the regional governments.

An international comparison of R&D expenditure in 2019

The overview in Table A-10 shows Austria's position compared to the other European Union Member States and other countries in terms of the most important R&D-related indices (source: Eurostat). Detailed information on R&D funding and R&D implementation by economic sector as well as on R&D employees is only available to use in international comparisons for the year 2019.

List of Tables in the Statistical Annex

Table A-1: Global estimate for 2022: Gross domestic expenditure on R&D funding of research and experimental development carried out in Austria, 2008–2022

Funding	2008	2009 [1]	2010	2011 [1]	2012	2013 [1]	2014	2015 [1]	2016	2017 [1]	2018	2019 [1]	2020	2021	2022
1. Gross domestic expenditure on R&D (in € millions)	**7,548.06**	**7,479.75**	**8,066.44**	**8,276.34**	**9,287.84**	**9,571.28**	**10,275.18**	**10,499.15**	**11,145.02**	**11,289.78**	**11,912.00**	**12,441.23**	**12,199.02**	**12,951.77**	**14,150.56**
Funded by:															
Federal government [1]	2,016.20	2,042.83	2,257.58	2,232.63	2,410.22	2,383.70	2,592.80	2,528.17	2,825.34	2,681.89	2,954.62	2,848.37	3,321.13	3,459.18	3,903.50
Research premium [2]	340.58	254.63	328.85	381.66	574.05	468.98	493.23	508.02	527.67	637.48	713.05	841.45	1,048.54	890.39	1,000.00
Regional governments [3]	354.35	273.37	405.17	298.71	416.31	307.45	461.59	344.97	445.78	392.66	500.57	464.38	568.68	590.20	613.30
Business enterprise sector [4]	3,480.57	3,520.02	3,639.35	3,820.90	4,243.33	4,665.75	4,901.28	5,222.22	5,377.52	5,532.82	5,610.62	5,982.34	5,026.22	5,659.54	6,156.57
Abroad [4]	1,240.53	1,255.93	1,297.63	1,401.67	1,495.94	1,590.21	1,663.95	1,737.69	1,802.16	1,874.27	1,944.37	2,110.77	2,022.80	2,121.35	2,224.70
Other [5]	115.83	132.97	137.86	140.77	147.99	155.19	162.33	158.08	166.55	170.66	188.77	193.93	211.65	231.11	252.48
2. Nominal GDP [6] (in € billions)	293.76	288.04	295.90	310.13	318.65	323.91	333.15	344.27	357.61	369.36	385.42	397.52	379.322	403.37	433.65
3. Gross domestic expenditure on R&D as % of GDP	***2.57***	***2.60***	***2.73***	***2.67***	***2.91***	***2.95***	***3.08***	***3.05***	***3.12***	***3.06***	***3.09***	***3.13***	***3.22***	***3.21***	***3.26***

Date: 22 April 2022.

Source: Statistics Austria. On the basis of funding data from R&D carried out in Austria. Data as at: April 2022.

1) 2009, 2011, 2013, 2015, 2017, 2019: Survey results (federal government including the Austrian Science Fund (FWF), the Austrian Research Promotion Agency (FFG) and National Foundation for Research, Technology and Development). 2008, 2010, 2012: Annex T of the Federal Finances Acts (in each case Part b, Cash Flow Statement); 2014, 2016, 2018, 2020: Detailed overview of research-related appropriation of federal funds for the Federal Finances Acts (in each case Part b, Cash Flow Statement); 2021, 2022: Detailed overview of research-related appropriation of federal funds for the Federal Finances Act 2022 (Part b, Cash Flow Budget).
   2008: Including €91.0 million National Foundation for Research, Technology and Development.
   2010: Including €74.6 million National Foundation for Research, Technology and Development.
   2012: 2012 Including €51.3 million National Foundation for Research, Technology and Development.
   2014: Including €38.7 million National Foundation for Research, Technology and Development.
   2016: Including €51.7 million National Foundation for Research, Technology and Development.
   2018: Including €141.0 million National Foundation for Research, Technology and Development.
   2020: Including €140.4 million National Foundation for Research, Technology and Development.
   2022: Including €140.0 million National Foundation for Research, Technology and Development.

2) 2009, 2011, 2013, 2015; 2017, 2019: Survey results. 2008, 2010, 2012, 2014, 2016, 2018, 2020, 2021, 2022: Source: Federal Ministry of Finance (BMF).

3) 2009, 2011, 2013, 2015, 2017, 2019: Survey results. 2008, 2010, 2012, 2014, 2016, 2018, 2020, 2021, 2022: Based on the R&D expenditure reported by the offices of the regional governments. (Landesrechnungsabschlüsse, Cash Flow Budget 2021 and 2022).

4) 2009, 2011, 2013, 2015, 2017, 2019: Survey results. 2008, 2010, 2012, 2014, 2016, 2018, 2020, 2021, 2022: Estimate by Statistics Austria.

5) Financing by local governments (excluding Vienna), chambers, social insurance institutions, higher education sector and other public funding and funding from the private non-profit sector.
   2009, 2011, 2013, 2015, 2017, 2019: Survey results. 2008, 2010, 2012, 2014, 2016, 2018, 2020, 2021, 2022: Estimate by Statistics Austria.

6) 2006–2021: Statistics Austria. 2022: Austrian Institute of Economic Research (WIFO), economic forecast. Date: April 2022.

Table A-2: Global estimate for 2022: Gross domestic expenditure on R&D funding of research and experimental development carried out in Austria as a percentage of GDP, 2008–2022

Funding	2008	2009 [1]	2010	2011 [1]	2012	2013 [1]	2014	2015 [1]	2016	2017 [1]	2018	2019 [1]	2020	2021	2022
1. Gross domestic expenditure on R&D (in € millions)	**2.57**	**2.60**	**2.73**	**2.67**	**2.91**	**2.95**	**3.08**	**3.05**	***3.12***	***3.06***	***3.09***	***3.13***	***3.22***	***3.21***	***3.26***
Funded by:															
Federal government [1]	0.69	0.71	0.76	0.72	0.76	0.74	0.78	0.73	0.79	0.73	0.77	0.72	0.88	0.86	0.90
Research premium [2]	0.12	0.09	0.11	0.12	0.18	0.14	0.15	0.15	0.15	0.17	0.19	0.21	0.28	0.22	0.23
Regional governments [3]	0.12	0.09	0.14	0.10	0.13	0.09	0.14	0.10	0.12	0.11	0.13	0.12	0.15	0.15	0.14
Business enterprise sector [4]	1.18	1.22	1.23	1.23	1.33	1.44	1.47	1.52	1.50	1.50	1.46	1.50	1.33	1.40	1.42
Abroad [4]	0.42	0.44	0.44	0.45	0.47	0.49	0.50	0.50	0.50	0.51	0.50	0.53	0.53	0.53	0.51
Other [5]	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06
2. Nominal GDP [6] (in € billions)	**293.76**	**288.04**	**295.90**	**310.13**	**318.65**	**323.91**	**333.15**	**344.27**	**357.61**	**369.36**	**385.42**	**397.52**	**379.32**	**403.37**	**433.65**

Date: 22 April 2022.

Source: Statistics Austria. On the basis of funding data from R&D carried out in Austria. Data as at: April 2022.

Footnotes: see Table A-1

Table A-3: Federal expenditure on research and research promotion, 2018–2021

Ministries[1]	Cash Flow Statement				Cash Flow Budget			
	2019[2]		2020[3]		2021[3]		2022[3]	
	€ millions	%	€ millions	%	€ millions	%	€ millions	%
Federal Chancellery (BKA)[4]	40.816	*1.4*	1.298	*0.0*	2.486	*0.1*	2.871	*0.1*
Federal Ministry for the Civil Service and Sport (BMÖDS)	-	-	.	.	.	.	.	.
Federal Ministry of Arts, Culture, Civil Service and Sport (BMKÖS)	.	.	49.851	*1.5*	46.639	*1.3*	50.441	*1.3*
Federal Ministry for Europe, Integration and Foreign Affairs (BMEIA)	2.803	*0.1*	.	.	.	.	.	.
Federal Ministry for European and International Affairs (BMEIA)	.	.	2.854	*0.1*	3.325	*0.1*	3.244	*0.1*
Federal Ministry of Labour, Social Affairs, Health and Consumer Protection (BMASGK)	12.938	*0.4*	.	.	.	.	.	.
Federal Ministry of Labour, Family and Youth (BMAFJ)	.	.	5.688	*0.2*	.	.	.	.
Federal Ministry of Layour and Economy (BMAW, formerly BMDW)	.	.	.	.	6.430	*0.2*	6.430	*0.2*
Federal Ministry of Social Affairs, Health, Care and Consumer Protection (BMSGPK)	.	.	7.581	*0.2*	8.732	*0.2*	9.479	*0.2*
Federal Ministry of Education, Science and Research (BMBWF)	2,314.871	*76.9*	2,433.458	*74.0*	2,666.156	*74.8*	2,826.001	*73.2*
Federal Ministry of Labour and Economy (BMAW)	105.462	*3.5*	112.758	*3.4*	115.656	*3.2*	170.506	*4.4*
Federal Ministry of Finance (BMF)	29.594	*1.0*	28.838	*0.9*	31.520	*0.9*	32.756	*0.8*
Federal Ministry of the Interior (BMI)	1.126	*0.0*	1.757	*0.1*	1.942	*0.1*	1.859	*0.0*
Federal Ministry of Defence (BMLV)	2.130	*0.1*	2.138	*0.1*	1.981	*0.1*	3.945	*0.1*
Federal Ministry for Sustainability and Tourism (BMNT)	40.335	*1.3*	.	.	.	.	.	.
Federal Ministry of Agriculture, Regions and Tourism (BMLRT)	.	.	43.572	*1.3*	49.141	*1.4*	70.298	*1.8*
Federal Ministry of Justice (BMJ)	.	.	0.036	*0.0*	0.064	*0.0*	0.139	*0.0*
Federal Ministry of Constitutional Affairs, Reforms, Deregulation and Justice (BMVRDJ)	0.046	*0.0*	.	.	.	.	.	.
Federal Ministry for Transport, Innovation and Technology (BMVIT)	459.523	*15.3*	.	.	.	.	.	.
Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK)	.	.	597.245	*18.2*	627.342	*17.6*	690.027	*17.8*
Total	**3,009.644**	***100.0***	**3,287.074**	***100.0***	**3,561.414**	***100.0***	**3,867.996**	***100.0***

Date: March 2022.

Source: Statistics Austria.

1) In accordance with the applicable version of the Federal Ministries Act 1986 (2019: Federal Law Gazette I No. 164/2017; 2020: Federal Law Gazette I No. 8/2020; 2021, 2022: Federal Law Gazette I No. 30/2021).

2) Federal Finances Act 2021 (BFG), Detailed overview of research-related appropriation of federal funds.

3) Federal Finances Act 2022 (BFG), Detailed overview of research-related appropriation of federal funds.

4) Including the highest executive bodies.

Table A-4: Detailed overview of research-related appropriation of federal funds, 2020 to 2022

Detailed overview of research-related appropriation of federal funds

Research-related federal expenditure by ministerial departments, 2020 to 2022

The following overviews are structured according to:

1. Contributions from federal funds to international organisations that have research and research promotion as (one of) their objectives **(Part a)**

2. Federal budget expenditure on research and research promotion in Austria **(Part b, Federal budget for research)**

For the compilation of these expenditures, the decisive aspect is the extent to which an expenditure is research-related, based on the definition of research in the OECD's Frascati Manual. The same definition is also applied by Statistics Austria for its research and experimental development (R&D) surveys.

BUNDESVORANSCHLAG 2022

Detailübersicht Forschungswirksame Mittelverwendungen des Bundes

(Beträge in Millionen Euro)

a) Beitragszahlungen an internationale Organisationen - Finanzierungsvoranschlag

VA-Stelle	Konto	UgI	Bezeichnung	Anm	Finanzierungsvoranschlag 2022			Finanzierungsvoranschlag 2021			Erfolg 2020		
					Insgesamt	hievon		Insgesamt	hievon		Insgesamt	hievon	
						%	Forschung		%	Forschung		%	Forschung
			Bundeskanzleramt										
			UG10										
10010100	7800	100	Mitgliedsbeiträge an Institutionen im Ausland		0,143	100	0,143	0,119	100	0,119	0,115	100	0,115
10010100	7800	110	Mitgliedsbeitrag AV-Infostelle		0,035	5	0,002	0,032	5	0,002	0,031	5	0,002
10010200	7800	100	Mitgliedsbeiträge an Institutionen im Ausland		0,007	30	0,002	0,006	30	0,002	0,007	30	0,002
10010402	7800	100	Mitgliedsbeiträge an Institutionen im Ausland	*	0,012	100	0,012	0,012	100	0,012	0,022	100	0,022
			Summe UG10		**0,197**		**0,159**	**0,169**		**0,135**	**0,175**		**0,141**
			Summe Bundeskanzleramt		**0,197**		**0,159**	**0,169**		**0,135**	**0,175**		**0,141**
			BM für europäische und internationale Angelegenheiten										
			UG12										
12020200	7800	101	Mitgliedsbeitrag für OECD	*	4,113	35	1,440	4,048	35	1,417	3,885	20	0,777
12020200	7800	102	OECD-Energieagentur (Mitgliedsbeitrag)	*					20				
12020200	7840	000	Laufende Transfers an Drittländer		2,689	35	0,941	2,750	35	0,963	3,124	35	1,093
12020200	7840	002	Organisation der VN für industr.Entwicklung(UNIDO)		0,660	46	0,304	0,660	46	0,304	0,659	46	0,303
12020200	7840	003	Org. VN Erziehung,Wissensch.u.Kultur(UNESCO)		1,620	30	0,486	2,000	30	0,600	2,026	30	0,608
12020200	7840	056	Drogenkontrollprogramm der VN (UNDCP)		0,726	10	0,073	0,406	10	0,041	0,728	10	0,073
			Summe UG12		**9,808**		**3,244**	**9,864**		**3,325**	**10,422**		**2,854**
			Summe BM für europäische und internationale Angelegenheiten		**9,808**		**3,244**	**9,864**		**3,325**	**10,422**		**2,854**
			BM für Finanzen										
			UG15										
15010100	7800	000	Laufende Transferzahlungen an das Ausland		0,151	100	0,151	0,151	100	0,151	0,100	100	0,100
			Summe UG15		**0,151**		**0,151**	**0,151**		**0,151**	**0,100**		**0,100**
			Summe BM für Finanzen		**0,151**		**0,151**	**0,151**		**0,151**	**0,100**		**0,100**
			BM für Bildung, Wissenschaft und Forschung										
			UG30										
30010300	7800	104	OECD-Schulbauprogramm		0,031	100	0,031	0,031	100	0,031			
30010400	7800	000	Laufende Transferzahlungen an das Ausland	*	0,435	100	0,435	0,435	100	0,435	0,459	100	0,459
			Summe UG30		**0,466**		**0,466**	**0,466**		**0,466**	**0,459**		**0,459**
			UG31										
31030100	7800	000	Laufende Transferzahlungen an das Ausland		0,800	100	0,800	0,800	100	0,800	0,778	100	0,778
31030100	7800	066	Forschungsvorhaben in internationaler Kooperation		0,201	100	0,201	0,003	100	0,003	0,181	100	0,181
31030100	7800	200	Beiträge an internationale Organisationen		2,012	50	1,006	1,340	50	0,670	1,182	50	0,591
31030204	7800	062	ESO		6,200	100	6,200	6,100	100	6,100	6,925	100	6,925
31030204	7800	063	Europ. Zentrum für mittelfristige Wettervorhersage		1,300	100	1,300	1,300	100	1,300	1,156	100	1,156
31030204	7800	064	Molekularbiologie - Europäische Zusammenarbeit		3,521	100	3,521	3,133	100	3,133	2,952	100	2,952
31030204	7800	065	World Meteorological Organisation		0,550	50	0,275	0,550	50	0,275	0,426	50	0,213
31030204	7800	200	Beiträge an internationale		0,900	50	0,450	0,885	50	0,443	0,871	50	0,436

			Organisationen										
31030204	7800	242	Beitrag für die CERN		25,200	100	25,200	24,231	100	24,231	23,598	100	23,598
			Summe UG31		**40,684**		**38,953**	**38,342**		**36,955**	**38,069**		**36,830**
			Summe BM für Bildung, Wissenschaft und Forschung		**41,150**		**39,419**	**38,808**		**37,421**	**38,528**		**37,289**
			BM für Digitalisierung und Wirtschaftsstandort										
			UG40										
40020100	7800	100	Mitgliedsbeiträge an Institutionen im Ausland		0,735	15	0,110	0,735	15	0,110	0,419	15	0,063
			Summe UG40		**0,735**		**0,110**	**0,735**		**0,110**	**0,419**		**0,063**
			Summe BM für Digitalisierung und Wirtschaftsstandort		**0,735**		**0,110**	**0,735**		**0,110**	**0,419**		**0,063**
			BM für Klimaschutz, Umwelt, Energie, Mobil., Innov. u.Technologie										
			UG34										
34010100	7800	200	Beiträge an internationale Organisationen		0,070	100	0,070	0,070	100	0,070	0,055	100	0,055
34010100	7800	488	Transferzahlungen an ESA Covid-19								6,000	100	6,000
34010100	7800	600	ESA-Pflichtprogramme		19,462	100	19,462	19,462	100	19,462	18,462	100	18,462
34010100	7800	601	EUMETSAT		8,801	100	8,801	8,801	100	8,801	8,653	100	8,653
34010100	7800	602	OECD-Energieagentur		0,050	100	0,050	0,050	100	0,050	0,045	100	0,045
34010100	7800	603	ESA-Wahlprogramme		30,616	100	30,616	30,616	100	30,616	30,616	100	30,616
34010100	7830	000	Laufende Transfers an Drittländer		0,195	100	0,195	0,195	100	0,195	0,170	100	0,170
			Summe UG34		**59,194**		**59,194**	**59,194**		**59,194**	**64,001**		**64,001**
			UG41										
41010100	7800	200	Beiträge an internationale Organisationen		0,110	6	0,007	0,110	6	0,007	0,116	6	0,007
41010300	7830	000	Laufende Transfers an Drittländer		0,319	100	0,319				0,318	100	0,318
41020100	7800	200	Beiträge an internationale Organisationen		0,020	100	0,020	0,020	100	0,020		100	
41020402	7800	200	Beiträge an internationale Organisationen		0,066	15	0,010	0,066	15	0,010	0,063	15	0,009
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	0,398	15	0,060
41020601	7800	200	Beiträge an internationale Organisationen		0,050	50	0,025	0,050	50	0,025	0,036	50	0,018
41020700	7800	200	Beiträge an internationale Organisationen						20		0,162	20	0,032
			Summe UG41		**1,077**		**0,458**	**0,758**		**0,139**	**1,128**		**0,449**
			Summe BM für Klimaschutz, Umwelt, Energie, Mobil., Innov. u.Technologie		**60,271**		**59,652**	**59,952**		**59,333**	**65,129**		**64,450**
			BM für Landwirtschaft, Regionen und Tourismus										
			UG42										
42010100	7800	100	Mitgliedsbeiträge an Institutionen im Ausland					0,003	50	0,002	0,003	50	0,002
42020202	7800	080	FAO-Beiträge	*				3,400	51	1,734	2,777	51	1,416
42020202	7800	083	Int. Vertrag für pflanzengenetische Ressourcen					0,025	100	0,025	0,025	100	0,025
42040100	7800	100	Mitgliedsbeiträge an Institutionen im Ausland		0,003	50	0,002						
420503			FAO-Beiträge		3,400	51	1,734						
42050300	7800	083	Int. Vertrag für pflanzengenetische Ressourcen		0,025	100	0,025						
			Summe UG42		**3,428**		**1,761**	**3,428**		**1,761**	**2,805**		**1,443**
			Summe BM für Landwirtschaft, Regionen und Tourismus		**3,428**		**1,761**	**3,428**		**1,761**	**2,805**		**1,443**
			Teil a -Summe		**115,740**		**104,496**	**113,107**		**102,236**	**117,578**		**106,340**

b) Bundesbudget Forschung - Finanzierungsvoranschlag
(ausgen. die bereits im Abschnitt a) ausgewiesen sind)

VA-Stelle	Konto	Ugl	Bezeichnung	Anm	Finanzierungsvoranschlag 2022			Finanzierungsvoranschlag 2021			Erfolg 2020		
					Insgesamt	hievon		Insgesamt	hievon		Insgesamt	hievon	
						%	Forschung		%	Forschung		%	Forschung
			Parlamentsdirektion										
			UG02										
02010500	7330	086	Nationalfonds für Opfer des Nationalsozialismus	*	2,309	5	0,115	1,321	4	0,053	1,912	5	0,096
			Summe UG02		**2,309**		**0,115**	**1,321**		**0,053**	**1,912**		**0,096**
			Summe Parlamentsdirektion		**2,309**		**0,115**	**1,321**		**0,053**	**1,912**		**0,096**
			Bundeskanzleramt										
			UG10										
10010100	7260	000	Mitgliedsbeiträge an Institutionen im Inland		0,011	28	0,003	0,010	28	0,003	0,008	28	0,002
10010100	7270	000	Werkleistungen durch Dritte		1,260	4	0,050	0,320	4	0,013	0,989	4	0,040
10010200	7260	000	Mitgliedsbeiträge an Institutionen im Inland			50			50		0,005	50	0,003
10010200	7270	000	Werkleistungen durch Dritte		3,935	4	0,157	4,312	4	0,172	1,918	4	0,077
10010401	7340	001	Pauschalabgeltung gem. § 32 Abs.5 BStatG		50,141	1	0,501	50,111	1	0,501	50,018	1	0,500
10010402			Österr. Staatsarchiv		15,171	3	0,455	15,171	3	0,455	14,637	3	0,439
			Summe UG10		**70,518**		**1,166**	**69,924**		**1,144**	**67,575**		**1,061**
			UG25										
25010500	7270	006	Werkleistungen durch Dritte (zw)		0,824	74	0,610	0,509	90	0,458	0,612	51	0,312
25010500	7420	313	Familie und Beruf Management GesmbH Förd. (zw)	*	0,940	74	0,696	0,940	74	0,696	1,100	64	0,704
25020100	7270	000	Werkleistungen durch Dritte		0,738	17	0,125				0,309		
25020200	7270	000	Werkleistungen durch Dritte								1,343	2	0,027
			Summe UG25		**2,502**		**1,431**	**1,449**		**1,154**	**3,364**		**1,043**
			Summe Bundeskanzleramt		**73,020**		**2,597**	**71,373**		**2,298**	**70,939**		**2,104**
			BM für Inneres										
			UG11										
11010200	7270	900	Werkleistungen durch Dritte	*	0,015	100	0,015				0,040	100	0,040
11010200	7281	310	AMIF Sonstige Werkleistungen (EU/zw)	*							0,020	100	0,020
11020600			Bundeskriminalamt	*	16,123	8	1,290	14,906	8	1,192	13,832	8	1,107
11020600	7270	900	Werkleistungen durch Dritte	*							0,036	100	0,036
11020800	7270	900	Werkleistungen durch Dritte	*	0,039	100	0,039	0,039	100	0,039	0,039	100	0,039
			Summe UG11		**16,177**		**1,344**	**14,945**		**1,231**	**13,967**		**1,242**
			UG18										
18010100	7660	900	Zuschüsse f. lfd. Aufwand an private Institutionen	*									
18010100	7670	309	Projekte des AMIF (EU) (zw)	*		100		0,315	100	0,315	0,260	100	0,260
18010100	7672	009	Projekte des AMIF (Kofinanzierung)	*		100		0,396	100	0,396	0,255	100	0,255
18010400	7670	309	Projekte des AMIF (EU) (zw)	*	0,260	100	0,260						
18010400	7672	009	Projekte des AMIF (Kofinanzierung)	*	0,255	100	0,255						
			Summe UG18		**0,515**		**0,515**	**0,711**		**0,711**	**0,515**		**0,515**
			Summe BM für Inneres		**16,692**		**1,859**	**15,656**		**1,942**	**14,482**		**1,757**
			BM für Justiz										
			UG13										
13010100	6430	000	Sonstige Beratungskosten	*	0,188	50	0,094	0,127	50	0,064	0,071	50	0,036
13030101	6430	000	Sonstige Beratungskosten	*	0,075	60	0,045						
			Summe UG13		**0,263**		**0,139**	**0,127**		**0,064**	**0,071**		**0,036**
			Summe BM für Justiz		**0,263**		**0,139**	**0,127**		**0,064**	**0,071**		**0,036**
			BM für Landesverteidigung										
			UG14										
14040100			Heeresgeschichtliches Museum	*	3,927	37	1,453	3,765	15	0,565	2,281	37	0,844
14050100	7270	000	Werkleistungen durch Dritte	*	0,200	58	0,116	0,200	58	0,116	0,070	58	0,041
14050100	7270	900	Werkleistungen durch Dritte	*	2,376	100	2,376	1,300	100	1,300	1,240	100	1,240
14050100	7411	028	FFG - Verteidigungsforschung						100			100	
14050202	4691	000	Versuche und Erprobungen auf kriegstechn. Gebiet						10		0,132	10	0,013

			Summe UG14		**6,503**		**3,945**	**5,265**		**1,981**	**3,723**		**2,138**
			Summe BM für Landesverteidigung		**6,503**		**3,945**	**5,265**		**1,981**	**3,723**		**2,138**
			BM für Finanzen										
			UG15										
15010100	6430	001	Arbeiten des WIIW		0,919	50	0,460	0,892	50	0,446	0,777	50	0,389
15010100	6430	002	Arbeiten des WSR		1,412	50	0,706	1,371	50	0,686	1,371	50	0,686
15010100	6430	003	Arbeiten des Wifo		4,653	52	2,420	4,520	52	2,350	4,329	52	2,251
15010100	7270	000	Werkleistungen durch Dritte	*	1,713	18	0,308	1,662	18	0,299	1,369	34	0,465
15010100	7661	002	Institut für Finanzwissenschaft und Steuerrecht										
15010100	7662	002	Institut für höhere Studien und wiss. Forschung	*	4,235	56	2,372	3,920	56	2,195	3,623	56	2,029
15010100	7669	020	Sonstige Förderungsbeiträge	*	0,400	100	0,400	0,400	100	0,400	0,353	100	0,353
			Forschungswirksamer Lohnnebenkostenanteil		25,939	100	25,939	24,993	100	24,993	22,565	100	22,565
			Summe UG15		**39,271**		**32,605**	**37,758**		**31,369**	**34,387**		**28,738**
			Summe BM für Finanzen		**39,271**		**32,605**	**37,758**		**31,369**	**34,387**		**28,738**
			BM für Kunst, Kultur, öffentlichen Dienst und Sport										
			UG17										
17020100	7411	071	Bundesinst. für Sporttechnologie/Training		2,500	100	2,500	2,500	100	2,500			
17020100	7672	132	Sporttechnologie Projekte		6,000	100	6,000	5,000	100	5,000	6,477	89	5,765
			Summe UG17		**8,500**		**8,500**	**7,500**		**7,500**	**6,477**		**5,765**
			UG32										
32010300			Denkmalschutz		42,181	18	7,593	39,811	18	7,166	37,136	18	6,684
32030100			Bundesmuseen		137,390	25	34,348	127,890	25	31,973	149,609	25	37,402
			Summe UG32		**179,571**		**41,941**	**167,701**		**39,139**	**186,745**		**44,086**
			Summe BM für Kunst, Kultur, öffentlichen Dienst und Sport		**188,071**		**50,441**	**175,201**		**46,639**	**193,222**		**49,851**
			BM für Arbeit										
			UG20										
20010101	7340	302	Überweisung an das AMS gem. § 41 (2) (zw)	*	622,311	1	5,250	588,834	1	5,250	550,000	1	4,384
20010201	7270	006	Werkleistungen durch Dritte (zw)	*	433,590		0,700	378,500		0,700	359,475		0,257
20010201	7668	900	Gemeinnützige Einrichtungen (zw)	*	110,000		0,400	103,650		0,400	115,112		
20010202	7270	000	Werkleistungen durch Dritte	*	6,500	1	0,080	6,500	1	0,080	5,778		0,004
			Summe UG20		**1.172,401**		**6,430**	**1.077,484**		**6,430**	**1.030,365**		**4,645**
			Summe BM für Arbeit		**1.172,401**		**6,430**	**1.077,484**		**6,430**	**1.030,365**		**4,645**
			BM für Soziales, Gesundheit, Pflege und Konsumentenschutz										
			UG21										
21010100	7270	000	Werkleistungen durch Dritte		4,149	3	0,124	4,229	3	0,127	3,363	3	0,101
21010300	7270	000	Werkleistungen durch Dritte		1,251	16	0,200	1,251	16	0,200	1,031	16	0,165
21010300	7660	900	Zuschüsse f. lfd. Aufwand an private Institutionen		5,150	2	0,103	5,150	2	0,103	5,579	2	0,112
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		14,800	4	0,592	8,300	4	0,332	1,502	4	0,060
21010400	7270	304	Werkleistungen EU-SILC		1,149	100	1,149	1,149	100	1,149	1,099	100	1,099
			Summe UG21		**27,086**		**2,462**	**20,666**		**2,205**	**13,161**		**1,831**
			UG24										
24010200	7420	012	Transferzahlungen AGES		55,878	11	6,147	55,878	11	6,147	49,878	11	5,487
24030100	7270	000	Werkleistungen durch Dritte		19,164	4	0,767	6,937	4	0,277	4,160	4	0,166
24030200	7270	000	Werkleistungen durch Dritte		5,168	2	0,103	5,168	2	0,103	4,869	2	0,097
			Summe UG24		**80,210**		**7,017**	**67,983**		**6,527**	**58,907**		**5,750**
			Summe BM für Soziales, Gesundheit, Pflege und Konsumentenschutz		**107,296**		**9,479**	**88,649**		**8,732**	**72,068**		**7,581**
			BM für Bildung, Wissenschaft und Forschung										
			UG30										

30010400			Qualitätsentwicklung und -steuerung	*	68,762	8	5,501	258,058	8	20,645	34,995	8	2,800
30010500			Lehrer/innenbildung		248,500	7	17,395	240,550	10	24,055	233,783	7	16,365
30010800	7270	900	Werkleistungen durch Dritte		3,788	90	3,409	2,233	90	2,010			
30010800	7340	003	Basisabgeltung (BIFIE)			80			80		4,167	80	3,334
30020700			Zweckgebundene Gebarung Bundesschulen	*	7,709	3	0,231	8,928	3	0,268	7,709	3	0,231
			Summe UG30		**328,759**		**26,536**	**509,769**		**46,978**	**280,654**		**22,730**
			UG31										
31010100			Zentralstelle und Serviceeinrichtungen		66,021	20	13,204	58,791	20	11,758	56,571	20	11,314
31020100			Universitäten		4.095,202	50	2.047,601	3.826,615	50	1.913,308	3.638,329	50	1.819,165
31020100	7270	000	Werkleistungen durch Dritte		0,360	50	0,180	0,330	50	0,165	0,079	50	0,040
31020100	7348	788	Institute of Precision Medicine RRF		5,000	100	5,000						
31020100	7353	440	Klinischer Mehraufwand (Klinikbauten)		68,995	50	34,498	64,030	50	32,015	39,503	50	19,752
31020200			Fachhochschulen		376,057	14	52,648	369,689	16	59,150	327,565	14	45,859
31020300	7270	900	Werkleistungen durch Dritte		1,782	22	0,392	1,303	22	0,287	2,558	22	0,563
31030100			Projekte und Programme	*	2,783	100	2,783	1,790	100	1,790	10,509	100	10,509
31030100	7260	000	Mitgliedsbeiträge an Institutionen im Inland		0,171	100	0,171	0,171	100	0,171	0,068	100	0,068
31030100	7270	034	Ersatzmethoden zum Tierversuch		0,117	100	0,117		100		0,083	100	0,083
31030100	7270	900	Werkleistungen durch Dritte		10,030	100	10,030	6,721	100	6,721	5,453	100	5,453
31030100	7280	018	OeAD-Abwicklung		1,687	100	1,687	5,442	100	5,442			
31030100	7411	069	OeAD Förderungen		17,036	100	17,036	10,237	100	10,237			
31030100	7411	070	OeAD Begleitmaßnahmen		3,060	100	3,060	0,003	100	0,003			
31030100	7413	788	Quantum Austria RRF		21,000	100	21,000						
31030100	7662	311	Institut für höhere Studien und wiss. Forschung		0,040	100	0,040	0,220	100	0,220	0,193	100	0,193
31030100	7665	007	Stiftung Dokumentationsarchiv		0,650	100	0,650	0,405	100	0,405	0,405	100	0,405
31030100	7679	120	Lfd. Transfers an sonstige juristische Personen		19,332	100	19,332	18,972	100	18,972	12,207	100	12,207
31030201			Zentralanstalt für Meteorologie und Geodynamik		26,047	31	8,075	26,047	38	9,898	22,915	31	7,104
31030202			Geologische Bundesanstalt		11,502	36	4,141	11,502	41	4,716	11,173	36	4,022
31030204			Forschungsinstitutionen	*	9,640	100	9,640	8,978	100	8,978	21,386	100	21,386
31030204	7270	031	Med Austron		1,740	100	1,740	1,500	100	1,500	1,500	100	1,500
31030204	7332	352	FWF Programme		251,200	100	251,200	255,100	100	255,100	203,000	100	203,000
31030204	7332	452	FWF Geschäftsstelle		13,000	100	13,000	12,199	100	12,199	11,300	100	11,300
31030204	7332	552	FWF Begleitmaßnahmen		1,500	100	1,500	0,001	100	0,001			
31030204	7340	004	ISTA		90,800	100	90,800	80,800	100	80,800	70,272	100	70,272
31030204	7340	006	ÖAW - LV		137,190	100	137,190	137,190	100	137,190	112,376	100	112,376
31030204	7340	010	ÖAW Beauftragungen und Programme			100			100		8,814	100	8,814
31030204	7661	022	Ludwig-Boltzmann-Gesellschaft		12,331	100	12,331	9,731	100	9,731	7,054	100	7,054
31030204	7679	007	Verein der Freunde der Salzburger Stiftung		1,000	100	1,000	1,000	100	1,000	1,000	100	1,000
			Summe UG31		**5.245,273**		**2.760,046**	**4.908,767**		**2.581,757**	**4.564,313**		**2.373,439**
			Summe BM für Bildung, Wissenschaft und Forschung		**5.574,032**		**2.786,582**	**5.418,536**		**2.628,735**	**4.844,967**		**2.396,169**
			BM für Digitalisierung und Wirtschaftsstandort										
			UG33										
33010100			Kooperation Wissenschaft-Wirtschaft		38,800	100	38,800	37,000	100	37,000	41,651	100	41,651
33010200			Innovation, Technologietransfer		116,296	100	116,296	63,246	100	63,246	50,685	100	50,685
33010300			Gründung innovativer Unternehmen		15,300	100	15,300	15,300	100	15,300	17,359	100	17,359
			Summe UG33		**170,396**		**170,396**	**115,546**		**115,546**	**109,695**		**109,695**
			UG40										
40020100	7417	004	aws Creative Impact COVID-19 Sonderaktion	*							2,700	100	2,700
40020100	7417	005	aws Creative Impact COVID-19, Abwicklung	*							0,300	100	0,300
			Summe UG40								**3,000**		**3,000**
			Summe BM für Digitalisierung und Wirtschaftsstandort		**170,396**		**170,396**	**115,546**		**115,546**	**112,695**		**112,695**

			BM für Klimaschutz, Umwelt, Energie, Mobil., Innov. u.Technologie											
			UG34											
34010200	7273	788	AWS Aufbau- und Resilienzfazilität RRF Abwicklung		0,200	100	0,200							
34010200	7340	100	Rat f. Forschung und Technologieentwicklung		1,800	100	1,800	1,800	100	1,800	1,650	100	1,650	
34010200	7411	021	Important Projects of Common European Interest		24,700	100	24,700	24,700	100	24,700		100		
34010200	7411	022	Important Projects of Common European Interest-Abw		0,050	100	0,050	0,050	100	0,050		100		
34010200	7411	788	Lfd Transfers an verbundene Unternehmungen RRF		9,800	100	9,800							
34010200	7413	001	Austrian Institute of Technology AIT-Förderungen		0,010	100	0,010	0,010	100	0,010	0,025	100	0,025	
34010200	7413	002	Austrian Institute of Technology AIT		63,700	90	57,330	57,530	90	51,777	55,680	90	50,112	
34010200	7413	003	Nuclear Engineering Seibersdorf NES		7,510	30	2,253	11,220	30	3,366	6,131	30	1,839	
34010200	7413	004	Silicon Austria Labs GmbH		24,115	100	24,115	17,416	100	17,416	8,739	100	8,739	
34010200	7414	002	Austria Tech		0,850	100	0,850	0,850	100	0,850	0,878	100	0,878	
34010200	7414	788	FFG Aufbau- und Resilienzfazilität RRF Abwicklung		0,200	100	0,200							
34010200	7417	788	AWS Aufbau- und Resilienzfazilität RRF		9,800	100	9,800							
34010200	7660	075	F&T-Förderung		0,340	100	0,340	0,340	100	0,340	0,439	100	0,439	
34010200	7662	341	Joanneum Research Forsch.ges.m.b.H(Techn.schwerp)		2,559	100	2,559	2,559	100	2,559	2,559	100	2,559	
34010200	7666	005	Österreichisches Institut für Nachhaltigkeit			100			100		0,002	100	0,002	
34010200	7667	006	Sonstige gemeinnützige Einrichtungen		1,245	100	1,245	1,245	100	1,245	1,405	100	1,405	
34010200	7668	040	Salzburg Research		0,410	100	0,410	0,410	100	0,410	0,389	100	0,389	
34010200	7690	002	Preisverleihungen		0,005	100	0,005	0,005	100	0,005	0,004	100	0,004	
34010300	7260	000	Mitgliedsbeiträge an Institutionen im Inland		0,180	100	0,180	0,160	100	0,160	0,188	100	0,188	
34010300	7270	000	Werkleistungen durch Dritte		2,200	100	2,200	2,120	100	2,120	3,784	100	3,784	
34010300	7280	030	FTI-Projekte, Beauftragungen an Dritte		0,500	100	0,500	1,000	100	1,000	0,769	100	0,769	
34010300	7411	001	FFG - Basisprogramme		135,000	100	135,000	145,000	100	145,000	95,700	100	95,700	
34010300	7411	002	FFG - FTI-Programme, Förderungen		178,655	100	178,655	182,655	100	182,655	149,977	100	149,977	
34010300	7411	003	FFG - FTI-Programme (F&E-Dienstleist.,Sonst.WV)		9,066	100	9,066	10,000	100	10,000	2,976	100	2,976	
34010300	7411	004	FFG - Administrative Kosten		21,775	100	21,775	20,000	100	20,000	17,208	100	17,208	
34010300	7411	488	FFG Covid-19								74,823	100	74,823	
34010300	7412	001	Austria Wirtschaftsservice GmbH AWS - Förderungen		24,130	100	24,130	22,000	100	22,000	15,988	100	15,988	
34010300	7412	003	Austria Wirtschaftsservice GmbH AWS - Admin.Kost.		2,370	100	2,370	0,500	100	0,500	0,839	100	0,839	
34010300	7417	488	aws COVID-19 Startup Hilfsfonds		0,064	100	0,064				12,192	100	12,192	
34010300	7432	030	FTI-Projekte, Förderungen		0,250	100	0,250	0,250	100	0,250	0,206	100	0,206	
			Summe UG34		**521,484**		**509,857**	**501,820**		**488,213**	**452,551**		**442,691**	
			UG41											
41010200	7330	080	Transferzahlungen an Klima- und Energiefonds	*	67,400	95	64,030	47,000	95	44,650	54,275	95	51,561	
41010200	7331	488	KLIEN Covid-19								32,000	95	30,400	
41020100	7270	000	Werkleistungen durch Dritte		3,030	50	1,515	1,727	50	0,864	1,101	50	0,551	
41020100	7270	800	Dekarbonisierung/E-Mobilität		81,622	45	36,730	30,200	45	13,590	0,190	45	0,086	
41020100	7270	801	E-Mobilität für alle: Urbane Elektromobilität		0,001	20		0,001	20			20		
41020100	7411	002	FFG - FTI-Programme, Förderungen		1,000	100	1,000	1,000	100	1,000		100		
41020100	7411	003	FFG - FTI-Programme (F&E-Dienstleist.,Sonst.WV)		0,010	100	0,010	0,010	100	0,010		100		
41020100	7411	004	FFG - Administrative Kosten		0,010	100	0,010	0,010	100	0,010		100		
41020100	7480	501	Progr.Kombinierter		4,300	50	2,150	4,300	50	2,150	2,261	50	1,131	

			Güterverk.Straße-Schiene-Schiff											
41020100	7660	000	Zuschüsse f. lfd. Aufwand an private Institutionen		1,030	95	0,979	1,030	95	0,979	0,005	95	0,005
41020100	7668	055	Technisches Museum Wien		0,601	80	0,481	0,601	80	0,481	0,336	80	0,269
41020300	7411	002	FFG - FTI-Programme, Förderungen										
41020300	7411	004	FFG - Administrative Kosten										
41020300	7489	001	Breitbandinitiative (admin. Aufwand)										
41020300	7489	002	Breitband - Förderungen										
41020402	7270	000	Werkleistungen durch Dritte		1,464	5	0,073	0,964	5	0,048	0,551	5	0,028
41020402	7270	006	Werkleistungen durch Dritte (zw)		1,500	5	0,075	2,000	5	0,100	1,342	5	0,067
			Summe UG41		**161,968**		**107,053**	**88,843**		**63,882**	**92,061**		**84,098**
			UG43										
43010200	7700	500	Investitionszuschüsse		95,314	1	0,953	74,337	1	0,743	56,586	1	0,566
43010300			Klima- und Energiefonds		98,400	12	11,808	113,800	12	13,656	35,875	12	4,305
43010500			Klima und Energie	*				82,614	1	0,826	58,718	1	0,587
43010500	7270	080	Forschungsaufwendungen		0,100	100	0,100	0,240	100	0,240	0,099	100	0,099
43010500	7420	021	Transferzahlungen an die UBA Ges.m.b.H					14,956	3	0,449	14,956	3	0,449
43020100	7270	080	Forschungsaufwendungen		0,155	100	0,155						
43020100	7420	021	Transferzahlungen an die UBA Ges.m.b.H		14,956	3	0,449						
			Summe UG43		**208,925**		**13,465**	**285,947**		**15,914**	**166,234**		**6,006**
			Summe BM für Klimaschutz, Umwelt, Energie, Mobil., Innov. u.Technologie		**892,377**		**630,375**	**876,610**		**568,009**	**710,846**		**532,795**
			BM für Landwirtschaft, Regionen und Tourismus										
			UG42										
42010100			Zentralstelle	*				0,270	100	0,270	0,294	100	0,294
42010200	7411	000	Lfd Transfers an verbundene Unternehmungen	*							37,301	33	12,309
42010200	7411	027	Lfd Transfers an Ernährungsagentur-AGES					21,803	33	7,195			
42010200	7411	029	Lfd Transf.an Bundesamt u. Forschungszentr.f.Wald					15,500	33	5,115			
42020300			Forschung und Sonstige Maßnahmen	*				3,000	100	3,000	2,678	100	2,678
42020401			Landwirtschaftliche Schulen	*				70,908	23	16,309	48,303	25	12,076
42020402			Landwirtschaftliche Hochschule					5,521	3	0,166	5,517	3	0,166
42020403			Landwirtschaftliche Bundesanstalten					3,670	65	2,386	3,498	65	2,274
42020405			HBLA u. Forschungsanst. f. Landw. Ernähr., Lebensm.- u. Biotechn. Tirol	*					1		13,528	1	0,135
42020501			HBLA für Wein- und Obstbau Klosterneuburg					10,621	30	3,186	10,333	30	3,100
42020502			Bundesamt für Weinbau					5,500	3	0,165	5,515	3	0,165
42020900	7411	002	FFG - FTI-Programme, Förderungen					4,920	100	4,920	4,417	100	4,417
42020900	7411	003	FFG - FTI-Programme (F&E-Dienstleist.,Sonst.WV)					1,230	100	1,230	0,525	100	0,525
42020900	7411	004	FFG - Administrative Kosten					1,000	100	1,000	0,607	100	0,607
42030101	7270	000	Werkleistungen durch Dritte					1,322	20	0,264	0,303	20	0,061
42030104			Forschung und Sonstige Maßnahmen Forst	*				0,300	100	0,300	0,660	100	0,660
42030204	7270	000	Werkleistungen durch Dritte	*				0,010	100	0,010	0,310	100	0,310
42030205			Bundesamt für Wasserwirtschaft					5,740	25	1,435	6,269	25	1,567
42030206			Siedlungswasserwirtschaft	*				0,429	100	0,429	0,785	100	0,785
42040100			Zentralstelle		4,464	100	4,464						
42040200	7411	027	Lfd Transfers an Ernährungsagentur-AGES	*	21,803	33	7,195						
42040200	7411	029	Lfd Transf.an Bundesamt u. Forschungszentr.f.Wald		15,500	33	5,115						
42040400	7411	002	FFG - FTI-Programme, Förderungen		4,920	100	4,920						
42040400	7411	003	FFG - FTI-Programme (F&E-Dienstleist.,Sonst.WV)		1,230	100	1,230						
42040400	7411	004	FFG - Administrative Kosten		1,000	100	1,000						

42040500			Land- und forstwirtschaftliches Schulwesen	*	87,050	23	20,022						
42050300	7660	022	Nationale Agrarmaßnahmen		0,054	100	0,054						
420504			Dienststellen Landwirtschaft		3,815	65	2,480						
42050400			Bundesamt für Weinbau	*	5,730	3	0,172						
42060100	7270	000	Werkleistungen durch Dritte		0,534								
42060200			Nationale und internat. Forstmaßnahmen	*	20,300	100	20,300						
42060400	7270	000	Werkleistungen durch Dritte	*	0,010	100	0,010						
42060500			Bundesamt für Wasserwirtschaft		6,300	25	1,575						
42060600			Siedlungswasserwirtschaft	*	0,800								
			Summe UG42		**173,510**		**68,537**	**151,744**		**47,380**	**140,843**		**42,129**
			Summe BM für Landwirtschaft, Regionen und Tourismus		**173,510**		**68,537**	**151,744**		**47,380**	**140,843**		**42,129**
			Teil b -Summe		**8.416,141**		**3.763,500**	**8.035,270**		**3.459,178**	**7.230,520**		**3.180,734**
			Gesamtsumme Teil a + b		**8.531,881**		**3.867,996**	**8.148,377**		**3.561,414**	**7.348,098**		**3.287,074**

BUNDESVORANSCHLAG 2022

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 Statistk 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 für den FV 2022 liegt bei 4,55%, für den FV 2021 bei 3,79% und für den Erfolg 2020 bei 4,50% (System rundet).
			Bundeskanzleramt
10010402	7800	100	*) jährlicher Betrag des österreichischen Staatsarchivs an den Internationalen Archivbeirat (neu seit BVA 2020).
25010500	7270	006	
25010500	7420	313	Die Budgetposition wurde erst 2018 eröffnet, um die Zahlungen an die FBG betreffend Förderungen getrennt auszuweisen.
25020100	7270	000	
25020200	7270	000	
			BM für Inneres
11010200	7270	900	*) Teilbetrag der Voranschlagsstelle.
11010200	7281	310	*) Teilbetrag der Voranschlagsstelle.
11020600	7270	900	*) Teilbetrag der Voranschlagsstelle.
11020600			* Teilbetrag der Voranschlagsstelle
11020800	7270	900	*) Teilbetrag der Voranschlagsstelle.
18010100	7670	309	*) Teilbetrag der Voranschlagsstelle Aufgrund Änderung der budgetären Zuordnung wurde der Asyl-, Migrations- und Integrationsfonds (AMIF) ab 2022 von der Voranschlagsstelle 18010100 in die Voranschlagsstelle 18010400 übergeführt.
18010100	7672	009	*) Teilbetrag der Voranschlagsstelle Aufgrund Änderung der budgetären Zuordnung wurde der Asyl-, Migrations- und Integrationsfonds (AMIF) ab 2022 von der Voranschlagsstelle 18010100 in die Voranschlagsstelle 18010400 übergeführt.
18010100	7660	900	*) Aufgrund einer Budgetstrukturänderung wurde die Voranschlagsstelle 11030100 ab 2018 in die Voranschlagsstelle 18010100 überführt. *) Teilbetrag der Voranschlagsstelle.
18010400	7670	309	*) Teilbetrag der Voranschlagsstelle Aufgrund Änderung der budgetären Zuordnung wurde der Asyl-, Migrations- und Integrationsfonds (AMIF) ab 2022 von der Voranschlagsstelle 18010100 in die Voranschlagsstelle 18010400 übergeführt.
18010400	7672	009	*) Teilbetrag der Voranschlagsstelle Aufgrund Änderung der budgetären Zuordnung wurde der Asyl-, Migrations- und Integrationsfonds (AMIF) ab 2022 von der Voranschlagsstelle 18010100 in die Voranschlagsstelle 18010400 übergeführt.
			BM für europäische und internationale Angelegenheiten
12020200	7800	101	*) BMG-Novelle
12020200	7800	102	*) BMG-Novelle .
12020200	7840	000	
			BM für Justiz
13010100	6430	000	*Studie zum "Schutz der sexuellen Integrität" (Auftragnehmer: Institut für Konfliktforschung), Auftragsvolumen: 76.500 EUR (hiervon noch offen: 38.250 EUR) *Studie zu „Österreichische Urteile wegen NS-Tötungsverbrechen“ (Auftragnehmer: FStN), Auftragsvolumen: 5.000 EUR, davon im Jahr 2020 bezahlt 5.000 EUR *Konsolidierung der Endberichte der AG zur "Ausforschung von mutmaßlichen NS-Tätern" (Auftragnehmer: FStN), Auftragsvolumen: 5.000 EUR, Auszahlung 2022) *Konzeptentwicklung zu "Korruptionsstatistik/Sicherheitsbericht" (Auftragnehmer: IRKS), Auftragsvolumen: 14.190 EUR im Jahr 2020 bezahlt

			*Studie zum "Reformbedarf des Ehe- und Partnerschaftsrechts" (Auftragnehmer: IRKS), Auftragsvolumen: 89.797 EUR im Jahr 2020 bezahlt *Evalierung und Weiterentwicklung des "Leistungskennzahlen-Systems für Erwachsenenschutzvereine" (Auftragnehmer: IRKS), Auftragsvolumen: 85.260 EUR, davon 28.420 EUR im Jahr 2020 bezahlt, weitere 28.420 EUR voraussichtlich im Jahr 2022 *Studie zum "Unterbringungsgesetz" (Auftragnehmer: IRKS) Auftragsvolumen: 88.500 EUR, letzte Rate im Jahr 2019 bezahlt, Refundierung im Jahr 2020 durch das BMI iHv. 29.500 EUR * Wissenschaftl. Begleitung der "Evaluierung von Großverfahren" (Auftragnehmer: Universität Wien, ALES), Auftragvolumen: 96.826,30 EUR, davon 28.447,89 EUR im Jahr 2021 bezahlt, weitere 66.378,41 EUR im Jahr 2022 *Erstellung "Rechtsextremismus-Bericht" (Auftragnehmer: DÖW), voraussichtliche Auszahlung iHv. 50.000 EUR im Jahr 2022
13030101	6430	000	*) * Studie iZm StVG-Novelle, Auftragsvolumen: 75.000 EUR
			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 56 %.
15010100	7270	000	*) Teilbetrag der Voranschlagsstelle (System rundet: 37,13 %)
15010100	7669	020	*) Teilbetrag der Voranschlagsstelle. Forschungsanteil liegt bei 27,361 % (System rundet).
			BM für Arbeit
20010101	7340	302	*) Erfolg 2020: Forschungsanteil liegt bei 0,8 %.
20010201	7270	006	*) Erfolg 2020: Forschungsanteil liegt bei 0,07 %.
20010201	7668	900	Forschungsanteil liegt bei 0,11 % (System rundet auf 0 %).
20010202	7270	000	*) Erfolg 2020: Forschungsanteil liegt bei 0,07 %.
			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 Digitalisierung und Wirtschaftsstandort
40020100	7417	004	*) "Creative Impact COVID-19 Sonderaktion": Die Kreativwirtschaft war aufgrund der engen Verflechtungen mit dem Event-, Tourismus- und Kulturbereich sehr stark von der COVID-19 Krise betroffen. Daher wurde eine Sonderaktion in Form von zwei Sondercalls durch die aws durchgeführt (Fokus:Post-Covid-19-Geschäftsmodelle). Die Budgetmittel wurden aus der UG40 bereitgestellt.
40020100	7417	005	) "Creative Impact COVID-19 Sonderaktion": Die Kreativwirtschaft war aufgrund der engen Verflechtungen mit dem Event-, Tourismus- und Kulturbereich sehr stark von der COVID-19 Krise betroffen. Daher wurde eine Sonderaktion in Form von zwei Sondercalls durch die aws durchgeführt (Fokus:Post-Covid-19-Geschäftsmodelle). Die Budgetmittel wurden aus der UG40 bereitgestellt.
			BM für Klimaschutz, Umwelt, Energie, Mobil., Innov. u.Technologie
41010200	7330	080	* KLIEN: ab 2016 werden bei dieser Post nur mehr F&E-Projekte finanziert; daher die Erhöhung von 39 auf 95 %.
43010500			*) Teilbetrag der VA-Stelle.
			BM für Landwirtschaft, Regionen und Tourismus
42010100			*) DB-Alt 42010100/DB-Neu 4204010 PSP-Element 42 P101010001 (bzw. 42 P101020001 bis 2020), ab 2022 inkl. Forschung Präs. 8 (bisher DB 42020300).
42010200	7411	027	
42010200	7411	029	
42010200	7411	000	Finanzstellen 90306 (AGES) und 90309 (BFW).
			0 Finanzstellen 90306 (AGES) und 90309 (BFW).
42020202	7800	080	*) Teilbetrag der VA-Stelle.
42020300			PDP-Element 42P101010001 (bzw. 42 P101010001 und 42P101020001 bis 2020).
			*42020300 PSP-Element 42P101010001 (bzw. 42P101010001 und 42P101020001 bis 2020) bis 2021; ab 2022 bei 42040100 bzw. 42050300
			*42050300 PSP-Element 42P101010001; ab 2022 (bisher bei DB 42020300)
42020401			*) Finanzstellen 22010 (Francisco-Josephinum), 22013 (Raumberg-Gumpenstein), 22016 (Gartenbau); 22112 (alpenl. Milchw.)
42020403			
42020405			*) ab 2021 bei DB 42020401.
42030104			*) PSP-Element 42P101010001 (bzw. 42P101010002 und 42P101020002 bis 2020).

42030204	7270	000	*)PSP-Element 42P101010001 (bzw. P101020003 bis 2020.)	
42030206			Teilbetrag des DB; lt. Mitteilung der Förderungsabwicklungsstelle.	
42040200	7411	027	*42010200/42040200	Finanzstellen 90306 (AGES) und 90309 (BFW)
42040500			*42020401/42040500	Finanzstellen 22010 (Francisco-Joseph.), 22013 (Raumberg-Gump.), 22016 (Gartenbau),
			22112 (alpenl. Milchw.; ab 2021)	
42050400			*) Teilbetrag der VA-Stelle.	
42060200			*42030104/42060200	PSP-Element 42P101010001 (bzw. 42P101010002 und 42P101020002 bis 2020); ab 2022
			inkl. Waldfonds	
42060400	7270	000	*42030204/42060400	PSP-Element 42P101010001 (bzw. 42P101020003 bis 2020)
42060600			*42030206/42060600	Teilbetrag des DB; lt. Mitteilung der Förderungsabwicklungsstelle

Ergebnisvoranschlag			
VA-Stelle	Konto	Ugl	Anmerkung
			Keine Anmerkungen erfasst.

Table A-5: Federal expenditure from 2006 to 2022 for research and research promotion by socio-economic objectives

Breakdown of Annex T of the Auxiliary Documents and the "Detailed overview of research-related appropriation of federal funds" (Part a and Part b) for the Federal Finances Acts (BGF)

Reporting year		Total federal expenditure for R&D	of which for													
			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
2006[1]	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[2]	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[3]	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[4]	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[5]	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[6]	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[7]	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[8]	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[9]	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[10]	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[11]	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[12]	in €1,000	2,889,779	144,552	70,329	728,136	106,887	68,214	74,493	609,919	159,300	45,228	35,171	4,899	9,730	832,921
	in %	*100.0*	*5.0*	*2.4*	*25.2*	*3.7*	*2.4*	*2.6*	*21.1*	*5.5*	*1.6*	*1.2*	*0.2*	*0.3*	*28.8*
2018[13]	in €1,000	2,913,369	147,535	69,753	752,214	107,966	69,823	75,212	615,795	158,546	45,196	35,534	5,245	8,955	821,595
	in %	*100.0*	*5.1*	*2.4*	*25.8*	*3.7*	*2.4*	*2.6*	*21.1*	*5.4*	*1.6*	*1.2*	*0.2*	0.3	*28.2*
2019[14]	in €1,000	3,009,644	160,949	70,930	780,351	92,750	82,573	75,403	609,233	172,216	48,224	30,273	5,466	-	881,276
	in %	*100.0*	*5.3*	*2.4*	*25.9*	*3.1*	*2.7*	*2.5*	*20.2*	*5.7*	*1.6*	*1.0*	*0.2*	-	*29.4*
2020[15]	in €1,000	3,287,074	157,168	76,088	838,117	147,692	86,093	66,989	644,298	187,622	124,921	31,374	4,817	-	921,895
	in %	*100.0*	*4.8*	*2.3*	*25.5*	*4.5*	*2.6*	*2.0*	*19.6*	*5.7*	*3.8*	*1.0*	*0.1*	-	*28.1*
2021[16]	in €1,000	3,561,414	165,598	82,913	962,903	126,653	109,147	93,885	711,467	204,872	65,670	33,096	5,992	-	999,218
	in %	*100.0*	*4.6*	*2.3*	*27.0*	*3.6*	*3.1*	*2.6*	*20.0*	*5.8*	*1.8*	*0.9*	*0.2*	-	*28.1*
2022[16]	in €1,000	3,867,996	170,132	107,597	1,024,595	162,215	142,191	76,547	760,059	217,314	75,765	35,391	6,735	-	1,089,455
	in %	*100.0*	*4.4*	*2.8*	*26.5*	*4.2*	*3.7*	*2.0*	*19.6*	*5.6*	*2.0*	*0.9*	*0.2*	-	*28.1*

Date: March 2022.

Source: Statistics Austria.

1) Annex T of the Auxiliary Document for the Federal Finances Act 2008 (BFG 2008), Cash Flow Statement. Revised data. – 2) Annex T of the Auxiliary Document for the Federal Finances Act 2009 (BFG 2009), Cash Flow Statement. – 3) Annex T of the Auxiliary Document for the Federal Finances Act 2010 (BFG 2010), Cash Flow Statement. – 4) Annex T of the Auxiliary Document for the Federal Finances Act 2011 (BFG 2011), Cash Flow Statement. – 5) Annex T of the Auxiliary Document for the Federal Finances Act 2012 (BFG 2012), Cash Flow Statement. – 6) Annex T of the Auxiliary Document for the Federal Finances Act 2013 (BFG 2013) (Cash Flow Budget), Cash Flow Statement. Revised data. – 7) Annex T of the Auxiliary Document for the Federal Finances Act 2014 (BFG 2014) (Cash Flow Budget), Cash Flow Statement. – 8) Annex T of the Auxiliary Document for the Federal Finances Act 2015 (BFG 2015) (Cash Flow Budget), Cash Flow Statement. Revised data. – 9) Federal Finances Act 2016 (BFG 2018), Detailed overview of research-related appropriation of federal funds, Cash Flow Statement. – 10) Federal Finances Act 2017 (BFG 2019), Detailed overview of research-related appropriation of federal funds, Cash Flow Statement. Revised data. – 11) Federal Finances Act 2018 (BFG 2018), Detailed overview of research-related appropriation of federal funds, Cash Flow Statement. – 12) Federal Finances Act 2019 (BFG 2019), Detailed overview of research-related appropriation of federal funds, Cash Flow Statement. Revised data. – 13) Federal Finances Act 2020 (BFG 2020), Detailed overview of research-related appropriation of federal funds, Cash Flow Statement. – 14) Federal Finances Act 2021 (BFG 2021), Detailed overview of research-related appropriation of federal funds, Cash Flow Statement. Revised data. – 15) Federal Finances Act 2022(BFG 2022), Detailed overview of research-related appropriation of federal funds, financing proposal. – 16) Federal Finances Act 2022 (BFG 2022), Detailed overview of research-related appropriation of federal funds, Cash Flow Statement.

Table A-6: Federal expenditure on research and research promotion by socio-economic objective and ministry, 2022

Breakdown of annual values 2022[1] of the "Detailed overview of research-related appropriation of federal funds" in the Federal Finances Act (BFG) 2022 (Part a and Part b)

Ministries		Total federal expenditure for R&D	of which for												
			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	2,871	-	-	-	-	2	-	-	2,204	-	210	-	-	455
	in %	*100.0*	-	-	-	-	*0.1*	-	-	*76.8*	-	*7.3*	-	-	*15.8*
BMKÖS	in €1,000	50,441	5,015	-	-	-	-	-	-	16,093	-	-	-	-	29,333
	in %	*100.0*	*9.9*	-	-	-	-	-	-	*31.9*	-	-	-	-	*58.2*
BMEIA	in €1,000	3,244	-	-	-	941	-	-	-	2,303	-	-	-	-	-
	in %	*100.0*	-	-	-	*29.0*	-	-	-	*71.0*	-	-	-	-	-
BMA	in €1,000	6,430	-	-	-	-	-	-	-	6,430	-	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-	-
BMBWF	in €1,000	2,826,001	137,220	42,015	529,090	39,505	55,551	75,426	702,310	171,453	39,041	33,448	3,422	-	997,520
	in %	*100.0*	*4.9*	*1.5*	*18.7*	*1.4*	*2.0*	*2.7*	*24.8*	*6.1*	*1.4*	*1.2*	*0.1*	-	*35.2*
BMAW (formerly	in €1,000	170,506	694	231	144,482	9,512	1,678	-	4,107	290	6,388	-	116	-	3,008
BMDW)	in %	*100.0*	0.4	0.1	*84.7*	5.6	1.0	-	2.4	0.2	3.7	-	0.1	-	1.8
BMF	in €1,000	32,756	1,244	1,765	4,990	380	603	821	5,882	8,506	438	357	-	-	7,770
	in %	*100.0*	*3.8*	*5.4*	*15.2*	*1.2*	*1.8*	*2.5*	*18.0*	*26.0*	*1.3*	*1.1*	-	-	*23.7*
BMI	in €1,000	1,859	-	-	-	-	-	-	-	1,859	-	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-	-
BMJ	in €1,000	139	-	-	-	-	-	-	-	139	-	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	100.0	-	-	-	-	-
BMK	in €1,000	690,027	25,193	3,733	340,485	111,319	84,149	-	40,236	3,805	29,726	1,376	691	-	49,314
	in %	*100.0*	*3.7*	*0.5*	*49.4*	*16.1*	*12.2*	-	*5.8*	*0.6*	*4.3*	*0.2*	*0.1*	-	*7.1*
BMLV	in €1,000	3,945	-	-	-	-	-	-	-	-	-	-	2,492	-	1,453
	in %	*100.0*	-	-	-	-	-	-	-	-	-	-	*63.2*	-	*36.8*
BMLRT	in €1,000	70,298	766	59,853	5,548	558	208	300	507	1,770	172	-	14	-	602
	in %	*100.0*	*1.1*	*85.2*	*7.9*	*0.8*	*0.3*	*0.4*	*0.7*	*2.5*	*0.2*	-	*0*	-	*0.9*
BMSGPK	in €1,000	9,479	-	-	-	-	-	-	7,017	2,462	-	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	*74.0*	*26.0*	-	-	-	-	-
Total	**in €1,000**	**3,867,996**	**170,132**	**107,597**	**1,024,595**	**162,215**	**142,191**	**76,547**	**760,059**	**217,314**	**75,765**	**35,391**	**6,735**	**-**	**1,089,455**
	in %	***100.0***	***4.4***	***2.8***	***26.5***	***4.2***	***3.7***	***2.0***	***19.6***	***5.6***	***2.0***	***0.9***	***0.2***	***0.0***	***28.1***

Date: March 2022.

Source: Statistics Austria.

1) Cash Flow Budget.

2) Including the highest executive bodies.

Table A-7: General research-related higher education institutions expenditure by the federal government 2000 –2022[1] "General University Funds"

Year	General University Funds	
	Total	R&D
	€ 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	3,294.879	1,658.500
2019	3,488.597	1,755.220
2020	3,698.739	1,859.785
2021	3,913.842	1,968.355
2022	4,191.895	2,109.617

Date: March 2022.

Source: Statistics Austria.

1) 2000–2022: Based on Annex T of the Auxiliary Document and the "Detailed overview of research-related appropriation of federal funds" for the Federal Finances Acts (BFG).

Table A-8: Research promotion schemes and contracts awarded by the federal government in 2021, by sector/area of performance and awarding ministry
Analysis of the federal research database[1] without "major" global financing[2]

Ministry	Partial amounts 2021	of which awarded to																				
		Higher education sector					Government sector							Private non-profit sector			Business enterprise sector					
		Universities (including teaching hospitals)	Universities of the arts	Universities of applied sciences	Other higher education sector [3]	Combined	Federal institutions (outside of the higher education sector)	Austrian Institute of Technology (AIT)	Austrian Academy of Sciences (OeAW)	Private non-profit facilities mostly run on public financing	Ludwig Boltzmann Gesellschaft – Austrian Association for the Promotion of Scientific Research	Other public sector [4]	Combined	Private non-profit facilities	Individual researchers	Combined	Institutes' sub-sector ("Kooperativer Bereich") incl. competence centres	Company R&D sub-sector ("Firmeneigener Bereich")	Combined	Austrian Science Fund (FWF)	Austrian Research Promotion Agency (FFG)	Abroad
	in €	in %																				
BKA	255,971	*5.7*	-	-	-	*5.7*	*43.0*	-	-	*37.1*	-	-	*80.1*	-	-	-	-	-	-	-	-	*14.2*
BMA	331,351	*5.4*	-	-	-	*5.4*	-	-	-	*59.7*	-	-	*59.7*	-	-	-	-	*34.9*	*34.9*	-	-	-
BMAFJ	79,200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*100.0*	*100.0*	-	-	-
BMBWF	47,490,047	*6.4*	-	-	-	*6.4*	*0.5*	*0.0*	*0.1*	*10.9*	-	*3.2*	*14.7*	*2.2*	*0.1*	*2.3*	-	*2.7*	*2.7*	-	*0.5*	*73.4*
BMAW (formerly BMDW)	668,187	*23.3*	-	-	-	*23.3*	-	*1.2*	-	*42.3*	-	*0.7*	*44.2*	*4.5*	-	*4.5*	*7.0*	*18.3*	*25.3*	-	-	*2.7*
BMEIA	94,791	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*100.0*	*100.0*	-	-	-
BMF	5,735,250	-	-	-	-	-	*32.2*	-	-	*18.9*	-	-	*51.1*	-	*1.0*	*1.0*	*0.2*	*3.1*	*3.3*	-	*40.3*	*4.3*
BMI	1,401,569	*0.5*	-	-	-	*0.5*	-	-	-	*34.9*	*1.7*	-	*36.6*	-	-	-	-	*12.5*	*12.5*	-	-	*50.4*
BMJ	128,999	*22.1*	-	-	-	*22.1*	-	-	-	*74.0*	-	-	*74.0*	*3.9*	-	*3.9*	-	-	-	-	-	-
BMK	1,610,714	*22.3*	-	-	-	*22.3*	*4.5*	-	-	*31.4*	-	-	*35.9*	*14.7*	-	*14.7*	*16.1*	*3.7*	*19.8*	-	*7.3*	-
BMLRT	8,338,183	*51.7*	-	*0.2*	-	*51.9*	*37.3*	*0.1*	-	*5.3*	-	-	*42.7*	*0.4*	-	*0.4*	*1.7*	*2.3*	*4.0*	-	*1.0*	-
BMLV	1,238,860	*2.3*	-	-	-	*2.3*	*4.4*	*12.9*	*0.6*	-	-	*21.4*	*39.3*	*4.6*	*16.1*	*20.7*	-	*35.4*	*35.4*	-	-	*2.3*
BMSGPK	2,419,535	*10.1*	-	-	-	*10.1*	*65.6*	-	-	*7.5*	-	*0.9*	*74.0*	*4.3*	*1.0*	*5.3*	-	*8.5*	*8.5*	-	-	*2.1*
Total	**69,792,657**	***11.8***	**-**	***0.0***	**-**	***11.8***	***10.0***	***0.3***	***0.1***	***12.2***	***0.0***	***2.6***	***25.2***	***2.1***	***0.5***	***2.6***	***0.7***	***4.2***	***4.9***	**-**	***4.0***	***51.5***

Date: April 2022.

Source: Statistics Austria.

1) Data as at: 23 March 2022.

2) i.e. without institutional funding where funding amounts exceed €500,000.

3) Private universities, university colleges of teacher education, testing agencies at technical federal colleges and other institutions categorised within the higher education sector.

4) State, local and chamber institutions as well as facilities of social insurance institutions.

Table A-9: Research promotion schemes and contracts awarded by the federal government in 2021, by socio-economic objective and awarding ministry
Analysis of the federal research database[1] without "major" global financing[2]

Ministry	Partial amounts 2020		of which for											
			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 general knowledge advancement
BKA	in €	255,971	-	-	-	-	-	-	-	255,971	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-
BMA	in €	331,351	-	-	-	-	-	-	-	331,351	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-
BMAFJ	in €	79,200	-	-	-	-	-	-	-	79,200	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-
BMBWF	in €	47,490,047	6,256,179	-	-	-	-	-	6,663,228	1,566,030	253,899	-	-	32,750,711
	in %	*100.0*	*13.2*	-	-	-	-	-	*14.0*	*3.3*	*0.5*	-	-	*69.0*
BMAW (formerly BMDW)	in €	668,187	-	-	-	-	-	5,100	5,000	403,035	-	-	-	255,052
	in %	*100.0*	-	-	-	-	-	0.8	*0.7*	*60.3*	-	-	-	*38.2*
BMEIA	in €	94,791	-	-	-	-	-	-	-	94,791	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-
BMF	in €	5,735,250	-	-	100,000	-	48,672	-	90,314	3,082,024	45,700	-	-	2,368,540
	in %	100.0	-	-	*1.7*	-	0.8	-	*1.6*	*53.8*	*0.8*	-	-	*41.3*
BMI	in €	1,401,569	-	-	-	-	-	-	-	1,401,569	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-
BMJ	in €	128,999	-	-	-	-	-	-	-	113,999	-	-	-	15,000
	in %	*100.0*	-	-	-	-	-	-	-	*88.4*	-	-	-	*11.6*
BMK	in €	1,610,714	-	3,000	375,600	36,000	-	-	132,489	-	361,891	147,000	-	554,734
	in %	*100.0*	-	*0.2*	*23.3*	*2.2*	-	-	*8.2*	-	*22.5*	*9.1*	-	*34.5*
BMLRT	in €	8,338,183	1,270,905	5,615,060	211,318	-	-	-	-	593,123	419,294	85,000	-	143,483
	in %	*100.0*	*15.2*	67.5	*2.5*	-	-	-	-	7.1	5.0	1.0	-	*1.7*
BMLV	in €	1,238,860	55,400	-	99,250	-	-	-	-	37,600	-	74,868	624,001	347,741
	in %	*100.0*	*4.5*	-	*8.0*	-	-	-	-	*3.0*	-	6.0	50.4	*28.1*
BMSGPK	in €	2,419,535	-	150,000	-	-	-	-	264,003	2,005,532	-	-	-	-
	in %	*100.0*	-	*6.2*	-	-	-	-	*10.9*	*82.9*	-	-	-	-
Total	**in €**	**69,792,657**	**7,582,484**	**5,768,060**	**786,168**	**36,000**	**48,672**	**5,100**	**7,155,034**	**9,964,225**	**1,080,784**	**306,868**	**624,001**	**36,435,261**
	in %	***100.0***	***10.9***	***8.3***	***1.1***	***0.1***	**0.1**	**0.0**	***10.3***	***14.3***	***1.5***	***0.4***	***0.9***	***52.1***

Date: April 2022.

Source: Statistics Austria.

1) Data as at: 23 March 2022.

2) i.e. excluding institutional funding where funding amounts exceed €500,000

Table A-10: An international comparison of research and experimental development (R&D) in 2019

Country	Gross domestic expenditure on R&D in % of GDP	Funding of gross domestic expenditure on R&D through		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	3.16	17.8	64.3	93,524	73.7	16.7	8.8	0.8
Bulgaria	0.83	23.6	37.6	26,399	67.2	7.3	24.9	0.6
Denmark [p]	2.93	28.7	59.6	62,229	62.6	34.1	2.9	0.4
Germany	3.17	27.8	64.5	735,584	68.9	17.4	13.7 [d]	.
Estonia	1.63	37.2	49.1	6,394	53.3	35.3	10.2	1.2
Finland	2.80	27.8	54.3	51,494	65.6	25.4	8.1	0.9
France	2.19	31.4	56.7	461,891	65.9	20.1	12.3	1.6
Greece	1.28	41.1	41.4	53,932	46.1	30.6	22.4	0.8
Ireland	1.23	22.6	62.8	32,170	74.5	21.7	3.8	.
Italy	1.46	32.3	55.9	355,854	63.2	22.5 [e]	12.6	1.8
Croatia	1.08	39.1	36.6	14,492	49.0	32.3	18.7 [d]	.
Latvia	0.64	35.4	24.3	5,924	26.3	54.8	18.9	.
Lithuania	0.99	32.3	34.0	12,998	43.2	36.4	20.4	.
Luxembourg	1.18	43.2	51.3	5,790	54.3	21.9	23.8	.
Malta	0.57	31.2	58.7	1,588	62.0	37.1	1.0	.
Netherlands	2.18	29.4	57.6	160,422	66.7	27.6	5.7 [d]	0.0 [d]
Austria [2]	**3.13**	**27.9**	**54.8**	**83,660**	**70.4**	**21.8**	**7.3**	**0.5**
Poland	1.32	38.8	50.7	164,006	62.8	35.6	1.3	0.3
Portugal	1.40	40.2	48.3	61,455	52.5	40.5	5.1	1.9
Romania	0.48	34.4	54.6	31,665	57.8	10.2	31.8	0.2
Sweden	3.39	24.2	62.4	92,172	71.7	23.7 [b]	4.5 [b]	0.1 [e]
Slovakia	0.83	40.5	46.8	21,196	54.8	25.2	20.0	0.0
Slovenia	2.05	24.7	61.5	16,983	73.8	11.8	13.8	0.6
Spain	1.25	37.9	49.1	231,413	56.1	26.6	17.0	0.3
Czechia	1.93	33.7	38.2	79,245	61.6	21.8	16.3	0.3
Hungary	1.48	33.3	52.9	56,943	75.1 [d]	14.2 [d]	10.0 [d]	.
Cyprus	0.71	35.4	36.4	2,121	43.0	38.3	7.4	11.3
EU – 27 states [*]	**2.23**	**29.4**	**59.0**	**2,921,544**	.	.	.	.
Bosnia and Herzegovina	0.19	44.5	36.1	2,037	37.8	57.8	4.4	0.0
Iceland	2.32	29.8	38.9	3,172 [1]	68.7	28.1	3.2	.
Montenegro	0.50 [1]	49.0 [1]	37.8 [1]	685	13.8	36.5	49.7	0.1
North Macedonia				1,930			9.0	
Norway	2.16	47.0	43.2	48,723	53.0	34.3	12.7	.
Switzerland	3.15	27.4	64.7	85,853	67.5	28.9	0.9	2.7
Serbia	0.89	45.9	9.1	20,545	39.5	34.7	25.8	0.0
Turkey	1.06	29.4	56.3	182,847	64.2	29.2	6.6	.
United Kingdom	1.76 [p]	25.9 [1]	54.8 [1]	486,088 [p]	68.0 [p]	23.1 [p]	6.6 [p]	2.3 [p]
Japan	3.20	14.7 [e]	78.9	903,367 [d]	79.2	11.7	7.8	1.3
Russia	1.04	66.3	30.2	753,796	60.7	10.6	28.3	0.4
South Korea	4.63	20.7	76.9	525,675	80.3	8.3	10.0	1.4
USA	3.08 [d,e]	22.3 [d,1]	63.1 [d,1]	.	73.9 [d,e]	12.0 [d,p]	9.9 [e]	4.3 [d,e]
People's Republic of China (without Hong Kong)	2.23	20.5	76.3	4,800,768	76.4	8.1	15.5	.

Date: 15 March 2022.

Source: Eurostat (date: 15 March 2022), Statistics Austria

b) Break in the time series. d) Different definition. – e) Estimated values. – p) Preliminary values.

1) 2018. –2) Statistics Austria; Results of the survey on research and experimental development (R&D).

Full-time equivalent = person-year.

Table A-11: Austrian Science Fund (FWF): Shares of new approvals by discipline (Austrian Systematics of the Sciences (ÖFOS) 2012 3-digit level), 2019–2021

Subject	2019		2020		2021	
	in %	in € millions	in %	in € millions	in %	in € millions
101*Mathematics	0.05	0.13	0.04	0.09	0.33	0.83
102*Computer sciences	0.43	1.02	0.55	1.34	0.37	0.95
103*Physics, astronomy	0.29	0.69	0.24	0.57	0.40	1.03
104*Chemistry	0.14	0.34	0.28	0.69	0.67	1.73
105*Geosciences			0.03	0.08	0.02	0.06
106*Biology	0.25	0.59	0.39	0.96	0.79	2.02
107*Other natural sciences	0.52	1.23	0.89	2.16	0.38	0.97
201*Construction engineering	0.70	1.65	0.49	1.19	0.37	0.95
202*Electrical engineering, electronics, information engineering	7.20	17.10	9.21	22.45	10.43	26.72
203*Mechanical engineering	3.19	7.59	4.06	9.90	6.35	16.26
204*Chemical process engineering	0.87	2.06	0.82	2.00	1.42	3.63
205*Materials engineering	0.21	0.51	0.33	0.81	0.77	1.97
206*Medical engineering	0.20	0.48	0.14	0.33	0.19	0.50
207*Environmental engineering, applied geosciences	0.49	1.17	0.72	1.74	0.41	1.06
208*Environmental biotechnology	0.12	0.29	0.26	0.63	0.17	0.45
209*Industrial biotechnology	0.30	0.70	0.23	0.57	0.15	0.38
210*Nanotechnology					0.15	0.39
211*Other technical sciences	0.05	0.13	0.14	0.34	0.50	1.29
301*Medical-theoretical sciences, pharmacy	1.34	3.17	2.19	5.35	1.86	4.76
302*Clinical medicine	1.13	2.68	3.35	8.17	1.22	3.12
303*Health sciences	0.50	1.20	0.34	0.83	0.55	1.41
304*Medical biotechnology	1.74	4.14	2.29	5.58	2.74	7.02
305*Other human medicine, health sciences	0.52	1.23	0.54	1.31	0.24	0.60
401*Agriculture and forestry, fisheriy	0.49	1.17	0.53	1.30	1.30	3.32
402*Animal breeding, animal production	0.40	0.95	0.44	1.07	0.48	1.23
403*Veterinary medicine	0.31	0.73	0.61	1.49	0.68	1.75
404*Agricultural biotechnology, food biotechnology	0.28	0.66	0.16	0.40	0.40	1.03
405*Other agricultural sciences	3.87	9.19	3.77	9.19	3.26	8.34
501*Psychology	5.63	13.37	4.17	10.15	3.20	8.20
502*Economics	1.91	4.53	2.52	6.13	2.53	6.47
503*Educational sciences	3.23	7.67	1.67	4.07	2.78	7.11
504*Sociology	1.99	4.72	1.14	2.79	1.17	3.00
505*Law	0.05	0.13	0.04	0.09	0.33	0.83
506*Political science	0.43	1.02	0.55	1.34	0.37	0.95
507*Human geography, regional geography, regional planning	0.29	0.69	0.24	0.57	0.40	1.03
508*Media and communication sciences	0.14	0.34	0.28	0.69	0.67	1.73
509*Other social sciences			0.03	0.08	0.02	0.06
601*History, archaeology	0.25	0.59	0.39	0.96	0.79	2.02
602*Linguistics and literature	0.52	1.23	0.89	2.16	0.38	0.97
603*Philosophy, ethics, religion	0.70	1.65	0.49	1.19	0.37	0.95
604*Arts	7.20	17.10	9.21	22.45	10.43	26.72
605*Other humanities	3.19	7.59	4.06	9.90	6.35	16.26
Total	**100.00**	**237.43**	**100.00**	**243.62**	**100.00**	**256.08**

Source: Austrian Science Fund (FWF).

Table A-12: Austrian Research Promotion Agency (FFG): Shares of new approvals by topic area of the promotion, 2019–2021

	2019		2020		2021	
	in %	Total funding in € millions	in %	Total funding in € millions	in %	Total funding in € millions
Energy/Environment	15.0	74.2	15.6	72.1	17.9	114.4
ICT	23.5	115.9	20.8	95.9	17.6	112.8
Life sciences	12.9	63.7	14.4	66.3	9.5	60.9
Mobility	10.3	50.8	14.5	66.8	20.4	130.5
Production	21.9	108.4	18.8	86.6	20.3	130.0
Security	2.9	14.5	3.3	15.4	2.1	13.6
Space	1.4	7.1	1.9	9.0	1.2	7.8
Other	12.0	59.3	10.8	49.8	10.9	70.0
Total	**100.0**	**493.8**	**100.0**	**461.9**	**100.0**	**640.1**

Source: Austrian Research Promotion Agency (FFG).

Table A-13: Austria Wirtschaftsservice (aws): Shares of new approvals by topic area of the funding (industry), 2019–2021

Subject area, subject fields or industry	2019		2020		2021	
	in %	in € millions	in %	in € millions	in %	in € millions
Services	22.0	246.4	20.9	215.2	19.0	242.1
Electricity, gas and water supply, waste water	1.0	11.7	0.6	6.3	0.8	9.6
Trade, maintenance, repair	16.4	183.8	15.5	159.8	15.4	195.9
Food products, beverages, tobacco	9.4	105.8	9.8	101.3	11.9	151.7
Manufacturing	40.3	452.3	41.9	431.8	42.3	537.7
Other industries	1.3	14.9	2.6	26.4	2.7	34.2
Tourism	5.8	65.3	5.2	53.2	4.6	59.0
Transport and communication	1.8	20.4	1.2	12.8	1.4	18.3
Not classified	1.9	21.5	2.3	23.2	1.9	23.9
Total	**100.0**	**1,222.2**	**100.0**	**1,030.0**	**100.0**	**1,272.4**

Source: Austria Wirtschaftsservice (aws).

Table A-14: Austria Wirtschaftsservice (aws): Shares of new approvals by organisation size, 2019–2021

Organisation type	2019		2020		2021	
	in %	in € millions	in %	in € millions	in %	in € millions
Sole proprietorships	12.4	138.6	19.1	196.9	14.4	183.1
Microenterprises	23.4	262.9	21.6	222.9	23.8	302.6
Small enterprises	27.9	312.9	23.7	244.4	24.1	307.2
Medium-sized enterprises	19.6	220.0	18.7	192.1	19.7	250.5
Large enterprises	15.1	169.5	14.6	150.8	16.1	205.3
Not classified	1.6	18.1	2.2	22.9	1.9	23.7
Total	**100.0**	**1,222.2**	**100.0**	**1,030.0**	**100.0**	**1,272.4**

Source: Austria Wirtschaftsservice (aws).

Table A-15: Christian Doppler Research Association (CDG): CD Laboratories by thematic cluster, 2019–2021

Thematic cluster	Number of CD Laboratories 2019	Budget 2019 in € millions	Number of CD Laboratories 2020	Budget 2020 in € millions	Number of CD Laboratories 2021	Budget 2021 in € millions
Chemistry	11	2.64	7	1.99	6	2.15
Life sciences and environment	18	7.18	17	6.41	16	6.26
Manufacture of machinery and equipment, instruments	7	1.93	6	1.93	6	1.63
Non-metal materials	14	5.30	17	5.36	17	5.78
Mathematics, informatics, electronics	21	7.15	26	7.41	26	9.71
Medicine	17	4.05	16	3.17	14	3.69
Economics, social sciences and jurisprudence	3	0.43	2	0.41	2	0.44
Total	**91**	**28.69**	**91**	**26.68**	**87**	**29.66**

Note: budget data 2021 are plan data as of 31 December 2021.

Source: CDG.

Table A-16: Christian Doppler Research Association (CDG): JR Centres by thematic cluster, 2019–2021

Thematic cluster	Number of JR Centres 2018	Budget 2019 in € '000	Number of JR Centres 2020	Budget 2020 in € '000	Number of JR Centres 2021	Budget 2021 in € '000
Chemistry	1	228	1	72	-	-
Life sciences and environment	2	544	3	691	3	888
Manufacture of machinery and equipment, instruments	1	175	2	174	1	230
Non-metal materials	1	138	1	160	1	90
Mathematics, informatics, electronics	8	1,703	7	1,447	7	1833
Medicine	1	369	1	395	1	272
Economics, social sciences and jurisprudence	1	224	2	464	2	502
Total	**15**	**3,381**	**17**	**3,402**	**15**	**3,814**

Note: budget data 2021 are plan data as of 31 December 2021.

Source: CDG.