A 0 R&I Policy in the New Legislative Period

The governing parties have outlined their plans for the new legislative period in the coalition agreement 'Mehr Fortschritt wagen – Bündnis für Freiheit, Gerechtigkeit und Nachhaltigkeit' (Dare More Progress – Alliance for Freedom, Justice and Sustainability).[1] They have expressed the will to tackle the grand societal challenges with vigour and to set the course for a social-ecological market economy. The new federal government will have to be judged by the extent to which it succeeds in driving transformative change in the economy and society and shaping it in a socially acceptable way. These complex tasks can only be mastered if they are tackled with clever concepts and verve.

Radical Innovation Needed for Transformative Change

The Federal Government cannot rely on the fact that it is sufficient to continue to develop the technologies and economic sectors that have made Germany economically strong in recent decades, and to focus on incremental innovations geared to the highest quality and greatest efficiency. This transformative change can only be realized with considerable, often radical technological innovations, social innovations and complementary behavioural changes. Previously used technologies and existing business models will be replaced and existing consumption patterns will be questioned. At the same time, new potential for value creation will emerge, which must be exploited.

For transformative change to succeed, a change of mindset and a willingness to take entirely new paths are required – not only from business and society, but also from politics. Research and innovation policy (R&I policy) can and must make important contributions here, especially in interaction with other policy areas. In addition to the task of pushing the development and use of radically innovative technologies and supporting social innovations, R&I policy itself must also be renewed – through new formats and structures of funding policy as well as through a cultural change towards more agility.

In its Annual Report 2021, the Commission of Experts has already formulated which new paths must be taken and which new research funding structures must be set up.[2]

Developing a Comprehensive Research and Innovation Strategy

The Commission of Experts considers it necessary to develop a new, comprehensive R&I strategy based on the experiences of the High-Tech Strategy (HTS). The results of the research accompanying the HTS should be taken into account for conceptual and content-related improvements.[3]

As R&I policy is increasingly called upon to contribute to addressing the grand societal challenges, the policy approach of New Mission Orientation should be increasingly pursued and further developed in the new R&I strategy. This policy approach is characterized by so-called missions that contain specific transformation objectives and are to be pursued through R&I policy and complementary measures of other policy fields. The Commission of Experts dedicated a separate chapter to New Mission Orientation in its Annual Report 2021 and refers to the recommendations for action formulated there.[4]

The governing parties have announced that they will continue to develop the HTS in a mission-oriented manner. The coalition agreement does not contain any further references to the new R&I strategy. The Commission of Experts emphasizes that it is necessary to develop a holistic R&I strategy that encompasses the entire innovation process. The new Federal Government needs a coherent policy approach that incorporates R&I processes in their diversity and totality with all facets and to which all ministries feel committed. The German innovation system must be equipped to successfully produce not only incremental, but also radical innovations. Technological and social innovations as well as new business models should be given equal consideration in the new R&I strategy. Research and development activities (R&D activities) are to be considered from basic research to applied research and experimental development. At the same time, however, innovation processes that are not based on R&D must also be initiated.[5] In addition, there must be a greater focus on transfer to economic and social application.

Expanding 3.5 Percent Target to Include Qualitative Dimensions

In its task of implementing a comprehensive R&I strategy, the Federal Government can rely on strong stakeholders in science, business, society and politics. In the past two decades, the German R&I system has developed very well – a joint success of private-sector R&I activities and a broad state funding policy. This success is reflected in the national R&D intensity, which is an important measure for assessing the performance of national innovation systems. After reaching the three percent target in 2017, Germany has now caught up with the international top group and is aiming for the 3.5 percent target (see figure C 2-1). Germany has thus certainly lived up to its claim to play a leading international role as a location for innovation.

The Commission of Experts welcomes the fact that the governing parties are pursuing the 3.5 percent target.[6] In transformative change, however, it is not only the level of R&D expenditure that matters, but also the areas in which R&D is being conducted. Yet the available statistics only allow limited statements to be made about the use of R&D expenditure for current R&I policy priorities. The Commission of Experts therefore sees the need to expand the purely quantitative parameter of 'R&D expenditure' to include qualitative dimensions. This cannot be reflected in the corresponding statistics for R&D processes in companies and universities. However, according to the Commission of Experts, federal expenditure on R&D can be appropriately classified. To this end, the Federal Government's R&D planning system (Leistungsplansystematik), which was last revised in 2009, must be further developed so that individual funding items can be assigned to different current policy goals. This can contribute to improved monitoring processes and thus to better R&I policies.

Box A 0-1 R&I Activities in the COVID-19 Crisis

R&D Intensity

Business sector, public sector and tertiary education institutions spent just under €106 billion on R&D in 2020. In the previous year, it was still €110 billion.[7] This means that the R&D intensity, i.e. the share of the gross domestic product that is allocated to R&D, fell from 3.17 percent in 2019 to 3.14 percent in 2020, despite the lower gross domestic product.

Innovation Behaviour in the Business Sector

As part of the Mannheim Innovation Panel (Mannheimer Innovationspanel, MIP), companies were surveyed in the course of 2021 about their innovation expenditures made in 2020 as well as their planned innovation expenditures in 2021 and 2022.[8]

In 2020, innovation expenditure by companies in Germany fell by 3.6 percent compared to 2019, to €170.5 billion. At the time of the survey (spring and summer 2021), companies planned to increase their innovation expenditure by 2.1 percent and 1.2 percent respectively in 2021 and 2022 compared to the previous year.[9] Provided that innovation expenditure in 2021 and 2022 was or will be implemented as planned, it will remain just below the 2019 level in 2022.

Investing in the Future Despite the COVID-19 Crisis

The conditions for advancing transformative change have deteriorated because of the pandemic. To date, there has only been a slight decline in current and planned R&I activities (see box A 0-1). However, the immense new debt of the Federal Government poses a severe problem.[10] The debt brake enshrined in the German constitution will also restrict the political room for manoeuvre in R&I policy in the coming years. It is therefore more important than ever to set priorities wisely.

In the coalition agreement, the governing parties declared that they would ensure the necessary investments in the future, especially in climate protection, digitalization, education and research as well as infrastructure, within the framework of the debt brake.[11] The Commission of Experts is in favour of transparently communicating the time frame of all Federal Government expenditures planned for this purpose and introducing a future quota for the federal budget. The ZEW – Leibniz Centre for European Economic Research GmbH Mannheim (ZEW – Leibniz-Zentrum für Europäische Wirtschaftsforschung GmbH) has developed a practicable concept for such a future quota on behalf of the Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung, BMBF). In addition to traditional investments, the calculation also considers expenditures for maintaining and increasing human capital, natural capital and technical knowledge.[12]

A 1 Tackling Climate Targets Vigorously

Germany has set itself ambitious goals in the fight against climate change, which the new Federal Government intends to pursue even more vigorously. To this end, the development of low-carbon (low-CO_2) technologies must be initiated and further advanced – from new energy carriers such as hydrogen and alternative fuels, to new storage media and short-term electricity storage, digital control and smart grids. In addition, measures must be taken to promote the diffusion of these technologies into the markets, as they still have price disadvantages compared to established climate-damaging technologies. To promote innovations related to sustainability and climate change, suitable investment and purchasing incentives must be created for companies and consumers. In addition to the classic instruments of R&I policy, CO_2 pricing and thus the damage-adequate charging of established climate-polluting technologies are of particular importance in this context. This makes new climate-neutral technologies more attractive and competitive, enabling them to spread more quickly on the markets. Because the price increases for goods and services due to the CO_2 price hits low-income households particularly hard, appropriate measures must be taken to socially compensate for the effects of the CO_2 price via the tax and transfer system.

Increasing the Incentivising Effects of Emissions Trading

Through the European Union Emissions Trading System (EU ETS), a CO_2 price is formed on the market for the CO_2 emissions of the energy sector and the emissions-intensive industrial sectors. For a long time, however, this market price was too low to provide significant incentives to develop and demand climate-neutral technologies and products. Although the price has recently increased noticeably,[13] the Commission of Experts welcomes the plans of the governing parties to advocate an ETS minimum price at the European level[14] to create reliable incentives for the development and diffusion

of innovative low-carbon or even CO_2-neutral technologies.[15]

As part of the Fuel Emissions Trading Act (Brennstoffemissionshandelsgesetz, BEHG) passed in 2019, CO_2 pricing now is regulated for the transport and heat sectors, which had not been previously included in the EU ETS. [16] In 2021, tradable emission certificates were introduced for these two sectors, which are to be sold at a fixed price until 2025 and auctioned from 2026. A price corridor of at least €55 and a maximum of €65 has been set for the year 2026. However, the Commission of Experts does not consider the fixed prices or the price cap to be sufficiently high to initiate an innovation and diffusion process that would enable the goal of net greenhouse gas neutrality by 2045 as set out in the Federal Climate Protection Act (Bundesklimaschutzgesetz). The Commission of Experts therefore welcomes the government parties' plan to reform the BEHG, as outlined in the coalition agreement,[17] and recommends that the system be transformed as quickly as possible into a genuine emissions trading system that at most allows for a minimum price. It also supports the intention to transfer national emissions trading to the European Emissions Trading Scheme ETS 2 planned by the European Commission.[18] The Commission of Experts considers the differentiation of reduction targets by sector provided for in the Federal Climate Protection Act to be impracticable and sees the problem that this does not result in the most cost-effective investments being made to save CO_2.

Critically Examining the Climate Impact of Subsidies

The Immediate Climate Protection Programme 2022 (Klimaschutz Sofortprogramm 2022) indicated that the initial financial support for the switch to climate-friendly technologies is to be gradually replaced by price incentives and regulatory measures.[19] The coalition agreement now provides for super depreciation for climate protection investments.[20] Although this instrument can generate significant innovation effects in the area of climate-friendly technologies and business models, it is in essence a new subsidy. The Commission of Experts points out that depreciation rules for special climate-friendly investments are always associated with the risk of greenwashing in the application process. Moreover, the demarcation between climate-protecting and non-climate-protecting investments is always subject to a certain arbitrariness.[21] The Commission of Experts therefore recommends that the instrument of super depreciation as a catalyst be limited in time. In the long term, efficient innovation incentives should be set in all sectors via a sufficiently high CO_2 price.

The governing parties have also agreed to fundamentally reform the state-induced price components in the energy sector, i. e. levies, surcharges and taxes on energy, and to reduce subsidies that are harmful to the environment and climate.[22] The Commission of Experts supports this plan and calls for swift implementation. However, since the examination of the harmfulness of subsidies to the climate can be complex in individual cases and the result may not always be clear,[23] the Commission of Experts advocates a general reduction in the level of subsidies.

Testing New Incentive Instruments with Carbon Contracts for Difference

In its pilot programme Carbon Contracts for Difference (CCfD)[24], the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz, BMUV; in the previous legislative period Federal Ministry for the Environment, Nature Conservation and Nuclear Safety – Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit, BMU)[25] plans to test an instrument to promote fundamentally mature technologies whose market introduction is not worthwhile at the prevailing CO_2 price level.[26] Through CCfD[27], differences between CO_2 avoidance costs and the respective current market price for emission certificates are compensated up to an agreed amount. This can provide additional incentives for investment and innovation.[28]

The Commission of Experts is ambivalent about this instrument. On the one hand, it welcomes in principle the testing of new incentive mechanisms such as CCfD within real-world laboratories. In particular, it supports the intended use of bidding procedures to promote the most efficient companies and technologies. At the same time, the Commission of Experts points out that CCfD is also a new form of subsidy that entails a number of problems. On the one hand, it is fundamentally subject to state aid law.[29] On the

other hand, the instrument can lead to competitive sustainable technologies being held back by companies in order to then offer them via CCfD. In addition, it needs to be clarified how the baseline emission levels are to be determined, the undercutting of which then counts as an emission reduction in the sense of the CCfD. Moreover, the draft policy provides for the promotion of certain technologies and is thus not designed to be open to new technologies. Finally, the draft contains several complex rules and conditions whose practicability is questionable. The Commission of Experts therefore recommends testing and evaluating the instrument within a limited time and technology range. In principle, the Commission of Experts considers the introduction of minimum CO_2 prices to be the much more practicable, less distorting and easier to implement instrument.

Developing Long-term Strategies for Negative Emissions

To limit the expected overshooting of the 1.5 degree target,[30] net-negative CO_2 emission paths must be established. Therefore, in addition to incentives to avoid emissions, it is necessary to implement measures to remove CO_2 from the atmosphere and store it safely in geological formations or in the deep sea, so-called negative emissions. The Commission of Experts welcomes the plans of the government parties to develop a long-term strategy on negative emissions.[31] There is still a considerable need for R&D in various terrestrial and marine approaches to increase natural atmospheric CO_2 removal as well as in approaches to technical CO_2 removal, so-called direct air capture, with regard to implementation and scaling. This need should be met through public funding. In the future, to promote the diffusion of negative emission technologies, negative emissions and CO_2 reductions should be treated equally in the EU ETS, provided that verification is reliable.[32]

Establishing Climate Clubs

Domestic low-emission technologies are in international competition with lower-cost emission-intensive technologies. Although a CO_2 price provides investment and innovation incentives for low-emission technologies at home, it also carries the risk that emission-intensive production processes will shift abroad and correspondingly emission-intensive products will be imported from abroad. The establishment of an international climate club with a uniform minimum CO_2 price ensures a level playing field within the club. With a common CO_2 border adjustment mechanism, low-emission technologies within the club are protected from competition with cheaper emission-intensive technologies from outside.[33] To compensate for international differences in CO_2 pricing, a levy based on the CO_2 footprint of imports is imposed on imported goods. These measures can create incentives for the development of low-emission technologies both inside and outside the climate club. The Commission of Experts therefore strongly supports the intention of the governing parties to launch an initiative together with their European partners to establish an international climate club open to all states with a uniform minimum CO_2 price and a joint CO_2 border adjustment.[34]

A 2 Catching Up and Avoiding Technological Gaps

To be able to take full advantage of the new potential for value creation that is emerging in the transformative change, Germany must assert itself as a location for innovation. However, Germany is lagging behind internationally in the development of radically new technologies and their application.[35] Asian countries, along with the USA, are increasingly emerging as providers of such tech-

nologies. China, in particular, has caught up internationally in the performance of its R&I system in recent years and is actively working to take a leading role in important future technologies and become the world's leading innovation location.

To take a strong position in global competition and maintain technological sovereignty, it is not only necessary for Germany to catch up with existing technological gaps, but also to become an international leader in future technologies. To this end, Germany should further develop its performance and attractiveness as an innovation location in concert with the other Member States of the European Union (EU) and advance its ambitious R&I policy goals in a division of labour. In addition, innovation partnerships should be promoted at the global level.

Establishing a Monitoring and Advisory Body for Key Enabling Technologies

Key enabling technologies are characterized (cf. chapter B 1) by the fact that they enable, support and promote innovation activities in a large number of other technologies and industries. They generate an above-average broad impact in terms of technologies and industries and thus make a decisive contribution to the transformation of the economy and society. Key enabling technologies can currently be identified in production technologies, materials technologies, bio- and life sciences and digital technologies. While Germany has strengths in production technologies and in the bio- and life sciences, it shows considerable weaknesses in the development of digital technologies. There is a danger of not keeping pace in this increasingly important technology area, which is also having an increasing impact on other key enabling technology areas such as production technologies. Germany is dependent on imports from China, particularly in the area of digital technologies (cf. chapter B 1). The Commission of Experts therefore welcomes the plans of the government parties to push forward the development of key enabling technologies in a targeted manner.[36]

To be able to promote key enabling technologies in a targeted manner, it is necessary to identify them continuously by means of foresight and monitoring measures and to track their development. The Commission of Experts sees the danger that certain industries will be declared key enabling technologies out of particular interests. For instance, the governing parties intend to declare naval submarine and surface shipbuilding a key enabling technology,[37] even though it fails to meet all the criteria for a key enabling technology.

To ensure that the complex task of identifying key enabling technologies is not determined by assertive individual interests, an independent monitoring unit should be commissioned, consisting of several relevant and, if possible, European research institutions. The Commission of Experts also advocates the establishment of an independent strategic advisory body to be entrusted with the evaluation of the results. This advisory body should continuously update a key enabling technologies portfolio and develop recommendations for action for the Federal Government on how to deal with selected key enabling technologies.

Further Promoting Digital Technologies of the Future

In the past, the Federal Government has already recognized the importance of various digital technologies of the future and begun to promote them through strategies or framework programmes.

For example, in November 2018, the then Federal Government adopted a strategy for the promotion of artificial intelligence (AI strategy) and updated it in December 2020.[38] €5 billion were made available for this purpose until 2025, including the funds from the Economic Stimulus and Future Package (Konjunktur- und Zukunftspaket). As of 31 August 2021, almost €3.5 billion has been included in the budgets of the federal ministries, but less than 10 percent of this has been spent.[39] While the exploratory paper of the coalition parties spoke of a new AI strategy to be set up,[40] the coalition agreement does not provide any detailed direction in this regard. The Commission of Experts suggests that the Federal Government continue to press ahead with the AI strategy and develop concepts to use the funds in a targeted manner.[41]

Another example is the framework programme 'Quantum Technologies – from the Basics to the Market' (Quantentechnologien – von den Grundlagen zum Markt), which was adopted in 2018 by the then Federal Government.[42] With funds from the Economic Stimulus and Future Package, a total

of around €2 billion is available for funding until 2025.[43] The Commission of Experts takes a positive view of the fact that a quantum computing roadmap was developed by a council of experts[44] and that quantum computers[45] are already being set up at various locations in Germany. It also welcomes the fact that the governing parties are committed to promoting quantum technology in the coalition agreement.[46] The Commission of Experts expects the Federal Government to further develop the framework programme for quantum technologies beyond 2025 and to provide adequate funding.

Further Expansion of the Digital Infrastructure

With the advancing digitalization of the economy and society, the need for digital infrastructure is growing. This promotes innovation and thus has a strong influence on Germany's future and competitiveness. In June 2021, 62.1 percent of households in Germany had a broadband network connection enabling transmission rates of at least 1 Gbit/s.[47] The share was significantly higher in urban areas, with 78.4 percent of all households, than in semi-urban and rural areas, where it was 47.1 and 22.9 percent, respectively.[48] The Digitalization Index 2021 shows that, despite the COVID-19 pandemic, there has been no digitalization surge at all levels for businesses.[49]

As digitalization is making its way into all areas of life, e. g. smart home, autonomous driving (cf. chapter B 2), health (cf. chapter B 4), it is important to have a supply of fast internet not only in conurbations but also in rural areas. The Commission of Experts therefore welcomes the fact that the coalition agreement names a whole bundle of potentially target-oriented instruments to accelerate the expansion of fibre-optic networks and networks for the latest mobile communications standard.[50]

Promoting E-government

By the end of 2022, 575 public administrative services must be offered electronically throughout Germany in accordance with the Online Access Act (Onlinezugangsgesetz, OZG).[51] As of 30 September 2021, only 84 of these administrative services have been digitized and made available online in every municipality.[52] The Standards Control Council (Normenkontrollrat) has determined that the goal of making all administrative services available online by the end of 2022 is no longer achievable.[53] The Commission of Experts therefore welcomes the fact[54] that the new government parties are designating clear responsibilities and finally pushing ahead with the implementation of the OZG and the standardization of structures and processes with a central budget.[55]

Rapidly Creating a High-performance Cloud Infrastructure

A functioning and reliable cloud infrastructure is one of the basic prerequisites for the success of the digitalization of the federal administration. The Commission of Experts therefore welcomes in principle the plans of the government parties to accelerate the expansion of the existing cloud infrastructure[56] towards a multi-cloud solution.[57] Here, concepts are also being drawn up with solutions from established cloud providers.[58] However, the Commission of Experts notes that despite the need for a rapid solution, open source solutions should also continue to be pursued.

Strengthening Cybersecurity

According to the assessment of the Federal Office for Information Security (Bundesamt für Sicherheit in der Informationstechnik, BSI), the threat situation from cyber criminals has intensified over the course of the last year.[59] Recent cyber attacks or security vulnerabilities, e. g. the critical Log4Shell vulnerability in some Java applications that became known in December 2021,[60] have shown that these can limit the sovereignty and ability to act of administration, science and business.[61] The Commission of Experts therefore welcomes the fact that the government parties are planning to focus on cybersecurity as part of a cybersecurity strategy.[62] To bundle skills and expertise, the Commission of Experts suggests that the Agency for Innovation in Cybersecurity (Agentur für Innovation in der Cybersicherheit) be involved and cooperate with the BSI. At the same time, the Commission of Experts criticizes the fact that the coalition agreement contains no statement on the further development of this immensely important agency.[63]

Focus on Promoting the Semiconductor Industry

Semiconductors and microchips have become indispensable in electronic products and thus also in automobiles. The current chip shortage illustrates the relevance of this technology area. It means, for example, that car manufacturers have to cut back on production and that household electrical appliances are not available.[64]

The production of semiconductors is a complex process currently characterized by the international division of labour. Individual countries specialize in certain technologies such as memory chips or processors as well as in certain manufacturing steps such as design or production.[65] The coalition parties plan to promote the semiconductor industry in Germany along the entire value chain.[66] The Commission of Experts states that promotion should focus on selected sub-sectors in which competitive advantages can be achieved jointly with the EU. In addition, the funding should be catalytic, i. e. not permanent. The Commission of Experts welcomes the Federal Government's intention to become more involved at European level in the Important Project of Common European Interest Microelectronics and Communication Technologies.[67]

Harnessing the Innovation and Value Creation Potential of Data

High-quality research data are a central basis for new insights as well as innovations. The Commission of Experts therefore welcomes the fact that the coalition parties want to improve and simplify access to data for research with a Research Data Act and want to further develop the National Research Data Infrastructure and also promote a European Research Data Space.[68] Because the innovation and value creation potential of health data is particularly high, it is necessary to facilitate the use of this data for science (cf. chapter B 4). The Commission of Experts therefore considers the Health Data Use Act (Gesundheitsdatennutzungsgesetz)[69] announced in the coalition agreement to be expedient, which takes into account the high sensitivity of health data. The planned decentralized research data infrastructure can help to improve access and the associated opportunities for use.

The establishment of a data institute planned in the coalition agreement, which is to drive data availability and standardization and establish data trustee models and licences,[70] can support the realization of innovation and value creation potential. However, the Commission of Experts points out that there are already existing competences in research data centres that currently fulfil some of these tasks. Close coordination should therefore take place to avoid parallel structures and to bundle competences.

A 3 Strengthening the Skilled Labour Base Through Education and Training

The proportion of companies whose business activities are hampered by a shortage of skilled workers rose sharply again in all sectors of the German economy in 2021. The lack of skilled workers is a problem especially for small and medium-sized enterprises (SMEs) in industry. Major shortages of skilled workers are emerging in the area of STEM professions.[71] In many professions relevant to the implementation of more climate protection, the foreseeable demand for skilled workers, including

in the skilled trades, cannot be met by the currently trained next generation.[72] In order for Germany to be able to realize the innovations and productivity gains required to cope with the ongoing transformations and major tasks of the future, the strengthening of the skilled labour base should be accelerated. To ensure a good supply of suitably qualified workers, schools and tertiary education institutions as well as vocational and continuing education and training must become more efficient, more needs-based and more socially permeable.

Better Teaching of STEM Skills in Schools

Key competences for coping with transformative change must already be developed at school. The Commission of Experts therefore observes with great concern the results of school performance studies, according to which the mathematical and scientific performance of pupils has fallen continuously since 2012. One in five young people does not reach the level of STEM skills that can be considered a viable basis for further education at school or in a profession.[73] As far as digitalization is concerned, additional financial resources from the Federal Government have recently made it possible to achieve improvements in infrastructure. However, many schools lack IT staff[74] to ensure administration and support for teachers.[75] In addition, many teachers are not yet sufficiently qualified to use digital tools in the classroom.[76]

The Commission of Experts therefore supports the plan of the governing parties to convene an education summit[77] to achieve cooperation geared towards ambitious educational goals with the Länder and municipalities within the existing constitutional framework. Since digital skills are a key qualification for mastering the challenges facing society, it also supports the plan to continue the Digital Pact for Schools (DigitalPakt Schule) until 2030[78] and to sustainably improve the digital equipment of schools. However, the provision of digital learning tools must be secured by innovative concepts for teaching, and sufficient staff capacities. This also applies to the planned additional equipment of schools in disadvantaged neighbourhoods via a starting opportunities programme (Startchancen-Programm),[79] which, in the view of the Commission of Experts, could make an important contribution to developing the talents of children and young people from disadvantaged backgrounds. To improve STEM skills, the Commission of Experts recommends that learning content and teaching methods be put to the test, that impending bottlenecks in the supply of qualified teachers in STEM subjects be combated more actively and that the school subject of computer science be expanded.

Ensuring the Quality of Tertiary Education

High-quality higher education is of direct importance for research and innovation. With the Pact for Future Strengthening Study and Teaching (Zukunftsvertrag Studium und Lehre), the Federal Government and the Länder have been providing substantial funds since 2020 to improve study conditions and teaching quality at all tertiary education institutions. The Commission of Experts welcomes the dynamization of these funds as provided for in the coalition agreement.[80] Provided that the Länder go along, this will provide the necessary planning security.

The Commission of Experts also welcomes the announced federal programme 'Digitale Hochschule' (Digital Tertiary Education Institutions),[81] to promote concepts for the expansion of innovative teaching, qualification measures, digital infrastructures and cyber security. Competitively awarded project funds create incentives for innovation. In addition, however, the Commission of Experts once again calls[82] for the Federal Government and the Länder to provide an annual digitalization allowance of €92 per student, which should be made dynamic, in order to permanently improve existing deficits in the conditions for digital teaching across the board.

Making the Dual VET System More Attractive

Dual-system vocational education and training (VET) in a workplace context contributes significantly to Germany's high labour productivity and makes it easier for employees and employers alike to implement innovations and manage transformative change. However, the VET system is undergoing a transformation that the COVID-19 crisis may have accelerated. In 2021, almost 10 percent fewer training contracts were concluded than in 2019. A strong

slump in the number of applications, which has been declining for a long time, contributed to this.[83]

The Commission of Experts advises the new Federal Government to make in-company VET more attractive from both the supply and demand sides and thus stabilize it. On the supply side, the support programme 'Ausbildungsplätze sichern' (Securing apprenticeship places), launched in 2020 for companies, should be continued for a limited period of time in view of the particular economic uncertainty that continues to exist. On the demand side, career guidance and counselling measures should be stepped up to boost interest, especially in the VET occupations relevant to managing transformative processes. The Federal Government should also work to ensure that all training regulations are adapted to digitalization. Advice and support for the implementation of digitalization-oriented training should be expanded, especially for SMEs, for example through increased support for training alliances.[84] The Commission of Experts supports the announced pact to strengthen and modernize vocational schools.[85] However, this must be provided with sufficient funds, which should be used primarily for the digitalization of these schools and the qualification of teachers there to teach increasingly complex content and skills.

Strengthening Professional Adaptability Through Continued Training

Transformative change processes increase the demands on professional adaptability and thus also on continuing education and training (CET). The possibilities for subsidizing employers who provide CET to employees in jobs that can be replaced by new technologies and those affected by structural change have been significantly expanded in recent years.[86] Nevertheless, the trend towards more subsidized CET measures has not yet noticeably increased.[87] The Commission of Experts therefore recommends that the existing possibilities within the framework of employment promotion be made better known and that the conditions for obtaining financial support be made simpler and more flexible. On a trial basis, the subsidies to employers to compensate for CET costs should be increased while maintaining an appropriate own contribution by the companies, and the effects of this measure should be evaluated.

The Commission of Experts, on the other hand, is critical of the qualification allowance (Qualifizierungsgeld)[88] planned by the governing parties. This new instrument is intended to enable companies in structural change to keep their employees in the company through qualification. However, it makes the system of CET support by the Federal Employment Agency (Bundesagentur für Arbeit, BA) even more complex, is preconditional because it is tied to a company agreement and can inhibit the mobility of workers necessary to cope with structural change. In this context, the Commission of Experts repeats its call from the Annual Report 2021 to promote preventive bridge solutions, i. e. anticipatory adaptation training for employees for whom continued employment with the previous employer is foreseeably not possible.[89] This requires the cooperation of all relevant stakeholders on the ground with the participation of the BA. The Commission of Experts therefore takes a positive view of the establishment of CET alliances and CET agencies[90] planned by the governing parties and recommends in this context that solutions, which involve adequate financial contributions from both the transferring and the receiving company, be tested and evaluated regionally.[91]

To better cushion structural change, support for employees who seek CET independently of their employer should also be expanded. To this end, it makes sense to provide adequate financial subsidies to cover living expenses during CET. In the opinion of the Commission of Experts, the 'Lebenschancen-BAföG'[92] announced by the governing parties to promote self-determined CET[93] is unsuitable for this purpose, as it is not linked to the prerequisites that the CET funded by it is usable in the labour market and thus contributes to improving individual employment opportunities.

In view of the need for increased lifelong learning, the Commission of Experts welcomes the announcement of the government parties to continue the National CET Strategy.[94] However, the announced new focus on general CET must not lead to vocational CET, which is key to coping with transformative change, falling behind.

A 4 Increasing Innovation Participation

Innovation activities on a broader level are needed if the grand societal challenges are to be met and the new innovation potentials associated with the transformations are to be unlocked in the process. In recent years, there has been a declining trend in innovator rates and a less dynamic start-up activity in the knowledge economy. To counteract these trends, the new Federal Government should improve the conditions for participation in R&I activities with the help of tailored support measures. R&I policy should address a broad group of stakeholders. Traditionally, start-ups and academic spin-offs as well as SMEs come to mind here. However, non-R&D enterprises, which are particularly characteristic of structurally disadvantaged regions, and so-called social enterprises, which address social and ecological problems with entrepreneurial means, should also be given greater attention.

Improving Conditions for Start-ups

Young companies with high growth potential, so-called start-ups, play an important role in the innovation system.[95] The Commission of Experts welcomes the intention of the government parties to adopt a comprehensive start-up strategy and to develop Germany into a leading start-up location.[96] The considerations to improve start-up conditions in general, for example by easing bureaucratic processes and by setting up nationwide one-stop shops for start-up advice, promotion and registration,[97] represent the first welcome steps in the desired direction.

An adequately equipped venture capital market creates good financing conditions for the establishment and successful development of technology companies. The governing parties have announced that they will continue to develop the Future Fund launched by the previous government in 2021.[98] With the modular expansion to include a growth fund and thus the opening to institutional investors, they are following earlier recommendations of the Commission of Experts.[99] With a view to further modular expansions, the Commission of Experts is in favour of also developing a module for impact investing, which, in addition to the goal of generating returns, also pursues social, environmental and climate-related goals that can be measured in the long term.[100] The Commission of Experts supports the objective of the governing parties to increase the share of female founders in the digital sector.[101] It proposes to develop a venture capital module specifically for female founders with resources from the Future Fund and to provide scholarship funds in the EXIST programme alongside this.

The planned facilitation of initial public offerings (IPOs), especially for growth companies and SMEs, as well as the improvement of the conditions for employee participation in start-ups are to be seen as positive.[102]

In the coalition agreement, spin-offs from science receive special attention. The culture of spin-offs at tertiary education institutions and non-university research institutions should be strengthened and the cultural change required for this should be accompanied by science entrepreneurship initiatives.[103] Evaluation results should be taken into account in the development of the corresponding measures.[104] Furthermore, the coalition agreement envisages providing tertiary education institutions with funds for the creation of a start-up infrastructure for technological and social entrepreneurship.[105] The Commission of Experts considers it essential to considerably professionalize the start-up and transfer infrastructure that generally already exists at tertiary education institutions, to structurally supplement it with makerspaces and similar formats, and to debureaucratize the processes implemented there.

Aligning R&I Funding with Potential

The coalition agreement provides for all federal funding programmes to be regularly reviewed for their regional impact and for the results to be

published in a periodic equivalence report.[106] This monitoring is intended to be a binding basis for the further development of all funding programmes. The Commission of Experts sees the danger that this approach will mix up R&I policy and structural policy goals. To avoid this, it believes that a differentiated, potential-oriented approach is required.[107]

In the opinion of the Commission of Experts, the focus of R&I policy must continue to be on the promotion of excellent innovation projects, even if not all regions will benefit equally.

In the course of transformative change, new regional innovation ecosystems will emerge, through which development opportunities for structurally weak regions can arise. The Commission of Experts considers the promotion of such regional innovation ecosystems, as is currently being pursued within the framework of the Innovation and Structural Change programme family (Programmfamilie Innovation und Strukturwandel),[108] to make sense if these funding formats are selected according to criteria of excellence.

The Commission of Experts sees a danger in the government parties' intention to prioritize support for the expansion and establishment of non-university institutions in regions that are currently under-equipped,[109] and that decisions will not be made on the basis of topical suitability. It therefore advocates making location decisions based on the potentials available in the regions and the thematic strengths already developing – in the sense of the smart specialization approach.[110]

The increase in funding announced in the coalition agreement for the Joint Task of Regional Economic Development (Gemeinschaftsaufgabe Regionale Wirtschaftsentwicklung) for Innovation Promotion, Digitalization, Operational Productivity Targets, Sustainability and Decarbonization[111] takes into account the Commission of Experts' call, expressed in the Annual Report 2020, for structural policy to be even more innovation-oriented than before.[112]

Avoiding Distortions in Innovation Competition

The governing parties have expressed the will to establish innovation regions based on the British model,[113] by creating privileged framework conditions for R&I activities, such as tax breaks, at individual locations. The Commission of Experts is extremely critical of this idea because it creates serious distortions in innovation competition. The goal should be that attractive overall conditions for R&I activities prevail in all regions. The emergence of lighthouses can be supported by promoting clusters – as is currently being done within the framework of the Clusters4Future Initiative (Zukunftscluster-Initiative).[114]

Making Public Procurement Innovation-oriented

Public procurement can provide important impulses for innovation activities and participation, given the considerable volume of procurement. The governing parties have agreed to make public procurement and awarding more economic, social, ecological and innovative.[115] The Commission of Experts is again in favour of making awarding practice more innovation-oriented and establishing a 'priority for the innovative offer' as an award criterion for this. However, such a criterion should include a careful weighing of the expected positive innovation effects against the potential additional costs of procurement.

A 5 Developing Agile Governance Structures

In its Annual Report 2021, the Commission of Experts emphatically pointed out that the R&I policy tasks and missions associated with the upcoming transformative change require agile policy action.[116] The Federal Government was called upon to develop corresponding governance structures for the ministries and administrations, on the basis of which not only fast and flexible action is taken, but long-term decisions are also proactively prepared, relevant stakeholders are involved at an early stage, and measures and structures implemented are continuously reviewed and adapted if necessary. In this context, isolated measures, especially agency concepts, have been discussed and proposed during the federal election campaign. The Commission of Experts has commented on this in policy briefs.[117] It welcomes the announcement by the governing parties to overcome a silo mentality and to endow permanent interdepartmental and interagency agile project teams and innovation units with concrete competences.[118]

Acting Agilely in Digital Policy

The digital transformation is proceeding very slowly in Germany (cf. chapter A 2) and must therefore be accelerated significantly in the new legislative period. Despite all efforts, the previous structures and processes within the Federal Government have not succeeded in igniting the necessary dynamism in the international competition for digitalization.[119] In the run-up to the coalition negotiations, the Commission of Experts advocated driving forward digitalization with a new type of ministry and equipping it with structures and processes that enable agile policy action.[120] Instead of establishing a separate digital ministry, the new Federal Government has expanded the responsibilities of the previous Federal Ministry of Transport and Digital Infrastructure (Bundesministerium für Verkehr und digitale Infrastruktur, BMVI), which is underlined by the renaming of the ministry as the Federal Ministry for Digital and Transport (Bundesministerium für Digitales und Verkehr, BMDV). At the same time, many tasks related to digitalization remain in other departments. In this new structure, it is necessary to coordinate the digital policy activities of the various ministries more tightly than before and to align them with each other. In addition to the responsibilities of the various ministries, the interfaces must also be clearly defined and structurally anchored through corresponding interdepartmental project teams or task forces.

Rapidly Improving Conditions for SprinD

With the establishment of the Federal Agency for Disruptive Innovation (SprinD), a completely new funding concept was institutionalized in 2019, which for the first time focuses on the promotion of radically innovative technologies and processes. SprinD's activities are aimed at transferring results from (basic) research, the implementation of which is associated with high risks and at the same time high investment requirements, into practical application. To be able to cope with its specific tasks, SprinD was given an institutional structure that is clearly different from the structures of the ministries and project executing agencies. The Commission of Experts has expressly welcomed the establishment of SprinD and calls on the Federal Government to swiftly and effectively implement the improvement of the legal and financial framework conditions for SprinD[121] announced in the coalition agreement. To this end, for example, leeway under procurement law, budgetary law and subsidy law must be more courageously exploited and, if necessary, expanded. It is important that SprinD can act independently of operational control by the ministerial bureaucracies.

Do Not Rely on Agency Solutions as a Panacea

In addition to SprinD, the coalition agreement outlines two new agencies to promote innovation activities.

The establishment of a German Agency for Transfer and Innovation (Deutsche Agentur für Transfer und Innovation, DATI) is planned with the aim of boosting application-oriented research and transfer as well as regional and supraregional innovation ecosystems.[122] According to the coalition agreement, this agency is to promote social and technological innovations, particularly at universities of applied sciences (UAS) and small and medium-sized universities. According to the government parties, existing funding programmes for UAS are to form the basis for DATI and be expanded. There are also plans to bundle relevant funding programmes from various ministries under the umbrella of DATI. The Commission of Experts views the establishment of such an agency with scepticism. The tasks assigned to DATI largely coincide with those for which the project management agencies are responsible. The Commission of Experts is of the opinion that the establishment of new agencies only makes sense if they take on tasks in the German R&I system that were not previously covered, neither by state funding programmes and research institutions nor sufficiently by the involvement of private stakeholders, and for the fulfilment of which institutional requirements are necessary that do not yet exist.[123] The Commission of Experts cannot recognize this in the case of a DATI. It would be more targeted to reform the project-executing agency model with the aim of raising efficiency and agility potentials.

The governing parties are planning to expand the promotional bank KfW as an innovation and investment agency – especially for AI, quantum technology, hydrogen, medicine, sustainable mobility, bioeconomy and circular economy. The Commission of Experts believes it makes sense to strengthen KfW's function as a promotional bank that facilitates investments in innovative technologies and acts as a co-venture capital provider. However, it is opposed to expanding KfW into an agency that engages in classic R&I promotion.

Integrating Evaluations and Policy Learning More Strongly into Processes

The Commission of Experts has already spoken out several times in favour of integrating policy learning more strongly into R&I policy processes.[124] A policy of experimentation and evaluations are important cornerstones here.

Insights into the effect of alternative regulatory approaches can be gained through the establishment of real-world laboratories. The Commission of Experts therefore considers the creation of a legal basis for real-world laboratories announced by the governing parties to be sensible.

Evaluations of R&I policy measures are important for generating learning effects for future R&I funding measures. The significance and thus the usefulness of these evaluations also depend on what information and data are available for the evaluations. The Commission of Experts recommends that evaluation should already be planned when designing R&I funding measures and that the institutions carrying out the evaluations should be given access to relevant information and data at an early stage. In order for evaluation results to be of greater value for policy learning and policy making, awareness of the benefits of evaluations should be raised. This requires a better understanding of how to conduct evaluations professionally, as well as a positive error culture that enables learning from failure.[125]

In recent decades, R&I policy has become increasingly diverse and complex. The current funding measures are based on various policy approaches pursued in parallel by different ministries.[126] Against this background, the Commission of Experts advocates not only evaluating the individual R&I policy measures individually, but also initiating an evaluation of the entire funding architecture. In this context, redundancies in R&I funding should be determined and funding gaps identified.[127]