REPORT ON RESEARCH,
INNOVATION AND TECHNOLOGICAL
PERFORMANCE IN GERMANY

COMMISSION OF EXPERTS
FOR RESEARCH
AND INNOVATION

EFI

# REPORT 2024

2025 2026 2027 2028 2029 2030 2031 2032

This is a translated version of the original German-language "Kurzfassung" which is the sole authoritative text.

# EXECUTIVE SUMMARY

**We would like to thank**

Lama Ahmad, Arian Ajiri, Dr. Maximilian Alber, Prof. Dr. Peter-André Alt, Amir Amidi, Dr. Beate Antonich, Dr. Fritz Audebert, Dr. Steffen Beerbaum, Prof. Dr. Tim Beissinger, Dr. Christian Bock, Dr. Christian Böhm, Milena Bömeke, Julia Bremer, Christopher Briem, Zarah Bruhn, Charlott C. Buchholz, Nicole Burkhardt, Marco Casalaina, Dr. Christine Chemnitz, Sybil Chen, Matthew Claxton, Jessamine Davis, Prof. Dr. Hans-Georg Dederer, Prof. Sabina Deitrick, Ph.D., Prof. Dr. Christian F. Doeller, Jay Douglass, Alexander Dudde, Carlos Escapa, Prof. Dr. Peter Feindt, Alexandra Feisthauer, Prof. Dr. Robert Finger, Bill Flanagan, Prof. Erica R. H. Fuchs, Ph.D., Dr. Dominik Ganser, Peter Ganten, Gian Gentile, Ph.D., Sandro Gianella, Cody Gill, Dr. Michael A. Glass, Prof. Dr. Michael Granitzer, Robert Grey, Prof. Dr. Hans W. Griepentrog, Alexandra Groß, Florian Gwosdz, Peter Hallinan, Prof. Dietmar Harhoff, Ph.D., Dr. Martin Hellfeier, Johannes Heidecke, Dr. Sven Hendricks, Dr. Stefan Heumann, Dr. Kai Hielscher, Dr. Robert Hoffie, Dr. Tobias Hoffmann, Prof. Dr. Karin Hoisl, Dr. David A. Honey, Eric Hough, Prof. Dr. Eva Jakob, Dr. Susan Jenkins, Prof. Dr. Christian Jung, Jay Katarincic, Zara Khan, Dr. Anja Klatt, Matthias Kleinz, Ph.D., David Korenke, Prof. Dr. Hilde Kühne, Prof. Dr. Uwe Latacz-Lohmann, Caitlin Lee, Ph.D., Johannes Lehmann, Philip Lehman, Ph.D., Stefan Lenz, Dr. Andreas Liebl, Prof. Dr. Hermann Lotze-Campen, Prof. Richard K. Lyons, Ph.D., Christian Manders, M. Wade Markel, Ph.D., Prof. Dr. Volker Markl, Craig Markovic, Christopher Martin, Rachel Mauer, Prof. Theresa Mayer, Ph.D., Prof. Tim McNulty, Ph.D., Pamela Mishkin, Catherine Mott, Dr. Bertold Neizert, Osman Nergiz, Michael Neuber, Paul Overby, Hubertus Paetow, Giambattista Parascandolo, Ph.D., Bill Peduto, Alexander Peter, Prof. Dr. Peter Pickel, Elizabeth Proehl, Ryan Pulley, Prof. Dr. Matin Qaim, Prof. Dr. Matthias Raith, Dr. Christian Rammer, Dr. Hedi Razavi, Christopher Reed, Prof. Phillip Regalia, Ph.D., Dr. Dominik Rehse, Dr. Arvid Requate, Constanze Ruesga Rath, Joachim Rukwied, Kirsten Rulf, Evelina Santa-Kahle, Prof. Sebastian Scherer, Ph.D., Nelli Schiebeler, Prof. Dr. Karl Schmid, Dr. Magnus Schmitt, Dr. Georg Schütte, Beth Schwanke, JD, Prof. Nicholas Shapiro, Ph.D., Sally Sleeper, Ph.D., Dr. Richard Socher, Prof. Dr. Achim Spiller, Stacey D. Standridge, Ph.D., Hans Jürgen Stephan, Prof. Dr. Stefan Stiene, Elisabeth Vögele, Dr.-Ing. Martin Walgenbach, Matthew A. Weinbaum, Dr. Peter Welters, Dr. Friederike Weritz, Laura Wittmann, Brad Zamft, Ph.D.,

all of whom contributed their expertise to the report.

We also express our thanks to all those who helped prepare the studies on the German innovation system.

The Commission of Experts wishes to emphasize that the positions expressed in the report do not necessarily represent the opinions of the aforementioned persons.

## Members of the Commission of Experts for Research and Innovation (EFI)

**Prof. Dr. Irene Bertschek**
**(Deputy Chair)**
ZEW – Leibniz Centre for European Economic Research, Research Unit Digital Economy, and Justus Liebig University Giessen, Faculty of Economics and Business Studies

**Prof. Dr. Guido Bünstorf**
University of Kassel, Faculty of Economics and Management, Economic Policy, Innovation and Entrepreneurship (EPIE) group, and International Center for Higher Education Research (INCHER)

**Prof. Dr. Uwe Cantner**
**(Chair)**
Friedrich Schiller University Jena, Faculty of Economics and Business Administration, Chair of Economics/Microeconomics, and University of Southern Denmark, Odense, Department of Marketing and Management

**Prof. Dr. Carolin Häussler**
University of Passau, Faculty of Business, Economics and Information Systems, Chair of Organisation, Technology Management and Entrepreneurship

**Prof. Dr. Till Requate**
Kiel University, Department of Economics, Chair of Innovation, Competition Policy and New Institutional Economics

**Prof. Dr. Dr. h.c. Friederike Welter**
Institut für Mittelstandsforschung (IfM) Bonn and University of Siegen, Faculty III School of Economic Disciplines, Professor of Business Administration, esp. SME Management and Entrepreneurship

This report is also the result of the highly competent and dedicated work of the staff of the Commission of Experts' Office and the staff of the Commission Members.

## Staff of the EFI Office

**Christine Beyer**
**Dr. Helge Dauchert**
**Dr. Lea Eilers**
**Lea Gudowski**
**Dr. Friederike Heiny**
**Dr. Petra Meurer**
**Antje Michna**
**Christoph Oslislo**
**Dr. Johannes Stiller**

## Staff of the Commission Members

**Eric Arndt** Kiel University, Department of Economics, Chair of Innovation, Competition Policy and New Institutional Economics

**Dr. Stefan Büchele** University of Kassel, Faculty of Economics and Management, Economic Policy, Innovation and Entrepreneurship (EPIE) group, and International Center for Higher Education Research (INCHER)

**Lukas Dreier** Friedrich Schiller University Jena, Faculty of Economics and Business Administration, Chair of Economics/Microeconomics

**Dr. Daniel Erdsiek** ZEW – Leibniz Centre for European Economic Research, Research Unit Digital Economy

**Robin Nowak** University of Passau, Faculty of Business, Economics and Information Systems, Chair of Organisation, Technology Management and Entrepreneurship

**Dr. Markus Rieger-Fels** Institut für Mittelstandsforschung (IfM) Bonn

# Executive Summary

# A Current Developments and Challenges

## A 0 Transformative R&I Policy

The current coalition government has taken over a project of superlatives from its predecessor: the transformation of the economy and society.

The energy transition, the mobility transition, the digitalization of the economy and society and the creation of sustainable agriculture are just some of the transformations that the Federal Government has placed at the centre of its Future Strategy for Research and Innovation. These transformations require a multitude of technological and social innovations. A complex mission concept consisting of strategies, reforms and measures must be developed and implemented for each one.

The Commission of Experts recognizes the progress that the Federal Government has achieved within the framework of its transformation-oriented policy. However, it fears that due to increasing geopolitical constraints and emerging domestic political unrest, resulting in part from the implementation of transformation-oriented measures, the long-term transformation orientation could give way to a more short-term crisis management policy.

The Commission of Experts therefore recommends that the Federal Government regularly incorporate the following five fundamental considerations into the design and implementation of transformation-oriented policy measures.

— Considering long-term and structural objectives in short-term measures.

— Incorporating social compensation into measures for transformative change from the outset.

— Not supporting structural change exclusively in financial terms.

— Leaving the search for innovative solutions to the economy and allowing society to participate.

— Securing human capital in the long term.

## A 1 Commentary on Current R&I Policy

### Implementing Future Strategy, Vigorously Pursuing Missions

The Commission of Experts deems the mission team format to be fundamentally suitable for implementing the numerous tasks subsumed within the missions.

The Commission of Experts considers it important to continue the involvement of the state secretary level in the development of the mission teams and to provide continuous strategic support for the operational work of the mission teams. It also considers it important that the mission teams are provided with their own budgets.

In addition, the fundamental question of the time frame of the Future Strategy arises. Given that the missions formulated by the Federal Government are extremely long-term projects, the realization of which requires complex institutional arrangements, achievement of the defined objectives within the current legislative period is illusory. Nevertheless, the Federal Government should continue to vigorously pursue the implementation of its missions and not sacrifice them to day-to-day short-term political considerations. A government that takes mission-oriented policy seriously must realize that a significant part of the successes of its own policy will not be achieved in the current legislative period.

### Introducing Real-world Laboratories Law Promptly

Real-world laboratories create the opportunity to reduce technological and economic uncertainties in the innovation process in a protected space, to test regulatory measures and framework conditions and to involve potential users in development at an early stage. This can significantly shorten the often long path to commercialization of innovations.

The Commission of Experts therefore expressly welcomes the Federal Government's initiative to introduce a real-world laboratories law and urges that the drafting process be brought to a swift conclusion.

Real-world laboratories are generally based on experimentation clauses that allow the competent authorities to authorize controlled exemptions from legal requirements and restrictions in order to test an innovation. It is important that the experimentation clauses in the respective laws are as broad as possible and not specifically defined for particular projects. The narrower an experimentation clause is defined, the greater the likelihood that it will no longer be applicable after a relatively short time.

### SPRIND Freedom Only Partially Implemented

The Commission of Experts considers the SPRIND Freedom Act, which came into force at the end of 2023, to be an overdue step in the desired direction. However, it criticizes the lack of courage in some points of detail to complete the liberation of the Federal Agency for Disruptive Innovation (Bundesagentur für Sprunginnovationen, SPRIND) and to give it the required independence from politics and the deadlines of the Federal Budget Code.

For example, the demand for the complete abolition of functional supervision by the federal ministries was only partially met in the SPRIND Freedom Act. Even if the functional supervision is to concentrate solely on ensuring the economic fulfilment of tasks and is to be carried out by the Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung, BMBF) alone instead of three ministries, the Commission of Experts sees the risk of dual control. After all, the BMBF is already represented on the supervisory board alongside the Federal Ministry of Finance (Bundesfinanzministerium, BMF), the Federal Ministry for Economic Affairs and Climate Action (Bundesministerium für Wirtschaft und Klimaschutz, BMWK) and two members of the Bundestag. The scope for political influence is therefore considerable.

All in all, the Commission of Experts hopes that the steps taken with the Freedom Act to unleash SPRIND will also herald a change of direction in research and innovation policy (R&I policy) – away from risk aversion and tight control towards entrepreneurial thinking and agility.

### Making DATI Open

A key innovation policy project of the Federal Government is finally taking shape with the convening of a founding commission for the German Agency for Transfer and Innovation (Deutsche Agentur für Transfer und Innovation, DATI) and the decision to establish the agency's headquarters in Erfurt. The so-called DATIpilot has also been launched as the first round for the selection of transfer projects. The two funding formats Innovation Sprints and Innovation Communities initiated as part of the DATIpilot have met with a great response. The Commission of Experts considers the high level of participation in the two funding formats to be a positive sign in terms of awareness and acceptance of the nascent DATI.

The Commission of Experts also attributes the large number of submitted project proposals to the fact that the conditions for participation in the DATIpilot were defined very openly. This openness contrasts positively with the original key issues paper, which was presented in April 2022 and criticized by the Commission of Experts for having too narrow a funding focus.

The Commission of Experts expects that this openness will also be reflected in the DATI concept that is yet to be developed.

### Making the Research Allowance More SME-friendly

Despite increasing application numbers, many companies are still unaware of the research allowance introduced in 2020. Smaller businesses in particular are often unaware of the existence of this new funding format. Moreover, three quarters of companies active in research and development (R&D) state that they have not yet applied for a research allowance. Like the level of awareness, small and medium-sized enterprises (SMEs) also lag far behind large companies when it comes to submitting applications. In addition to targeted public relations work to improve awareness of the research allowance, initial survey-based studies point above all to the need to reduce the administrative effort involved in applying for the research allowance.

The extent to which the research allowance has succeeded in motivating companies to increase their R&D expenditure cannot be deduced from the studies to date. The same applies to the question of whether companies that have not previously conducted R&D have been motivated to commence R&D activities. Given the declining innovator rate, these issues are of key importance and represent a particular desideratum for the evaluation of the research allowance.

### Facilitating IP Transfer for Spin-offs

Germany is struggling to attract research-based spin-offs from scientific institutions such as tertiary education institutions and non-university research institutions. One of the main reasons for this is the difficulty of transferring intellectual property (IP), in the form of patent sales or licence agreements, from the scientific institution to the company being founded.

The IP Transfer 3.0 initiative was launched to facilitate a more straightforward and start-up-friendly transfer of IP to research-based spin-offs. Among other things, it adopts a model that provides for so-called virtual participation in the spin-offs in return for the transfer of IP. In contrast to conventional participation, the IP donors waive their voting rights in virtual participation.

To mitigate the structural conflicts of interest between scientific institutions and entrepreneurs in IP transfer negotiations, the Commission of Experts recommends modifying the incentive systems. For example, the transfer success of scientific institutions should not be measured on the basis of patent revenues and licence income, but rather more in terms of the sustained success of the spin-offs they support.

### Removing the Strict Separation Between Military and Civilian R&D

The relationship between military and civilian research and development (R&D) can be divided into two categories: spillovers and dual use. In many countries, spillovers and dual use are deliberately promoted as they lead to increases in performance and efficiency in both the military and civilian sectors.

Prominent examples include the DARPA (Defense Advanced Research Projects Agency) in the USA and the military unit 8200 in Israel. Germany has so far largely foregone these positive effects due to its strict separation of military and civilian research.

In view of increasing global threats, the Commission of Experts recommends re-evaluating the options for managing military R&D. Studies show that military R&D can have positive effects on civilian R&D via spillovers and thereby also positively impact productivity and employment in the civilian sector in addition to increasing performance in the military sector. To achieve this efficiently, synergies between military and civilian research should be made possible. The strict separation that has been customary in Germany for decades needs to be fundamentally reconsidered and abolished where appropriate.

## Facilitating the Utilization of Standard Essential Patents

The Commission of Experts welcomes the EU's initiative to make the market for standard essential patents (SEPs) more transparent and thus reduce the existing information asymmetry between patent holders and licensees. It deems the planned drafting of voluntary guidelines for SEP licensing and the introduction of a conciliation process prior to the initiation of a legal dispute to be fundamentally sensible. The Commission of Experts is also in favour of setting up an SEP register and introducing an assessment procedure in the form of an essentiality check. However, it is sceptical as to whether an essentiality check can be carried out for the entire SEP portfolio.

The Commission of Experts is equally critical of the establishment of a procedure for determining an aggregate royalty for SEP.

Since the value of SEP licences cannot be defined objectively, but is determined by supply and demand, setting a value that is not based on the market is highly unlikely to lead to an acceptable result for licensors and licensees.

The Commission of Experts is moreover sceptical as to whether the European Union Intellectual Property Office (EUIPO), which is only responsible for the registration of EU trade marks and designs but not for patents, can fulfil the tasks assigned to it within a narrow time frame.

## Finally Harnessing the Potential of Data

In its reports, the Commission of Experts has repeatedly emphasized the huge importance of data for the research and innovation system (R&I system). It therefore welcomes the fact that the Health Data Utilization Act has now been passed, paving the way for the use of health data to improve diagnosis and treatment for patients.

However, more measures still need to be taken and implemented, such as the establishment of an agricultural data room and the passing of the Research Data Act.

There are already numerous proposals for improving the infrastructure and access to public data and for pooling publicly funded data. These involve, among other things, necessary adjustments to existing legislation and its inconsistent interpretation in the Länder (including the General Data Protection Regulation – GDPR, the Federal Statistics Act and the Tax Statistics Act).

The Commission of Experts reiterates that significant progress in the provision and use of data is essential in order to achieve progress also in the areas of data application and to achieve the digital transformation.

## A 2 Determining the Causal Effects of Interventions

Many of the evaluation studies on measures of research and innovation policy (R&I policy) carried out on behalf of the Federal Government do not allow any conclusions to be drawn as to whether the developments observed can actually be attributed to the policy measures analysed. The main reason for this is that evaluation studies often do not fulfil the methodological requirements for a causal analysis, not least because the prerequisites for the appropriate use of suitable methods are not always met. The lack of knowledge about the impact of measures impedes evidence-based policy learning. The Federal Government is therefore called upon to systematically and comprehensively integrate causal analyses of the effects of measures into R&I policy and thus create the conditions for the proper and professional implementation of these analyses and their usability for policy learning.

To this end, it is necessary to include causal analyses in the specifications when tendering for evaluation studies, to improve the availability of data for the evaluating organizations and to publish all commissioned evaluation studies.

# B Core Topics 2024

## B 1 New Technologies for Sustainable Agriculture

Global population growth, climate change, the decline in arable land and the negative impact on the environment caused by agriculture itself, such as biodiversity loss and groundwater pollution, constitute major challenges for agriculture.

Agriculture must by tendency produce larger quantities of food with fewer environmentally harmful inputs such as pesticides and fertilisers, while at the same time arable land is decreasing and climate conditions are changing. The use of digital and smart technologies as well as green genetic engineering offer agriculture numerous opportunities to increase productivity, make cultivation methods more sustainable and improve resilience to climate change.

Although digital and smart technologies can significantly reduce negative environmental impacts, agricultural businesses and farms currently have little incentive to use such technologies as they are still comparatively expensive. There is also a lack of digital infrastructure and interoperability between hardware and digital applications. The opportunities offered by green genetic engineering cannot be fully utilized due to restrictive legislation and a lack of acceptance and information among the public and politicians. The Commission of Experts therefore recommends the following measures, among others, to the Federal Government and in particular to the Federal Ministry of Food and Agriculture (Bundesministerium für Ernährung und Landwirtschaft, BMEL), the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz, BMUV) and the Federal Ministry for Digital and Transport (Bundesministerium für Digitales und Verkehr, BMDV):

— The use of pesticides and fertilisers should be subject to a levy based on the Danish model.

— The digital infrastructure in rural regions must be expanded.

— The Federal Government should create a standardized data room for agriculture across the Länder and adopt clear regulations on data protection and data sovereignty.

— The Federal Government should expand and financially support vocational and continuing education and training measures regarding the use of digital and smart technologies.

— With regard to green genetic engineering, the Federal Government needs a scientifically sound and coordinated communication strategy that is also reflected in political action.

— The Federal Government should vote in favour of the EU Commission's proposal for differentiated regulation of genome-edited plants in the European Council.

— In the long term, the Federal Government should lobby the EU in favour of regulating green genetic engineering independently of the genetic engineering technique.

## B 2 International Mobility in the Science and Innovation System

A competitive science and innovation location is dependent on competent personnel for its universities, research institutions and businesses. In the global competition for scientists and employees in research and development, Germany has only been moderately successful in the past.

According to a study for the Commission of Experts' 2014 Annual Report, more scientists left Germany between 1996 and 2011 than immigrated to the country. It was particularly difficult to attract top scientists to work in Germany at that time.

A similarly negative picture emerged with regard to the international mobility of R&D employees. In line with the analyses in the 2014 Annual Report, developments in the international mobility of scientists and R&D employees are mapped based on evaluations of scientific publications and patent applications. The analyses show that the situation has changed significantly since the 2014 Annual Report.

Germany has become a net receiving country for publishing scientists. Many highly-published authors return to Germany after spending time abroad. A reducing net outward flow can be observed among patent-active inventors. Overall, Germany is therefore on a favourable trajectory. However, the German science and innovation system continues to lose human capital across the board, and demographic ageing will likely lead to staff shortages here too.

The Commission of Experts therefore recommends the following measures, among others:

— The administrative processes associated with international mobility should be integrated into an overall process and accelerated with the help of a digital system that links all parties involved in the process (diplomatic missions abroad, registration offices, research institutions or businesses and those wishing to immigrate).

— To ensure that visa applications are processed promptly, the German missions abroad should be strengthened in terms of organization and, if necessary, staffing.

— The Federal Government should advocate international harmonization of social security regulations relevant to the immigration of skilled workers.

— Programmes to promote excellence in the science system should be expanded. The Federal Government and Länder programme (Bund-Länder-Programm) for the creation of tenure-track professorships should be continued with a clear focus on international careers in science.

## B 3 Social Innovation – A Key Element To Address Societal Challenges

The grand societal challenges such as climate change, demographic ageing, and digitalization will not be overcome by technological changes alone. Rather, social innovations are needed that lead to changes in individual and collective behaviour. Policymakers have recognized the importance of social innovations and consider social entrepreneurs to be important drivers of these innovations. However, evidence-based research and innovation policy (R&I policy) in this regard lacks reliable and representative data on the emergence, dissemination and impact of social innovations. Policy justifications have so far been based on conceptual considerations. For example, it can be deduced that social innovations are not developed to the optimum extent for society as a whole. In addition, the funding options for social enterprises are made more difficult in principle by the fact that the involvement of profit-oriented investors could jeopardize the enterprises' orientation towards the common good. The Commission of Experts therefore recommends the following measures, among others:

— The Federal Government should emphatically support the development of standardized indicators for social innovation, both nationally and internationally, and the creation of an internationally representative database. Care must be taken to ensure that the success of policy measures to promote social innovation and social enterprises can be properly measured and analysed.

— The Federal Government should open up existing innovation funding programs even further for social innovations. This allows for improved consideration of complementarities between social and technological innovations.

— Existing funding programs should be supplemented with specific advisory services such as legal form advice for social enterprises and region-specific consulting services.

— The Federal Government should support a trade fair for social innovations, to promote both networking among various stakeholder groups and the generalization of successful social innovations.

— The measures planned by the Federal Government to promote alternative forms of financing should be implemented swiftly to meet the special needs of social enterprises.

## B 4 Artificial Intelligence

As a key enabling technology, artificial intelligence (AI) is characterized by highly dynamic development, has a wide range of applications and unlocks a wealth of potential for innovation and growth. AI therefore has enormous transformative potential that can lead to fundamental structural change in the economy and society. In the recent past, generative AI in particular has developed rapidly. China and the USA are leading the way in technological development in the field of AI. Germany and Europe are lagging far behind and are at risk of falling even further behind. There is a danger that Germany and Europe will become unilaterally dependent and thus lose technological sovereignty. Technological sovereignty is also an important prerequisite for ensuring that European values are upheld in the development and use of AI. The Commission of Experts makes the following recommendations, among others:

— To allow Germany to successfully position itself in the international innovation competition for new technology variants or generations, the Federal Government should continue to firmly support basic AI research.

— Powerful computing capacities must be created to enable the secure development of next-generation foundation models.

— The Federal Government should vigorously drive forward the measures it has initiated to improve the data infrastructure and accelerate the provision of its own data.

— An AI ecosystem is dependent on well-qualified specialists. The Federal Government should work towards ensuring that appropriate programmes are provided in school, academic and vocational education.

— Initiatives to promote open source AI should be supported. Programmes to improve the security architecture of open source models should be launched. Research projects to better understand how open source AI contributes to the AI ecosystem should be set up and measures to promote open source AI should be evaluated.

— The EU's Artificial Intelligence Act (AI Act) should be adapted over time based on the knowledge and experience gained in regulatory practice. In terms of governance, care must be taken to ensure that the bureaucratic burden for the stakeholders subject to the AI Act remains within reasonable limits. The real-world laboratories provided for in the AI Act should be used as an instrument for regulatory learning as quickly as possible.

**Contact and further information**
Office of the Commission of Experts
for Research and Innovation (EFI)
Pariser Platz 6
D-10117 Berlin
Tel.: +49 (0) 30 322 982 564
E-Mail: kontakt@e-fi.de
www.e-fi.de