

14.12.2021

Updated National Roadmap for Research, Development and Innovation

INTRODUCTION

RDI roadmap and its objectives

The National Roadmap for Research, Development and Innovation, adopted by the Government in spring 2020, consists of a set of measures to develop the RDI operating environment. The roadmap provides guidelines for sustainable growth and wellbeing as well as for increasing the volume and the level of ambition of R&D activities. The goal is to increase R&D expenditure to 4% of GDP by 2030.

In addition to increasing the volume and quality of RDI activities, the roadmap measures will strengthen competence centres and ecosystems, increase cooperation between R&D actors and diversify the role of the public sector as a driver and user of innovation activities. The roadmap measures will raise competence levels, improve the international attractiveness of Finland's RDI environment, and encourage companies to invest more in RDI activities in Finland.

The strategic development priorities of the RDI roadmap remain unchanged: competence, partnerships and public sector innovativeness. The roadmap measures supporting these priorities have been updated and measures already undertaken have been removed. New measures are also included. The RDI roadmap monitoring indicators are unchanged.

The measures in the updated roadmap are actions to be implemented or launched during this government term. They will support the roadmap's objectives for 2030. A number of measures included in the RDI roadmap are expected to raise the level of R&D funding in the coming years.

The increase in public R&D funding has been examined by a parliamentary RDI working group, appointed by the Prime Minister's Office, whose report will be published by the end of 2021. The working group has explored ways to strengthen commitment to a long-term increase in public research and development funding. In addition, the working group has assessed a permanent R&D tax incentive as part of the overall solution. The working group has also established key principles for the development of the RDI system, namely predictability and long-term vision, leverage, comprehensiveness, scientific freedom and high quality research and education, effectiveness, competitiveness, cooperation, internationalisation, recognition of global challenges, and technology neutrality.

RDI systems on different continents have responded flexibly to the COVID-19 crisis. Research projects to develop COVID-19 vaccines have been launched in record time. The resulting solutions are based on decades of research and development work carried out over decades. The crisis has also accelerated the use of digital tools and strengthened international cooperation and public-private partnerships in coronavirus-related fields. The crisis has hastened the transition to more open science and innovation.

The exceptional situation has affected different fields of research in different ways. The pandemic has delayed research as experimental activities become more difficult. Gaps in production and innovation capabilities have arisen in the worst affected sectors.

The pandemic and its effects are accelerating the need to develop socially sustainable solutions. Investments in research and development in accordance with Finland's Recovery and Resilience Plan will support, in particular, the implementation of the green transition and digitalisation, strengthen the shared use of research infrastructures and increase R&D intensity to boost growth over the longer term.

The roadmap and its measures will be updated periodically in consultation with RDI actors. The Ministerial Working Group on Competence, Education, Culture and Innovation decided in autumn 2020 that the RDI roadmap would be updated during 2021. This first update of the RDI roadmap was coordinated by the Ministry of Education and Culture and the Ministry of Economic Affairs and Employment. The update takes

into account the changes that have taken place in the operating environment, feedback from RDI actors and other stakeholders, as well as reports and reviews by working groups to develop the RDI system.

The Research and Innovation Council discussed the update of the RDI roadmap on 17 November 2021. The Ministerial Working Group on Competence, Education, Culture and Innovation approved the RDI roadmap on 14 December 2021. The measures in the updated roadmap will be monitored regularly and implementation reported to the Ministerial Working Group on Competence, Education, Culture and Innovation.

CURRENT SITUATION OF RDI SYSTEM

Development of R&D expenditure

R&D expenditure indicates the intensity with which a country is building wellbeing based on research activities and high technology. Investment in research and development activities is growing worldwide. The United States remains the country that invests most in R&D. China is rising strongly. In Asia more broadly, business enterprise R&D investment is significant. By international standards, Finland's R&D expenditure is still at a good level. In contrast with peer countries, however, Finland's R&D expenditure is trending downward (see Figure 1 below). In the period 2014–2018, the decline in Finland's R&D expenditure-to-GDP ratio was second largest in the world. (Shneegans et al. 2021). Finland has lagged behind the level of the best in the world.

Figure 1. Development of Finland's R&D expenditure in a global comparison. By international standards, Finland still invests relatively heavily in R&D activities, but the development of Finland's R&D expenditure-to-GDP ratio was among the weakest of the EU countries over the last decade. Source: OECD Main Science and Technology Indicators



In recent years, Finland's R&D expenditure-to-GDP ratio has risen slightly. Business enterprise R&D expenditure has grown since 2017, but growth is not sufficient to achieve the goal of 4% R&D intensity by 2030. (Ali-Yrkkö et al. 2021, Statistics Finland 2021). Over the past ten years, Finland's GDP has also lagged

behind the development of the other Nordic countries. A major reason for this is that labour productivity has increased in Finland only modestly since the 2008 financial crisis.

The public sector accounts for around one third and the private sector for around two thirds of Finland's R&D expenditure. Two thirds of public sector R&D funding goes to the higher education sector, one fifth to the public sector (including private non-profit activities) and around 12% to companies. According to the General Government Fiscal Plan 2022–2025, the grant authorisations of the Academy of Finland and Business Finland, in particular, will decrease in central government R&D funding in 2023 (see Figure 2 below). The decrease is mainly due to the ending of non-recurring items such as the Recovery and Resilience Facility (RRF) and other fixed-term funding under the Government Programme as well as a reduction in proceeds from profits on state-owned gambling activities.

RDI activities are long-term and their results are seen with a delay. The outcomes of investments involve significant risks, which can be reduced through public RDI subsidies. In encouraging the RDI activities of companies, a credible prospect of long-term commitment is required from public funding. The unpredictability of public R&D funding is one of the weaknesses of Finland's RDI system. In Finland, the share of business enterprise R&D expenditure accounted for by central government funding is below the averages of EU and OECD countries (OECD 2021: Main Science and Technology Indicators).

Figure 2. Estimated development of government R&D funding in the General Government Fiscal Plan period 2022–2025 and the 4% target path^[1]. Source: Statistics Finland: Central government funding for R&D activities, Statistics Finland: R&D funding in the State budget, BP 2022, GGFP 2022–2025.

¹ Central government R&D funding for 2023–25 has been estimated on the basis of General Government Fiscal Plan 2022–25 figures, assuming that the share of R&D funding from central government funding to universities and universities of applied sciences and from the operating expenditure of research institutes remains the same on average in 2021–22. Due to an increase in intake places, in universities and universities of applied sciences investments will be transferred to the education side, so the share of funding allocated to R&D activities may be lower than estimated. The cancellation of cuts in proceeds going to science is not included in the estimates (Academy of Finland authorisations, funding for universities). The figures for 2021–2023 include a total of approximately EUR 360 million of RRF grant authorisations from the Academy of Finland and Business Finland.

The figures for 2020 do not include coronavirus grants (EUR 980 million) disbursed via Business Finland. The figures for 2021 include EUR 200 million of Business Finland loan authorisations transferred from 2020, most of which relate to disruption loans.



Intensified international competition further emphasises the importance of the quality of RDI activities and the need to develop the RDI operating environment. At the turn of the millennium, Finland regularly ranked at or near the top in international competitiveness comparisons and its innovation system was considered to be very advanced.

The importance of cooperation will be further underlined in the future, both nationally and internationally. Cooperation between companies and research organisations has traditionally been strong in Finland. In a Eurostat comparison, Finland was ranked 7th place in joint publications. Companies' direct funding to universities has been declining for the past 10 years (Husso & Moilanen 2021). Changes in the operating environment and the solving of systemic problems require wide-ranging cross-sectoral cooperation and interdisciplinarity. Universities and universities of applied sciences and other research organisations involved in international cooperation, and companies investing in RDI activities have a key role in solving societal challenges. They act as producers, disseminators and appliers of knowledge as well as developers of new technologies. Research and innovation policy is central to solving serious problems in society and promoting sustainable growth and wellbeing.

Education, competence and research

Competent personnel are a vital factor in successful R&D and innovation activities. Finland's education system is comprehensive and in many ways of high quality. Nearly everyone completes basic education and learning outcomes are still at a good level by international standards. The number of intake places in higher education is approximately one and a half times the cohort size, and demand for education is high. However, the system does not in all respects function as expected by society and individuals or produce the desired results. The learning outcomes of basic education have deteriorated and educational equality has not progressed. Significantly fewer young adults (aged 25–34) in Finland complete a higher education degree than in peer countries. The vision and roadmap for higher education and research in 2030 set as goal that at least half of the young adults will complete a higher education degree by the end of the decade (Ministry of Education and Culture 2017; also Prime Minister Marin's Government Programme). Reaching

this goal is a key prerequisite for achieving an adequate number of experts in R&D and means that the basic funding of universities and universities of applied sciences will make a significant contribution to overall success in realising the goal.

Lack of availability of competent labour is a significant barrier to growth. Finland has the largest shortage of highly educated workers in the OECD countries. In order to achieve an employment rate of 75%, Finland needs more than 100,000 new workers by 2025 (OECD 2021: Skills for Jobs Database). The number of foreign students and RDI professionals settling in Finland does not currently meet the targets. At present, around half of the international students who have completed a higher education degree in Finland are employed in Finland. Through their activities, universities, universities of applied sciences, research institutes and regional actors integrate international experts into Finnish society and working life in cooperation with the business community and public sector employers. In the future, it will be necessary to pay further attention to the factors promoting international students who have completed a high education degree in Finland to remain in the country.

The RDI funding of Finnish universities and universities of applied sciences and the human resources of the research community have remained fairly stable in recent years. In contrast, the R&D person-years of government research institutes have been declining for a long time. Of the sources of funding for universities and universities of applied sciences, Business Finland's funding has decreased somewhat and the Academy of Finland's share has correspondingly increased. The publishing activities of researchers operating in Finland are of good quality and quantity by European standards. In terms of the number of most cited publications, however, Finland lags behind the world's leading countries. Finland has only a relatively small number of fields in which the level of research is among the world's best. (State of Scientific Research in Finland 2021). Finland must aim for the top globally, which will require the effective use of the available resources. Finland needs strong and internationally attractive centres of excellence.

It should also be noted that the academic careers of many researchers are fragmented, often as a result of research funding. For example, during doctoral thesis research, 72% of researchers had had two or more sources of funding – employment, a grant or similar (Kokkonen et al. 2018). The fragmentation and unpredictability of research funding has a substantial impact on the attractiveness of a research career in Finland – for both potential young domestic and international experts. The importance of this perspective is emphasised by the fact that the availability of competent RDI personnel is a key factor in business enterprise RDI investments (see Ali-Yrkkö et al. 2021).

Business enterprise R&D activities

In Finland, R&D activities depend on a narrow group of companies, and large business enterprises are the driving forces behind the business community's R&D. Almost half of large business enterprises are engaged in R&D activities, compared with just over 7% of SMEs. Business enterprises with more than 500 employees account for more than half of business enterprise R&D expenditure (52% in 2020), but medium-sized enterprises (50–249 employees) have seen the strongest growth (48% in 2016–2020) in relative terms.

Three sectors account for 60% of business enterprise R&D expenditure: electronics, computers and electrical equipment (30%); information and communication (18%); other machinery and equipment (12%). After a decline of just under ten years, business enterprise R&D expenditure turned upwards and grew by 19% in 2016–2020 (at current prices). In the service sectors, growth has been higher (36% in 2016–2020) than in industry on average (9.1%). The strongest growth has been in knowledge-intensive service sectors, such as information and communication (44%) and research and development (60%). In industry other than the electrical and electronic industry, R&D expenditure has also started to grow since 2016 (21.5%).

In 2020, 55% of Business Finland's R&D funding for companies went to service sectors and 38% to industrial sectors. The sectors receiving most of Business Finland's R&D funding are information and communications (32%), electronics, computers and electrical equipment (11.5%), research and development (8.4%), other

machinery and equipment (7.5%), and architectural and other services (7.6%). (Statistics Finland: Research and development).

Among the broader longer-term challenges are to diversify the business structure in a more knowledge- and research-intensive direction, to identify growth companies and to increase the RDI capabilities of the SME sector.

The activities of companies and their value chains have internationalised strongly in recent decades. This internationalisation has also extended to the R&D activities of companies. Even if the R&D expenditure of Finnish-origin companies increases, the growth will not necessarily be in Finland. The most important location factors for R&D activities are the availability of R&D personnel and the proximity of a company's other units and customers. The most significant factors in the location of R&D abroad have been the cost and availability of R&D personnel and R&D subsidies. Sweden, the Baltic countries and Germany are Finland's strongest competitors as R&D location countries. (Ali-Yrkkö et al. 2021)

Overall, Finland's strengths continue to be a relatively high-quality RDI system, the general cost level of RDI activities, a strong knowledge base in a few areas of expertise and sectors, and a strong and developing startup culture.

RDI ROADMAP MEASURES

I Competence

The targeted growth in the volume and ambition of RDI activities requires a significant increase in the national level of competence and education. At the same time, as R&D funding increases there will also be a need for many more highly educated experts and other RDI professionals. This will challenge the current education and RDI system.

Finland must become a more attractive RDI operating environment in the international competition for domestic and foreign researchers and other experts. There is a need to build high-quality research environments, improve the attractiveness of research careers and expand the recruitment of foreign professionals.

A high level of research and science is a prerequisite for receiving international research funding. Knowledge and technology created abroad must also be utilised more intensively. The mobility of researchers between companies, administration and research organisations needs to be strengthened.

The needs of working life will be taken into account in competence development projects. In addition to education leading to a degree, diverse opportunities for continuous learning are required throughout the entire duration of working life. Civics, science education and investments in LUMA competence (mathematics, science and technology) will deepen and increase the human resources available in the RDI environment.

Wide-ranging raising of competence levels

1. At least 50% of all young adults in Finland will have completed a higher education degree by 2030. To achieve this goal, higher education intake will be increased until 2030. The Ministry of Education and Culture will agree on the necessary measures with higher education institutions.
2. Through broad-based cooperation, more foreign students and researchers will be recruited into Finnish higher education institutions. To meet competence needs, the goal is for the number of new foreign degree students to gradually triple (15,000) from at present by 2030.
3. Higher education institutions, research institutes and regional actors will integrate international experts into higher education institutions, Finnish society and working life in cooperation with the business community and public sector employers. The goal is for 75% of foreign students who have completed a bachelor's or master's degree to be employed in the Finnish labour market by 2030.
4. The Ministry of Education and Culture will implement a process to reform the education responsibility system. The aim is to give higher education institutions better opportunities to meet the competence needs of society and working life. The process will specify quality criteria for the allocation of educational responsibilities, taking into account the links between education and research, development and innovation.
5. The Ministry of Education and Culture and the Ministry of Economic Affairs and Employment as well as higher education institutions and other educational institutions will ensure that the parliamentary reform of continuous learning takes into account the RDI competence needs of industries, including high productivity sectors. Utilising foresight information, education will be targeted multisectorally at the needs of the business community and other societal needs.
6. The Ministry of Education and Culture and the Academy of Finland will continue to support the profiling of universities and universities of applied sciences in their strong areas of competence.

7. Together with the Academy of Finland, the Ministry of Education and Culture will prepare and implement further measures on the international assessment of the Academy of Finland, which will be completed in 2022.

Research careers, international experts and mobility

8. The measures of the 2021 report by the Ministry of Education and Culture's working group on research careers will promote the utilisation of doctoral expertise in society more widely than at present. The measures will diversify the career paths of doctors and promote mobility and placement in different sectors of society. The aim is also to raise the education level of companies' personnel. A report on the implementation of the measures will be made in 2024.

9. The Ministry of Education and Culture will examine the current arrangements for researcher education. At the same time, a study will be conducted as to whether the current regulation of the degree system also meets practical needs in researcher education.

10. In 2021–2022, the Academy of Finland will explore reforming the forms of funding for young researchers to support research work and careers.

11. The arrival in Finland of foreign students and experts will be streamlined.

i. Business Finland and the Finnish National Agency for Education will use Work in Finland and Study and Work in Finland services to support the recruitment of international students and the hiring of international experts for higher education institutions, research institutes and companies.

ii. Led by the Ministry of the Interior, a preliminary study will be made on a comprehensive reform of legislation on aliens (and permit procedures). The potential comprehensive reform would be implemented in the next government term. In cooperation with ministries, permit practices and the customer path (including Virtual Finland) will be digitalised in order to streamline work- and education-based immigration.

iii. Business and employment services will support the recruitment of international experts into Finnish innovation and growth ecosystems.

Broad-based utilisation of competence in RDI activities

12. The Ministry of Education and Culture, the Academy of Finland and higher education institutions will utilise, where applicable, in their activities the content and recommendations of a study to be completed in spring 2022 on the promotion of the equality, non-discrimination and diversity of teaching and research staff.

13. The Ministry of Education and Culture will support actors in science education and promoters of science competence in, among other places, science centres and teacher education. The objective is to deepen and expand citizens' problem-solving abilities and understanding of the development of science, with the aim of promoting learning and Finland's competence-based growth.

14. According to the vision of the National Strategy for Mathematics, Science and Technology (LUMA), both the individual and society will benefit from the growth of LUMA skills and competence in terms of increased wellbeing and sustainable development. Led by the Ministry of Education and Culture, an action plan for the strategy will be prepared in broad-based cooperation with stakeholders in 2022.

15. The Ministry of Education and Culture will commission an evaluation of the operating model of the Year of Research-Based Knowledge 2021 and the implementation of its objectives during 2022.

II Partnership model

A flexible partnership model will create conditions for long-term RDI cooperation. Support for partnerships will strengthen high-quality research environments, cutting edges, networks and ecosystems. The aim is to improve utilisation of RDI activities to renew the business community and society, and to increase the international attractiveness of Finland for research, business and investment.

The partnerships will be supported through the Academy of Finland's flagship programme, Business Finland's business driver funding, and other funding that supports cooperation. The Academy of Finland and Business Finland will intensify their strategic cooperation in developing and implementing the partnership model. RDI partnerships and public-private cooperation will be supported through ecosystem agreements between the central government and university towns and cities and other regional funding instruments. There is a need to strengthen the coherence of national and regional development activities in order to increase their effectiveness. Funding instruments will facilitate different types of partnerships in support of long-term RDI cooperation.

Support for partnerships must be long-term and predictable. Participants will be required to make a long-term commitment to the goals and development of each partnership. The coverage of the model, new ways of working and cross-administrative cooperation must be increased further in order to strengthen the quality and effectiveness of RDI activities. The funding base needs to be expanded by exploiting the potential of EU and other international cooperation and support funding.

High-quality RDI activities require high-quality and competitive research and innovation infrastructures, the utilisation of new knowledge and the strengthening of internationalisation. Companies need to be encouraged to engage in bolder RDI activities and utilise research more than at present. In addition, new approaches are required to support the solving of societal challenges.

Further development of the partnership model

16. The responsible ministries and funding organisations will develop the flexible partnership model and its funding instruments to be more broadly based, to support the quality and effectiveness of research as well as sustainable growth and the renewal of business and industry. The mutual complementarity and coverage of funding instruments will be strengthened to support all phases of RDI activities as well as all RDI actors, such as universities, universities of applied sciences, research institutes, companies of all sizes and third sector actors.

- i. RDI funding providers, together with stakeholders, will develop funding instruments and programme activities taking into account all phases of RDI activities as well as experiences with piloting the partnership model and the recommendations of evaluations.
- ii. Business Finland will allocate RDI funding to innovation and business ecosystems that renew business and industry and create international business and high value-added jobs. The development of new ecosystems will strengthen applied research aimed at renewing society and industries as well as the role of new business activities arising from research. Business Finland will support a major renewal of businesses, new structural solutions and thereby bolder risk-taking.
- iii. Based on a mid-term evaluation of the Academy of Finland's Flagships, the Academy of Finland and the Ministry of Education and Culture will prepare further measures to strengthen the centres of excellence built around the flagships and to support research, development of flagship ecosystems and companies' participation in ecosystems.

iv. In order to increase the effectiveness and quality of RDI activities, RDI system actors will utilise the competence and infrastructures produced by projects promoting digitalisation and the green transition and supported by the Sustainable Growth Programme for Finland.

17. Ministries will launch the preparation of a new challenge- and mission-based approach to implementing and funding research and innovation. Through missions, the aim to address major global challenges and transitions, which often require systemic solutions, the simultaneous utilisation of several policy actions (RDI, regulation, procurement, information management) and cross-sectoral cooperation. Preparation will draw on experiences and evaluations of current policies and funding.

18. Together with its own and other administrative branch actors as well as companies, the Ministry of Education will develop practices for the joint provision of RDI services to companies and public sector organisations by vocational education, higher education institutions and research institutes. Methods will be built on existing cooperation and vocational education competence, particularly in practice-based innovations.

19. Regional specialisation and the role of cities as innovation development platforms as well as the construction of internationally networked innovation clusters will be strengthened through ecosystem agreements between the central government and university towns and cities as well as other regional funding instruments. Funding providers, regional councils, Centres for Economic Development, Transport and the Environment, other regional actors and cities will intensify dialogue and cooperation to increase synergies between RDI measures. EU financial instruments will be harnessed to support cooperation between regional actors and networking of regions nationally and internationally.

Research infrastructures and innovation environments

20. High-quality research and innovation infrastructures are essential for high-quality RDI activities. Strengthening and developing them will require a significant permanent increase in the current level of funding and predictability in funding.

i. The Academy of Finland will appoint a new Research Infrastructure Committee for the term beginning in spring 2022 and will assign it the task of updating the national research infrastructures roadmap. The Academy of Finland's research infrastructure funding will promote the openness and shared use of research infrastructures at the national level in order to strengthen the effectiveness of research.

ii. Companies and public research organisations will develop shared and open experimental and pilot environments.

iii. Ministries, funding providers, research organisations and IT Centre for Science (CSC) will develop a research and innovation environment for data management and computing (including high-performance and quantum computing) and its services for the RDI needs of higher education institutions, research institutes and companies. The national research infrastructure for data management and computing will be updated, taking into account European (including EuroHPC) developments.

iv. In 2022, the Ministry of Education and Culture will launch an evaluation of the tasks, activities and funding of the Academy of Finland's Research Infrastructure Committee and its predecessor, the FIRI expert group.

Availability and utilisation of data in RDI activities

21. Ministries will promote data utilisation through open science, regulation, agreements and industry self-regulation, drawing on European and international cooperation.

22. Ministries will identify barriers to data availability and utilisation, competence, funding and investment needs, and international best practices. In addition, ministries will develop the measurement of the effects of value creation related to the data utilisation and promote the opening and use of the data resources of public sector authorities in RDI activities. Adequate availability of labour in the sector (including data analytics, artificial intelligence and cybersecurity) must be ensured in order to achieve these goals.

Research effectiveness, further processing and research-based companies

23. The Ministry of Economic Affairs and Employment, the Ministry of Education and Culture, funding providers and research organisations will jointly develop and compile a knowledge base on the commercialisation of research results and on research- and student-based companies as well as on sources of smart capital for a databank to be established later. The databank will enhance opportunities for domestic and international investors to finance and develop (smart capital) research-based companies at an earlier stage than at present.

24. Higher education institutions and research institutes will strengthen cooperation in the development and implementation of competence (including IPR practices) that support the further processing and commercialisation of research results as well as nationally networked services, operating models and business accelerators.

EU and international cooperation, networks and funding

25. The action plan for the utilisation of EU programmes, being prepared under the leadership of the Ministry of Economic Affairs and Employment, the Ministry of Education and Culture and the Ministry of Finance, will set qualitative and quantitative goals for Finland's EU participation and funding allocation. Adequate resources will be ensured for participation in and utilisation of the programmes.

i. Ministries and funding providers will coordinate better than at present national policies and funding related to EU partnerships.

ii. Higher education institutions, research institutes and companies will work together to develop approaches to utilising EU programmes.

iii. Led by the Ministry of Economic Affairs and Employment, new operating models will be developed to support the parallel use of national, regional and EU financial instruments (including Horizon Europe, Digital Europe, InvestEU programmes) with the aim of strengthening ecosystems.

26. The share of total R&D funding accounted for by international funding will be increased. Ministries will encourage RDI organisations seeking funding to strengthen their capabilities to apply for and utilise international R&D funding.

27. Under the leadership of the Ministry of Education and Culture, guidelines will be prepared during 2022 to strengthen the internationalisation of higher education and research.

28. Led by the Ministry of Education and Culture, the coverage of the Team Finland Knowledge network's operating locations will be reviewed to ensure that the network meets the needs of international higher education and RDI co-operation in the best possible way.

29. The Team Finland network will support the deepening of research and innovation cooperation with third countries, strengthening the market knowledge and partnerships of Finnish companies and RDI actors, as well as connecting to global value networks and demand-driven business ecosystems.

30. As part of their normal activities, RDI actors and ministries will strengthen science diplomacy and cooperation within it.

III Innovative public sector

The role of the public sector is to identify and exploit the potential of RDI activities and markets to advance policy objectives and to create an environment conducive to research and the development, dissemination and adoption of innovations.

Promoting RDI is a common task for all branches and levels of government. The comprehensive, proactive and broadly inclusive approach of the Government's RDI policy needs to be further strengthened. RDI policies must be part of all policies. In addition, measures promoting RDI in different policy sectors and governmental levels should be mutually supportive and parallel.

The rapid development of research, technologies and innovation and the consequent changes in people's lives, society and the economy impose a wide range of new demands on the functioning of the public sector. RDI activities will meet the development challenges of the public sector. The innovation capacity of the public sector must be strengthened by developing operating methods, competence and incentives. Innovative public procurement, regulation favourable to research and innovation, and the opening up of public information resources will create conditions for RDI activities and demand for innovations.

Research data as well as foresight and evaluation activities must be utilised more than at present. Research-based knowledge is needed, particularly on the effectiveness of RDI activities and the impact of regulation on RDI activities.

Management and coordination of RDI policy

31. The comprehensive approach of the Government's RDI policy and stakeholder dialogue, including the Research and Innovation Council's operating model, will be developed and the preparation and implementation of the RDI policy broadened. Foresight and research information will be utilised in the preparation of the RDI policy.

32. In cooperation with the ministries, a review will be conducted of the main titles of the State budget, with the aim of utilising existing budget funds for RDI activities within the administrative branches.

Renewal of the public sector

33. The Public Sector Innovation Cooperation Group, led by the Ministry of Finance, will prepare a public sector innovation programme to support the renewal and innovation capacity of the public sector. New operating models will be piloted for the implementation of systemic societal changes.

34. Innovative public procurement will be utilised to promote sustainable growth. The activities of the Competence Centre for Sustainable and Innovative Procurement KEINO will be directed towards solving societal challenges.

35. Led by the Ministry of Employment and the Economy, guidelines and practical tools will be prepared to support the preparation of regulation favourable to research and innovation (including regulatory experimentation) as well as an impact assessment.

36. The ministries will ensure that the expertise of research organisations and researchers is diversely utilised in drafting legislation from the very beginning of drafting projects. The aim is to develop a regulatory environment favourable to research and innovation.

IV Roadmap monitoring indicators

The measures in the updated roadmap will be monitored regularly and implementation reported to the Ministerial Working Group on Competence, Education, Culture and Innovation. In monitoring, the following RDI roadmap monitoring indicators will be used:

- R&D expenditure/GDP,% (broken down into business enterprise and public sector expenditure) (Statistics Finland)
- Business enterprise R&D expenditure by size class (Statistics Finland)
- Government funding for R&D/GDP, % (Statistics Finland)
- Foreign direct investment/GDP (Statistics Finland)
- EU RDI funding to be repatriated through Horizon programme (Business Finland EUTI)
- Business enterprise funding for research organisations (cooperation between companies and research organisations) (Statistics Finland)
- Internationalisation of RDI activities (residence permits issued by Finnish Immigration Service Migri for experts and researchers) (Migri)
- Number of foreign students and researchers (Statistics Finland)
- Share of doctoral degree holders of all R&D employees, change (Statistics Finland, Vipunen)

V Sources

Ali-Yrkkö, J., Deschryvere, M., Halme, K., Järvelin, A-M., Lehenkari, J.; Pajarinen, M.; Piirainen, K.; Suominen, A. (2021). The R&D activity of companies and the prerequisites for increasing R&D investments (in Finnish). Publications of the Government's analysis, assessment and research activities 2021:50.

Husso, K. & Moilanen, F. (2021) Interaction between the private sector and public research organisations in Finland: Special perspective on company–university cooperation (in Finnish). Publications of the Ministry of Economic Affairs and Employment 2021:20.

OECD (2021). Main Science and Technology Indicators. <https://www.oecd.org/sti/msti.htm>

OECD (2021). Skills for Jobs Database. https://www.oecdskillsforjobsdatabase.org/#FR/_

Ministry of Education and Culture (2017) Higher education and research 2030: Background memorandum for Vision for Finnish higher education and research 2030 (in Finnish), Publications of the Ministry of Education and Culture 2017:44. Statistics on the state of scientific research in Finland (2021). Research Funding. Academy of Finland.

Shneegans, S.; Lewis, J. and T. Straza (eds) (2021). UNESCO Science Report: the Race Against Time for Smarter Development – Executive Summary. UNESCO Publishing: Paris

Statistics on the state of scientific research in Finland (2021): Research funding (PDF, in Finnish). Academy of Finland

Statistics on the state of scientific research in Finland (2021): Research personnel (PDF, in Finnish). Academy of Finland

Statistics on the state of scientific research in Finland (2021): Scientific publishing (PDF, in Finnish). Academy of Finland

Official Statistics of Finland (OSF): Research and development [e-publication]. ISSN=1798-6206. 2020. Helsinki: Statistics Finland [referred: 7.12.2021]. Access method: http://www.stat.fi/til/tkke/2020/tkke_2020_2021-10-28_tie_001_en.html

Official Statistics of Finland (OSF): Government R&D funding in the State budget [e-publication].ISSN=1459-9074. Helsinki: Statistics Finland [referred: 14.12.2021]. Access method: https://www.stat.fi/til/tkker/index_en.html

Finnish Government (2019) Inclusive and competent Finland – a socially, economically and ecologically sustainable society. Programme of Prime Minister Sanna Marin's Government 2019. 10 December 2019. Publications of the Finnish Government 2019:33.

Ministry of Finance (2021). Government proposal to Parliament for the 2022 State budget (in Finnish) [referred: 13.12.2021], Access method: https://budjetti.vm.fi/indox/tae/frame_year.jsp?year=2022&lang=fi

Ministry of Finance General Government Fiscal Plan for 2022–2025