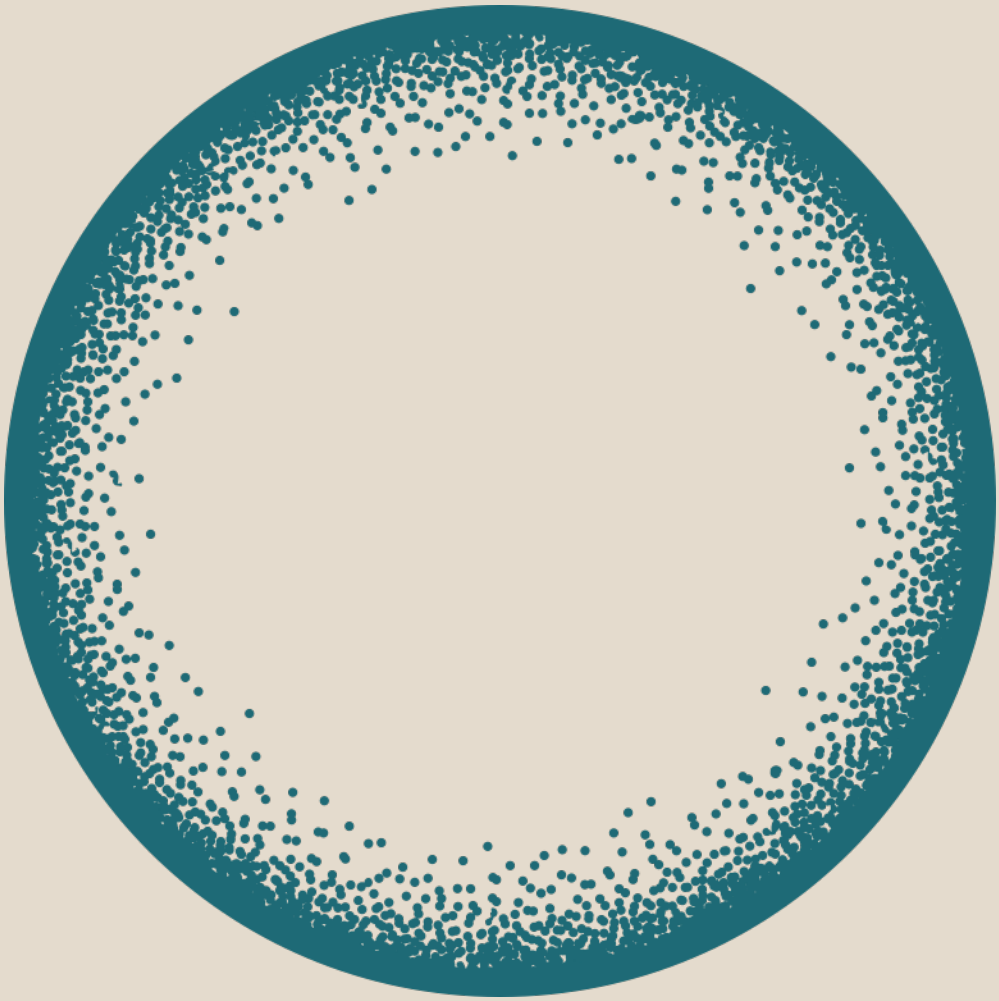
FORUM FOR A NEW ECONOMY

NO. 05
2020

Working Papers

Challenge-driven economic policy: A new framework for Germany

Rainer Kattel, Mariana Mazzucato, Keno Haverkamp and Josh Ryan-Collins



Impressum:

Forum New Economy Working Papers

ISSN 2702-3214 (electronic version)

Publisher and distributor: Forum for a New Economy

Neue Promenade 6, 10178 Berlin, Germany

Telephone +49 (0) 30 767596913, email press@newforum.org

Lead Editor: Thomas Fricke

An electronic version of the paper may be downloaded

· from the SSRN website: www.SSRN.com

· from the RePEc website: www.RePEc.org

· from the Forum New Economy website: https://www.newforum.org

Challenge-driven economic policy: A new framework for Germany

Rainer Kattel*, Mariana Mazzucato, Keno Haverkamp and Josh Ryan-Collins

Institute for Innovation and Public Purpose, University College London

Abstract

German government is stepping into a new era with its COVID-19 recovery support measures. It is leaving behind its ordoliberal foundations which see the role of the state as making sure policy conditions enable markets to function properly. In this view, the state should fix market failures and leave the rest to industry. Already before the pandemic, German policy makers were showing increasing appetite to go beyond market-fixing and experiment with a more overt activist state. With the handling of COVID-19, Germany has taken another step in this direction– it is now at the forefront of taking bold policy action to reshape its economy in the face of the pandemic. Yet, this paper argues Germany's public funding of R&D supports mostly incremental advances and its financial system is largely still funding carbon lock-in and value extraction rather than transforming the economy to deal with 21st century challenges. Germany needs to build on its recent economic policy initiatives, and successful institutions such as the KfW, and develop a bold new industrial strategy that encompasses science, technology and innovation, financial and procurement policies. The new industrial strategy is not about 'more state' or 'less state', but a different type of state. One that is able to act as an investor of first resort, catalysing new types of growth, and in so doing crowd in private sector investment and innovation which represent expectations about future growth areas. This requires a new form of collaboration between state and business – more about picking the willing than picking winners.

JEL codes: E50, G20, H57, L50, O30

Keywords: Germany, industrial policy, mission-oriented innovation.

*Corresponding Author: Rainer Kattel, Institute for Innovation and Public Purpose (IIPP), University College London (UCL), 11 Montague Street, London, WC1B 5BP, UK. r.kattel@ucl.ac.uk

Research for the report was supported by the New Economy Forum. We are grateful for comments and suggestions on an earlier draft by Heike Belitz, Peter Bofinger, Kenneth Frisse, Michael Hüther, Dalia Marin, Philipp Nießen, Christian Odendahl and Jens Südekum.

1. INTRODUCTION

The COVID-19 pandemic presents a profound challenge to governments worldwide — from the provision of income support to citizens and aid to struggling companies, to strengthening frontline health services. By the summer of 2020, countries around the world had dedicated eight trillion US dollars and counting, to relief packages with fiscal support or credit and equity injections.[1] The crisis has affected a number of countries disproportionally due to different degrees of preparedness, foresight and public-sector capacity to steer economic activity.

Countries like the UK and the US in particular have realised how vulnerable their production and public health systems were; and how difficult it is to ramp up production and coordinate supply chains of food, medicine, ventilators, protective equipment and test kits. In these economies, the pandemic has pointed to the damage done by managerial reforms in the public sector, such as outsourcing, and by financialisation of the economy. These have diminished the resilience of socio-economic systems remarkably. Many corporations in the US and UK have been more occupied with financialised practices such as maximising value for shareholders than solving societal problems and prioritising their broader stakeholders.[2]

Germany stands in stark contrast to these experiences. Impressive infection-test capacity in Germany was made possible by the existence of public laboratories and the presence of industries that could supply the required safety equipment and chemicals.[3] While countries in Southeast Asia learned from their relatively recent experiences of tackling SARS and were quick to respond with large-scale tracking of infections, establishing travel limitations and social distancing rules;[4] in Germany learning from managing floods and influenza during the last two decades led to operational emergency plans and risk analyses available since 2013 for pandemics and floods.[5] Existing labour market support systems such as the *Kurzarbeit* scheme have prevented a surge in unemployment. By the end of May 2020, there were over eight million people benefitting from the *Kurzarbeit* scheme.[6]

---

[1] IMFBlog, 'Fiscal Policies to Contain the Damage from COVID-19', *IMF Blog* (blog), 2020, https://blogs.imf.org/2020/04/15/fiscal-policies-to-contain-the-damage-from-covid-19/.

[2] William Lazonick and Mariana Mazzucato, 'The Risk-Reward Nexus in the Innovation-Inequality Relationship: Who Takes the Risks? Who Gets the Rewards?', *Industrial and Corporate Change* 22, no. 4 (1 August 2013): 1093–1128, https://doi.org/10.1093/icc/dtt019.

[3] Guy Chazan, 'How Germany Got Coronavirus Right | Free to Read', 4 June 2020, https://www.ft.com/content/cc1f650a-91c0-4e1f-b990-ee8ceb5339ea.

[4] Charlie Leadbeater, Ravi Gurumurthy, and Christopher Haley, 'The COVID-19 Test', nesta, 2020, https://www.nesta.org.uk/blog/covid-test/.

[5] Geert Bouckaert et al., 'European Coronationalism? A Hot Spot Governing a Pandemic Crisis', *Public Administration Review* n/a, no. n/a (2020), https://doi.org/10.1111/puar.13242.

[6] See German employment agency's data here: https://statistik.arbeitsagentur.de/Statistikdaten/Detail/202005/arbeitsmarktberichte/monatsbericht-monatsbericht/monatsbericht-d-0-202005-pdf.pdf

Germany is also at the forefront of taking bold policy action to reshape its economy in the aftermath of the pandemic. Other countries are lending to companies with no strings attached while Germany is proposing to take ownership stakes in ailing companies,[7] an idea that seems to enjoy wide support among leading domestic economists.[8] While in the 2010s, German response to the financial and fiscal crisis was largely defined by austerity[9] and by supporting existing industrial practices such as scrappage support for old cars (*Abwrackprämie*), this time the government has taken a bolder sustainable approach in its support measures published on June 3rd, 2020.[10] There seems to be much stronger appetite for bold action among coalition partners[11] and the recovery plans have been received mostly positively[12] or even very positively by leading economists.[13]

Germany finds itself indeed in a peculiar situation of having gone in the last two decades from the 'sick man of the euro'[14] to *Exportweltmeister* to one of the exemplar countries in COVID-19 handling and responses. And while there are signs of a changing economic consensus,[15] the collective political mindset seems to be about catching up with leading economies rather than being a leading economy.[16]

The new industrial strategy agenda, *Nationale Industriestrategie 2030*,[17] launched in 2019, seems already outdated by the policies tackling COVID-19. Germany is stepping into a new era. *Nachfolgemodell Deutschland*, the modernisation agenda of the past four decades, relied on the *Ordnungspolitische Prinzipien* which cast the state as guardian of framework conditions

---

[7] Laurie Macfarlane and Simone Gasperin, 'State Holding Companies: An Opportunity for Economic Transformation?', Medium, 9 June 2020, https://medium.com/iipp-blog/state-holding-companies-an-opportunity-for-economic-transformation-3604093bab87.

[8] Peter Bofinger et al., 'Economic Implications of the Corona Crisis and Economic Policy Measures', *Wirtschaftsdienst* 100, no. 4 (1 April 2020): 259–65, https://doi.org/10.1007/s10273-020-2628-0.

[9] Achim Truger, 'Austerity in the Euro Area: The Sad State of Economic Policy in Germany and the EU', *European Journal of Economics and Economic Policies: Intervention* 10, no. 2 (1 September 2013): 158–74, https://doi.org/10.4337/ejeep.2013.02.02.

[10] Bundesfinanzministerium, 'Corono-Folgen Bekämpfen, Wohlstand Sichern, Zukunftsfähigkeit Stärken. Ergebnus Koalitionsausschuss 3. Juni 2020', 2020, https://www.bundesfinanzministerium.de/Content/DE/Standardartikel/Themen/Schlaglichter/Konjunkturpaket/2020-06-03-eckpunktepapier.pdf?__blob=publicationFile&v=8.

[11] Wirtschaftsforum, 'Wege in Den Neustart – Weichen Für Die Zukunft Stellen', Diskussionspapier (Wirtschaftsforum der SPD e.V, 2020).

[12] Sebastian Dullien, 'GroKo-Paket Bleibt Hinter Möglichkeiten Zurück', Forum for a New Economy, 4 June 2020, https://newforum.org/the-state/groko-paket-bleibt-hinter-moeglichkeiten-zurueck/.

[13] Jens Südekum, 'Corona-Hilfen: Dieses Konjunkturpaket Hat Tatsächlich Wumms - WELT', 2020, https://www.welt.de/debatte/kommentare/plus209085389/Corona-Hilfen-Dieses-Konjunkturpaket-hat-tatsaechlich-Wumms.html.

[14] See *The Economist*, June 3rd, 1999, https://www.economist.com/special/1999/06/03/the-sick-man-of-the-euro.

[15] Caroline de Gruyter, '[Column] Hawks to Doves? Germany's New Generation of Economists', EUobserver, 2020, https://euobserver.com/opinion/148467.

[16] Frank Dohmen et al., 'Deutschland: Was Taugt Das 50-Milliarden-Zukunftspaket Der Bundesregierung? - DER SPIEGEL', 2020, https://www.spiegel.de/wirtschaft/deutschland-was-taugt-das-50-milliarden-zukunftspaket-der-bundesregierung-a-00000000-0002-0001-0000-000171527061.

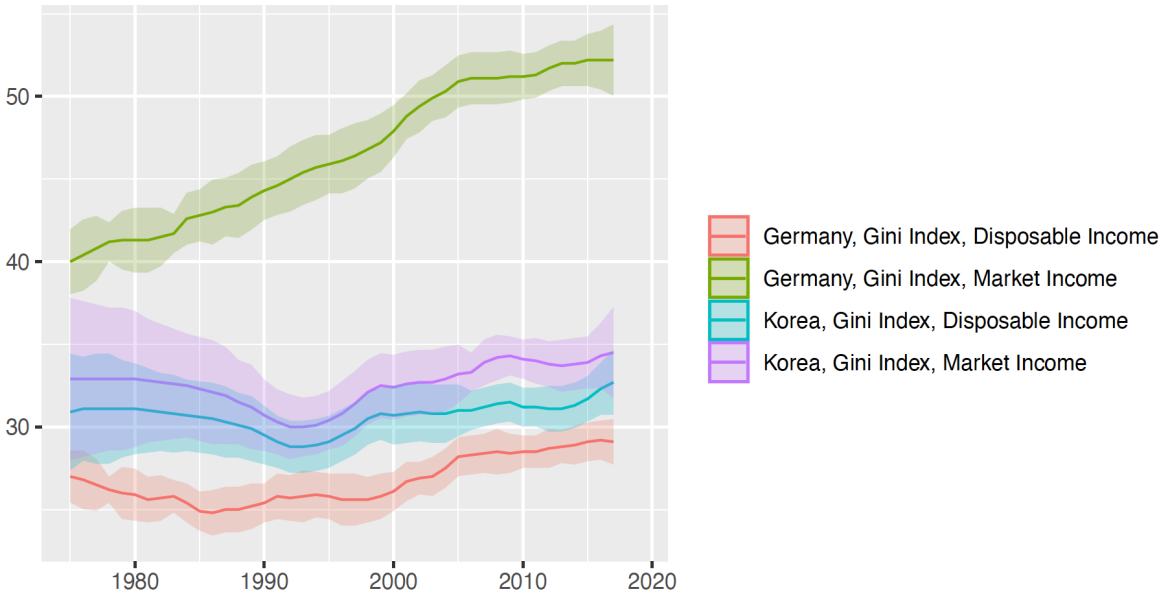
[17] Official strategy is available at: https://www.bmwi.de/Redaktion/DE/Publikationen/Industrie/nationale-industriestrategie-2030.pdf?__blob=publicationFile&v=24.

that enable markets to function properly.[18] In the Anglo-American context, a parallel notion sees market failure as the main justification for government interventions, including industrial policy.[19] This model of economic belief, and the corresponding governance agenda, has evolved over the past three decades into a policy regime that comes at a price of rising imbalances in Germany, both in terms of the share of GDP between asset owners and workers, as well as income inequalities.[20] This regime has also failed to provide clear incentives to ready the economy for the 21st century's greatest challenges such as climate emergency.[21]

Inequality is a growing problem for Germany. As shown by Gabriel Palma, and depicted on Figure 1, high income countries such as Germany are able to retain their relatively low Gini indices by considerable fiscal transfers. For instance, Germany and South Korea have similar Ginis, yet "this remarkable similarity hides a major difference in how they got there, with Germany's route being far more convoluted than Korea's: in order to get to a disposable income Gini of about 30, Germany needs a relative reduction of its market Gini of 44 per cent, while Korea needs a decrease of just 9 per cent".[22] Importantly, the distributive strength of the German system was one of the key features of the ordo-liberal consensus. This linkage between industrial development and "developmental society" has now been broken.[23]

[18] Jörg Meyer-Stamer, *Moderne Industriepolitik oder postmoderne Industriepolitiken?*, Schriftenreihe Moderne Industriepolitik 1 (Berlin: Friedrich-Ebert-Stiftung, Stabsabt, 2009).
[19] Dani Rodrik, 'Industrial Policy for the Twenty-First Century', SSRN Scholarly Paper (Rochester, NY: Social Science Research Network, 1 November 2004), https://papers.ssrn.com/abstract=666808.
[20] Charlotte Bartels and Carsten Schöder, 'The State of Inequality in Germany', *Forum for a New Economy* (blog), 10 June 2020, https://newforum.org/inequality/der-stand-der-ungleichheit-in-deutschland/.
[21] Karl Aiginger and Dani Rodrik, 'Rebirth of Industrial Policy and an Agenda for the Twenty-First Century', *Journal of Industry, Competition and Trade* 20, no. 2 (1 June 2020): 189–207, https://doi.org/10.1007/s10842-019-00322-3.
[22] Jose Gabriel Palma, 'Behind the Seven Veils of Inequality. What If It's All about the Struggle within Just One Half of the Population over Just One Half of the National Income?', *Development and Change* 50, no. 5 (2019): 1133–1213, https://onlinelibrary.wiley.com/doi/full/10.1111/dech.12505.
[23] Linda Weiss, *The Myth of the Powerless State*, 1 edition (Ithaca, NY: Cornell University Press, 1998).

Figure 1. Gini index according to market and disposable income, Germany and Korea.[24]



Indeed, in some respects Germany is falling behind. Its share of patents in future technologies is falling.[25] The oft-praised *Energiewende* seems to be stuck in a multitude of support programmes and lack of policy coordination.[26] In the case of electric cars, there are so many various systems of paying for charging that nobody actually knows how much a kwh of energy costs.[27]

The response to COVID-19 has galvanised discussions of German economic policy that rethink some of its foundations. Economic policy fit for 21st century challenges has to go beyond market failures and a catching-up psyche. Policy makers should strive to shape markets in order to address major societal challenges;[28] coordinate a wide range of policy efforts and markets for sustainable and inclusive outcomes; [29] and seek to leapfrog towards future transformational

---

[24] Frederick Solt, 'Measuring Income Inequality Across Countries and Over Time: The Standardized World Income Inequality Database', *Social Science Quarterly* 101, no. 3 (2020): 1183–99.

[25] "Bei 43 von 58 Technologien konnte sich Deutschland im Jahr 2000 über einen Platz unter den drei Ländern freuen, die im Besitz der meisten Weltklassepatente waren. Im Jahr 2010 steigerte sich das Land noch einmal leicht und belegte sogar 47-mal einen Platz unter den Top 3. 2019 hat sich dieser Wert auf 22 Technologien mehr als halbiert." Bertelsmann Stiftung, 'Weltklassepatente in Zukunftstechnologien', 2020, https://www.bertelsmann-stiftung.de/de/publikationen/publikation/did/weltklassepatente-in-zukunftstechnologien.

[26] Christoph Gatzen et al., 'Technologische Innovationen und neue Geschäftsmodelle für die Energiewende - Die Rolle der deutschen F&I Politik: Studie im Auftrag der unabhängigen Expertenkommission Forschung und Innovation (EFI)', Research Report (Studien zum deutschen Innovationssystem, 2019), https://www.econstor.eu/handle/10419/194281.

[27] Stiftung Warentest, 'Elektromobilität - Strom tanken an der Ladestation – das reinste Tarifchaos - Stiftung Warentest' (Stiftung Warentest, 2020), https://www.test.de/Elektromobilitaet-Strom-tanken-an-der-Ladestation-das-reinste-Tarifchaos-5482877-0/.

[28] Mariana Mazzucato, Rainer Kattel, and Josh Ryan-Collins, 'Challenge-Driven Innovation Policy: Towards a New Policy Toolkit', *Journal of Industry, Competition and Trade* 20, no. 2 (1 June 2020): 421–37, https://doi.org/10.1007/s10842-019-00329-w.

[29] Jan Fagerberg and Gernot Hutschenreiter, 'Coping with Societal Challenges: Lessons for Innovation Policy Governance', *Journal of Industry, Competition and Trade* 20, no. 2 (1 June 2020): 279–305, https://doi.org/10.1007/s10842-019-00332-1.

technologies.[30] Such an approach is not new in German economic history. As modern economics emerged in 19th century Germany, it crystallised around *soziale Frage* as the focus for economic policy making.[31] This led to a unique blend of roles for the government: on the one hand, focusing on the directionality of economic development and on the other hand, creating and supporting institutions that enabled quite autonomous self-government by industry through 'cooperative competition'.

In his seminal 1987 article on technology policy, Henry Ergas distinguished between mission-oriented and diffusion-oriented technology policies. The former are focused on radical technological breakthroughs; the latter are focused on providing technology-related public goods (such as education and basic research).[32] According to Ergas, German policy falls into the diffusion-oriented category. He argued that countries like Germany are "characterized by policies that encourage widespread access to technical expertise and reduce the costs that small and medium-size firms face in adjusting to change. In essence, the policy framework serves to increase the capacity for absorbing incremental change without threatening the basic structure of industry."

Ergas saw two major challenges with diffusion-oriented economic policy frameworks:

> First, the system as it has evolved is geared to existing industries, which basically set the technology agenda: That is, they determine the direction of research, dominate the process of standardisation, and have a large role in training and education policies. Entirely new industries and technologies may find it difficult to capture the attention they deserve. Second, even in the existing industries, the decentralised, "bottom-up," approach leads to a strong emphasis on movement *along* technological trajectories, while reducing the visibility of, and preparedness for, major shifts in trajectories.

A similar focus on incremental evolution and efficiency gains characterise management and administrative reforms in Germany over the past three decades.[33] While there have been strong

---

[30] Leonardo Burlamaqui and Rainer Kattel, 'Development as Leapfrogging, Not Convergence, Not Catch-up: Towards Schumpeterian Theories of Finance and Development: Review of Political Economy: Vol 28, No 2', 2016, https://www.tandfonline.com/doi/abs/10.1080/09538259.2016.1142718.

[31] Wolfgang Drechsler, 'Kathedersozialismus and the German Historical School', *Handbook of Alternative Theories of Economic Development*, 28 October 2016, https://www.elgaronline.com/view/edcoll/9781782544661/9781782544661.00011.xml; Erik S. Reinert, *The Visionary Realism of German Economics: From the Thirty Years' War to the Cold War*, ed. Rainer Kattel, 1 edition (Anthem Press, 2019); Bertram Schefold, 'The German Historical School and the Belief in Ethical Progress', in *Ethical Universals in International Business*, ed. F. Neil Brady, Studies in Economic Ethics and Philosophy (Springer Berlin Heidelberg, 1996), 173–96.

[32] Henry Ergas, 'Does Technology Policy Matter?', in *Technology and Global Industry*, by Bruce Guile and Harvey Brooks (Washington, D.C.: National Academic PRess, 1987).

[33] Christopher Pollitt and Geert Bouckaert, *Public Management Reform: A Comparative Analysis - Into The Age of Austerity*, 4 edition (OUP Oxford, 2017).

attempts at public-sector reforms at the local level, with varying degrees of success, major federal reforms have been far and few between, its administrative values being driven by Weberian and legalistic orientation on stability and predictability.[34]

In the pre-COVID-19 world, governments were increasingly turning their attention to tackling 'grand challenges' or 'wicked issues', such as climate change, demographic challenges, and the promotion of health and wellbeing.[35] Behind these challenges lie the difficulties of generating sustainable and inclusive growth. Policy makers increasingly dedicated their attentions to not only the rate of economic growth but also its direction.[36] Tackling grand challenges requires revitalising both private and public investment, innovation and collaboration. It is not about 'more state' or 'less state' but a different type of state.[37] One that is able to act as an investor of first resort, catalysing new types of growth, and in so doing crowd in private sector investment and innovation which represent expectations about future growth areas. This requires a new form of collaboration between state and business – more about picking the willing than picking winners.[38] In the German context, the goverment recognised the need for a new policy framework two years ago with *High-Tech Strategy 2025*. This focuses on missions as a main instrument to coordinate science, technology and innovation (STI) policies.

COVID-19 has magnified and accelerated the need for challenge-led policy frameworks and actors. The pandemic and its consequences offer an opportunity to rethink our economic policy foundations and recast them for the needs of the 21st century. The COVID-19 crisis has underlined the importance of public-sector capacity and capabilities, and the importance of the public sector as not only market fixer but market shaper.[39]

---

[34] Gerhard Hammerschmid and Anca Oprisor, 'German Public Administration: Incremental Reform and a Difficult Terrain for Management Ideas and Instruments', *Public Administration Reforms in Europe*, 24 June 2016, https://www.elgaronline.com/view/edcoll/9781783475391/9781783475391.00012.xml.

[35] Mariana Mazzucato, 'Mission-Oriented Research & Innovation in the European Union : A Problem-Solving Approach to Fuel Innovation-Led Growth.', Website (Publications Office of the European Union, 21 February 2018), http://op.europa.eu/en/publication-detail/-/publication/5b2811d1-16be-11e8-9253-01aa75ed71a1/language-en; Mariana Mazzucato, 'Mission-Oriented Innovation Policy: Challenges and Opportunities', UCL Institute for Innovation and Public Purpose, 25 September 2017, https://www.ucl.ac.uk/bartlett/public-purpose/publications/2017/sep/mission-oriented-innovation-policy-challenges-and-opportunities.

[36] Mariana Mazzucato and Carlota Perez, 'Innovation as Growth Policy: The Challenge for Europe', SPRU Working Paper Series (SPRU - Science Policy Research Unit, University of Sussex Business School, July 2014), https://econpapers.repec.org/paper/srussewps/2014-13.htm.

[37] Susana Borrás and Jakob Edler, 'The Roles of the State in the Governance of Socio-Technical Systems' Transformation', *Research Policy* 49, no. 5 (1 June 2020): 103971, https://doi.org/10.1016/j.respol.2020.103971.

[38] Mariana Mazzucato, *The Entrepreneurial State: Debunking Public vs. Private Sector Myths*, First Edition edition (London ; New York: Anthem Press, 2013).

[39] Mariana Mazzucato and Rainer Kattel, 'COVID-19 and Public Sector Capacity', *Oxford Review of Economic Policy*, 2020.

This report develops a framework for challenge-driven economic policy and then applies it to Germany. We argue that Germany can build on its existing strengths in diffusion-oriented economic policy by complementing it with challenge-driven and mission-oriented approaches and institutions. This combination would allow the government to be proactive in setting the directionality for public and private-sector investments and collaborations, and create better capabilites for coordination in the economic policy arena.

2. CHALLENGE-DRIVEN ECONOMIC POLICY FRAMEWORK

Twenty-first-century policy making is increasingly defined by the need to respond to major social, environmental, and economic challenges. Sometimes referred to as 'grand challenges', these include addressing climate change, ageing populations, health and well-being concerns, as well as the difficulties of generating sustainable and inclusive growth. Against this background, policy makers are embracing the idea of using industrial and innovation policy to tackle these grand challenges.[40] Examples of challenge-led policy frameworks include the United Nation's Sustainable Development Goals (SDGs), the European Union's Horizon Europe research and development programme,[41] the UK's 2017 Industrial Strategy White Paper[42] and New Zealand's 2019 Wellbeing Budget.[43]

However, challenge-driven policy frameworks are implemented in parallel to well-established modernisation[44] and competitiveness[45] frameworks. While modernisation, and in particular competitiveness frameworks, relies on the idea that government should first and foremost fix market failures, a challenge-driven agenda does not have such clearly defined theoretical origins and analytical lenses. We believe challenge-led growth requires a new conceptual and analytical framework that has at its core the idea of confronting the *direction of growth* – growth that is, for example, more inclusive and sustainable. Such a framework should focus on market shaping and market co-creating.[46] This is a question of both theory and policy practice.

---

[40] Mazzucato, Kattel, and Ryan-Collins, 'Challenge-Driven Innovation Policy'.
[41] Mazzucato, 'Mission-Oriented Research & Innovation in the European Union'.
[42] HM Government, 'Industrial Strategy: Building a Britain Fit for the Future', GOV.UK, 2017, https://www.gov.uk/government/publications/industrial-strategy-building-a-britain-fit-for-the-future.
[43] New Zealand Treasury, 'The Wellbeing Budget 2019', 30 May 2019, https://treasury.govt.nz/publications/wellbeing-budget/wellbeing-budget-2019.
[44] Sabine Kropp, 'Modernisierung Des Staates in Deutschland: Konturen Einer Endlosen Debatte', *Politische Vierteljahresschrift* 45 (1 September 2004): 416–39, https://doi.org/10.1007/s11615-004-0062-3.; Helen Margetts, Perri 6, and Christopher Hood, eds., *Paradoxes of Modernization: Unintended Consequences of Public Policy Reform* (Oxford, New York: Oxford University Press, 2010)..
[45] EU's Lisbon Strategy from 2000 is perhaps the best-known example of this, see https://portal.cor.europa.eu/europe2020/Profiles/Pages/TheLisbonStrategyinshort.aspx.
[46] Mariana Mazzucato, 'From Market Fixing to Market-Creating: A New Framework for Innovation Policy', *Industry and Innovation* 23, no. 2 (17 February 2016): 140–56, https://doi.org/10.1080/13662716.2016.1146124.

In theory, challenge-driven policy questions both established neoclassical and evolutionary concepts.[47] In practice, it reassesses selection targets.

Industrial policies have always been composed of both a horizontal (general) and a vertical (selective) element. Horizontal policies have historically been focused on skills, infrastructure and education, while vertical policies have focused on particular sectors such as transport, health, energy, or technologies. These two traditional approaches approximate to differing schools of economics: neoclassical economics-inspired horizontal policies focusing on supply-side factors and inputs; and evolutionary economics-inspired policies emphasizing demand-side factors and systemic interactions.[48] Although certain sectors might be more suited to vertical strategies, the 'grand challenges' expressed in SDGs are cross-sectoral by nature and hence we cannot simply apply a vertical approach to them. Both neoclassical and evolutionary approaches to industrial policy have relied on the idea that the best policy outcome is economy-wide development, without specifying its nature and direction. This has led to managing economies according to GDP growth rates, competitiveness indices and rankings, or other macro indicators (e.g. exports, patents). Yet, many SDGs are only indirectly related to the economy and hence many of the key issues around SDGs have not been theorised in the context of innovation and industrial policy.

We argue that through well-defined goals, or more specifically 'missions' that are focused on solving important societal challenges, policy makers have the opportunity to determine the *direction* of growth by making strategic investments, coordinating actions across many different sectors, and laying the foundations for new industrial terrains that the private sector can develop further.[49] The result would be an increase in cross-sectoral learning and macroeconomic stability. Such mission-led and market shaping activity is not about top-down planning by an overbearing state; it is about providing a direction for growth, guiding business expectations about future growth areas, and catalysing self-discovery by firms that otherwise would not happen.[50] It is not about de-risking and levelling the playing field, nor about supporting

[47] Johan Schot and W. Edward Steinmueller, 'Three Frames for Innovation Policy: R&D, Systems of Innovation and Transformative Change', *Research Policy* 47, no. 9 (1 November 2018): 1554–67, https://doi.org/10.1016/j.respol.2018.08.011.

[48] Richard Nelson and Sidney Winter, 'Neoclassical vs. Evolutionary Theories of Economic Growth: Critique and Prospectus', *Economic Journal* 84, no. 336 (1974): 886–905, https://econpapers.repec.org/article/ecjeconjl/v_3a84_3ay_3a1974_3ai_3a336_3ap_3a886-905.htm; Dani Rodrik and Ricardo Hausmann, 'Doomed to Choose: Industrial Policy as Predicament', 2006.

[49] Mariana Mazzucato and Caetano C. R. Penna, 'Beyond Market Failures: The Market Creating and Shaping Roles of State Investment Banks', *Journal of Economic Policy Reform* 19, no. 4 (1 October 2016): 305–26, https://doi.org/10.1080/17487870.2016.1216416.

[50] Mazzucato and Perez, 'Innovation as Growth Policy'.

more competitive sectors over less,[51] since the market does not always know best, but about tilting the playing field in the direction of the desired societal goals, such as the SDGs.

2.1. Missions 101

In this report we follow the definition of challenges and missions used in the work of the UCL Institute for Innovation and Public Purpose.[52] We differentiate between (1) broad challenges, (2) missions, (3) sectors and (4) specific solutions.

A challenge is a broadly defined area which a nation may identify as a priority (whether through political leadership or the outcome of a movement in civil society). These may include areas such as inequality, climate change or the challenges of an ageing population. On a global level, challenges have been expressed by the United Nations as 17 Sustainable Development Goals (SDGs).

While the SDGs are useful to ensure attention, for the most part they remain too broad to be actionable. Missions, on the other hand, are concrete problems that different sectors can address to tackle a challenge, such as reducing carbon emissions by a given percentage over a specific period. Sectors define the boundaries within which firms typically operate, such as transport, health or energy. Missions require different sectors to come together in new ways: climate change cannot be fought by the energy sector alone. It will also require changes in transport and nutrition, as well as many other areas. Finally, solutions are specific projects undertaken by businesses, governments, universities or the third sector that can help support a mission. Solutions have clear objectives and should involve many different sectors, and can be supported through the use of supportive policy interventions and financial instruments.

The granularity of missions therefore sits between broad challenges and modular solutions. Missions should be broad enough to engage the public and attract cross-sectoral investment; but focused enough to involve industry and achieve measurable success. By setting the direction for a solution, missions do not specify how to achieve success. Rather, they stimulate the development of a range of different solutions to achieve the objective. As such, a mission should make a significant and real contribution to meeting grand challenges.

---

[51] Philippe Aghion et al., 'Industrial Policy and Competition', *American Economic Journal: Macroeconomics* 7, no. 4 (October 2015): 1–32, https://doi.org/10.1257/mac.20120103.

[52] See for more details Mazzucato, 'Mission-Oriented Research & Innovation in the European Union'; Mazzucato, 'Mission-Oriented Innovation Policy'; Mariana Mazzucato and Laurie Macfarlane, 'A Mission-Oriented Framework for the Scottish National Investment Bank', 2019, https://www.ucl.ac.uk/bartlett/public-purpose/publications/2019/mar/mission-oriented-framework-scottish-national-investment-bank..

While President Kennedy's moon-shot is the best-known example of mission-oriented policies, governments across the world in the 1960s seem to have been open to such bold policies. The first generation mission-oriented policies followed a "big science meets big problems" maxim that worked spectacularly well in some instances (e.g. the space race and the internet) but in others created inertia or, worse, long-term problems (e.g. nuclear energy). Importantly, the success of mission-oriented policies relied on innovative institutional solutions (e.g. creating demand for new solutions through procurement, prize schemes, or similar) and mission-oriented agencies (such as DARPA and related procurement programmes in the US).[53]

In contrast to previous generations of mission-oriented policies, the current manifestation does not have a dominant design regarding its public-value framing or its governance system. There is, however, a distinct focus on increasing the social responsiveness of science and innovation, and economic policy in general.

The current generation of mission-oriented policies has multiple drivers and a somewhat heterogeneous set of actors:

A. Multilateral organisations such as the European Union have been prominent in urging the development of new missions around sustainability and other decidedly socio-economic (as opposed to solely technological) issues.[54]

B. Large private philanthropies such as the Gates Foundation and others have sought out specific problems (e.g. diseases) to solve and have concentrated not only their funding but also important networks on those problems as missions.

C. Bottom-up social movements have been able to influence the directionality of research, e.g. ACT UP's impact on HIV research and its increased funding.[55] Similarly, Germany's *Energiewende* would have not happened without the green movement.[56]

Rather than concentrating on a specific sector (such as energy) or technology (such as nuclear), as was often the case in the previous generation, current attempts are characterised by deliberate cross-sectoral focus.[57] Finally, experimentalism is seen as a key feature of mission-driven

---

[53] Mazzucato, *The Entrepreneurial State*.
[54] L. Soete and A. Arundel, *An Integrated Approach to European Innovation and Technology Diffusion Policy: A Maastricht Memorandum* (Commission of the European Communities, 1993); Mazzucato, 'Mission-Oriented Research & Innovation in the European Union'.
[55] Charles Leadbeater, 'Postscript: Movements with Missions Make Markets', *Industrial and Corporate Change* 27, no. 5 (1 October 2018): 937–42, https://doi.org/10.1093/icc/dty033.
[56] Jan Fagerberg, 'Mission (Im)Possible? The Role of Innovation (and Innovation Policy) in Supporting Structural Change & Sustainability Transitions', *Working Papers on Innovation Studies*, Working Papers on Innovation Studies (Centre for Technology, Innovation and Culture, University of Oslo, February 2018), https://ideas.repec.org/p/tik/inowpp/20180216.html.
[57] Mazzucato, 'Mission-Oriented Innovation Policy'.

policies and organisations, which is reflected in randomised control trials being embraced by philanthropists and social enterprises at the one extreme, and by service design principles of prototyping within various public agencies at the other.[58]

2.2. Critical role of finance and procurement in missions

Mission-oriented finance by public-sector institutions has been the source of most of the radical innovations over the last century.[59] And note that this is not just public funding of basic research. While private finance is often important in commercialising new technologies, it is not true that the role of public finance is restricted to narrowly defined upstream areas with public goods. In the US, DARPA (the Defense Advanced Research Projects Agency) has had its hand visible all along the innovation chain—not only in the first links (basic, applied, and even early-stage seed funding of companies).[60] The same is increasingly true of some strategic financing provided directly by public banks.[61]

While the market failure doctrine focuses on the need for public finance to fund 'public goods' such as basic research, it cannot explain the fact that public finance has been active along the entire innovation chain with budgets focused on big mission-oriented projects, from putting a man on the moon to tackling climate change. Figure 2 below shows the important role that public agencies (in orange) have played across the entire innovation chain, from 'blue sky' research funded by agencies like the National Science Foundation to more applied research being done by agencies like the NIH and the Advanced Research Projects Agency-Energy (ARPA-E) of the US Department of Energy. As venture capitalists have become increasingly short-termist, early-stage risk finance for companies is increasingly coming from public agencies like the Small Business Innovation Research Program (SBIR) or the guaranteed loan scheme of different agencies.

---

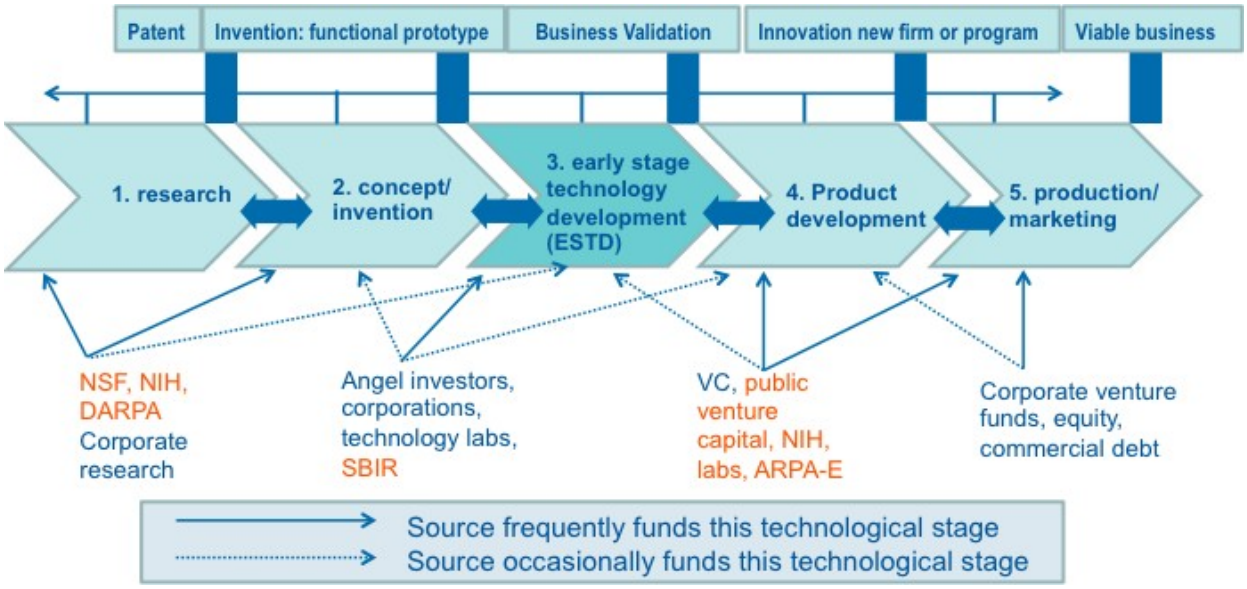
[58] Piret Tõnurist, Rainer Kattel, and Veiko Lember, 'Innovation Labs in the Public Sector: What They Are and What They Do?', *Public Management Review* 19, no. 10 (26 November 2017): 1455–79, https://doi.org/10.1080/14719037.2017.1287939.

[59] Fred L. Block and Matthew R. Keller, *State of Innovation*, 1 edition (Routledge, 2011); Mazzucato, *The Entrepreneurial State*.

[60] William Bonvillian, 'DARPA and Its ARPA-E and IARPA Clones: A Unique Innovation Organization Model', *Industrial and Corporate Change* 27, no. 5 (2018): 897–914, https://doi.org/10.1093/icc/dty026.

[61] Mazzucato and Penna, 'Beyond Market Failures'.

Figure 2: Public Financing of Innovation across the Entire Innovation Chain[62]



Public procurement has played a critical role in the innovation chain. In pre-WWII periods public procurement was the key means of supporting the development of new technologies for public missions (especially military ones). [63] In post-WWII decades it became also an important policy tool for industry creation, protection and overall industrial upgrading. [64] The current wave of policy change allocates an even wider role for public procurement. As argued by Lember et al., "public procurement is increasingly seen as a horizontal policy measure that should be applied across the public sector and regardless of the characteristics or missions of public agencies."[65]

The idea is that by placing a sophisticated demand on markets, desirably through functional requirements and standards,[66] public procurers can introduce strong incentives for private providers to come up with new solutions or to upgrade their production-related processes in order to cope with the demand made by government. When doing so, public procurement can offer

[62] Mariana Mazzucato and L. Randall Wray, 'Financing the Capital Development of the Economy: A Keynes-Schumpeter-Minsky Synthesis', SSRN Scholarly Paper (Rochester, NY: Social Science Research Network, 7 May 2015), https://doi.org/10.2139/ssrn.2603847.

[63] David C. Mowery, 'Defense-Related R&D as a Model for "Grand Challenges" Technology Policies', *Research Policy*, The need for a new generation of policy instruments to respond to the Grand Challenges, 41, no. 10 (1 December 2012): 1703–15, https://doi.org/10.1016/j.respol.2012.03.027.

[64] Rainer Kattel and Veiko Lember, 'Public Procurement as an Industrial Policy Tool: An Option for Developing Countries?', *Journal of Public Procurement* 10, no. 3 (1 January 2010): 368–404, https://doi.org/10.1108/JOPP-10-03-2010-B003.

[65] Veiko Lember, Rainer Kattel, and Tarmo Kalvet, 'Quo Vadis Public Procurement of Innovation?', *Innovation: The European Journal of Social Science Research* 28, no. 3 (3 July 2015): 403–21.

[66] Charles Edquist and Jon Mikel Zabala-Iturriagagoitia, 'Functional Procurement for Innovation, Welfare and the Environment: A Mission-Oriented Approac', *Papers in Innovation Studies*, Papers in Innovation Studies (Lund University, CIRCLE - Center for Innovation, Research and Competences in the Learning Economy, 21 January 2020), https://ideas.repec.org/p/hhs/lucirc/2020_001.html.

private providers a niche for developing their ideas or even existing products. By covering all or part of the development costs while providing direct feedback, public agencies can help enterprises drive down their own expenditure on production. Also, governments can use public procurement to stimulate private providers to carry out R&D in areas where market interest is muted due to high uncertainty, specifically around societal grand challenges such as ageing, environmental sustainability and health.

Green public procurement can been seen as a special case of mission-oriented stimulus, whereby public organisations are expanding markets for sustainable products.[67] Green procurement is a direct case of public sector purchasing power being directed towards a grand challenge. While such procurement practices are increasingly supported by rules of engagement, the field is quite undertheorised and researched.[68]

2.3. Missions meet knowledge diffusion: policy complementarity for transformative change

To understand how to drive public and private investment towards mission-oriented innovations, it is necessary to understand how their complementary roles are shifting as technological revolutions periodically transform the economy. As Carlota Perez has shown, "five technological revolutions have occurred since the first 'industrial revolution', each driving a great surge of development that brings profound and qualitative shifts across society. These surges, driven by a powerful cluster of interdependent new and dynamic industries and infrastructures, usher in major structural changes in production, finance, distribution, communication and consumption, transforming the whole economy and providing a new techno-economic paradigm – or common sense best-practice – for all activities."[69]

While the pattern of paradigm shifts are recurring they are also unique each time around and countries adapt differently to different phases of paradigms shifts: "while each revolution brings a paradigm shift in the direction of innovation and the general criteria for competitiveness, it is ultimately the social forces and their institutions that define what part of that new opportunity space will be deployed and how".[70]

---

[67] Wenjuan Cheng et al., 'Green Public Procurement, Missing Concepts and Future Trends – A Critical Review', *Journal of Cleaner Production* 176 (1 March 2018): 770–84, https://doi.org/10.1016/j.jclepro.2017.12.027.

[68] Francesco Testa et al., 'What Factors Influence the Uptake of GPP (Green Public Procurement) Practices? New Evidence from an Italian Survey', *Ecological Economics* 82 (1 October 2012): 88–96, https://doi.org/10.1016/j.ecolecon.2012.07.011; Cheng et al., 'Green Public Procurement, Missing Concepts and Future Trends – A Critical Review'.

[69] Carlota Perez, *Technological Revolutions and Financial Capital: The Dynamics of Bubbles and Golden Ages* (Cheltenham: Edward Elgar Publishing Ltd, 2003); Carlota Perez and Tamsin Murray Leach, 'A Smart Green "European Way of Life": The Path for Growth, Jobs and Wellbeing', *Beyond the Technological Revolution Working Papers*, 2018, http://beyondthetechrevolution.com/workingpaper/.

[70] Perez and Murray Leach, 'A Smart Green "European Way of Life": The Path for Growth, Jobs and Wellbeing'.

There are two key conclusions from Perez' work for our context:

First, paradigms shifts are characterised by the changing balance between private and public sectors: technological revolutions themselves are mostly driven by casino capitalism and exuberant investment into new opportunities by private actors. This is then followed up by socialisation of the new paradigm by public-sector leadership and actions. Interestingly, there have been some key outliers: for instance, the case of Germany in the late 19th century when the state led both what Perez calls the installation and the deployment of the new paradigm. It is arguable that Germany in that era was the original entrepreneurial state, commanding both the catching-up and forging head of its national rivals in about half a century.[71]

Second, we are in the middle of the ICT-driven paradigm and its deployment over the next two to three decades coincides with the green turn in our lifestyles and attitudes. As Perez argues, 'smart green' is a combination not a contradiction; neither is it a coincidence. Deciding on a smart green lifestyle "as direction for innovation could be the most suitable way to bring about a successful deployment of the ICT age."[72]

So, policy makers have a window of opportunity to reap the benefits of both the diffusion of the ICT paradigm throughout the economy and the transition to sustainable lifestyles. Both, however, require the state to step in and ensure that economic agents follow the sustainable directionality and support the shift in lifestyles, and that these new ways of producing and consumption get spread across the economy and society.

Smart green growth requires a new mix of complementary policies: one set focusing on transforming the directionality of investments and innovations[73] (e.g., green vs brown financial regulations; or changes in lifestyles);[74] and the other set making sure new greener and smarter ways of production are diffused throughout major industries (e.g., electrification of industry and transport systems).

---

[71] Reinert, *The Visionary Realism of German Economics*.

[72] Perez and Murray Leach, 'A Smart Green "European Way of Life": The Path for Growth, Jobs and Wellbeing'.

[73] Matteo Deleidi, Mariana Mazzucato, and Gregor Semieniuk, 'Neither Crowding in nor out: Public Direct Investment Mobilising Private Investment into Renewable Electricity Projects', *Energy Policy* 140 (1 May 2020): 111195, https://doi.org/10.1016/j.enpol.2019.111195.

[74] Thomas Wiedmann et al., 'Scientists' Warning on Affluence | Nature Communications', *Nature Communications* 11, no. 3107, accessed 16 September 2020, https://www.nature.com/articles/s41467-020-16941-y.

2.4. Public-sector dynamic capabilities for market shaping

For governments to create such policy complementarities between diffusion- and mission-oriented policies, public actors require a set of dynamic capabilities for market shaping policy mixes, and in particular for creating and implementing mission-oriented policies:[75]

First, a market shaping (co-creating) role requires the state to have capabilities for leadership and engagement: missions can all too quickly become either just fashionable labels on 'business-as-usual' practices or too rigid top-down planning exercises. Thus, capabilities to engage with a wide set of social actors and to show leadership through bold vision are vital at a time of rising 'democratic deficit' in many developed countries. Some of the grand challenges contest the way of life as we know it (e.g. suburbanisation accompanied by congested transportation systems). Capabilities to encourage popular engagement align a capacity to set missions with potential for contestation and adaptability.

Second, in order to find coherent policy mixes of instruments and funding, coordination capabilities are fundamental to success. As these missions are not just about technological solutions but also have strong socio-political ambitions, experimentation capabilities matter perhaps more than ever. Equally important are evaluation capabilities that do not simply rely on market-failure-based approaches (e.g. cost–benefit analysis) but can also integrate user research, social experiments, and system-level reflection (e.g. dynamic efficiencies).[76]

Third, administrative capabilities need to rely on a diversity of expertise and skills from engineering to human-centric design: organisational forms that mix unrelated knowledge areas (e.g. in urban mobility and planning, lifestyles are just as important as new energy storage systems[77]) and organisational fluidity (e.g. cross-departmental teams) seem to be fundamental for managing new missions.

---

[75] Rainer Kattel and Mariana Mazzucato, 'Mission-Oriented Innovation Policy and Dynamic Capabilities in the Public Sector', *Industrial and Corporate Change* 27, no. 5 (1 October 2018): 787–801, https://doi.org/10.1093/icc/dty032.

[76] Ralf Lindner et al., 'Addressing Directionality: Orientation Failure and the Systems of Innovation Heuristic. Towards Reflexive Governance', *Discussion Papers 'Innovation Systems and Policy Analysis'*, Discussion Papers 'Innovation Systems and Policy Analysis' (Fraunhofer Institute for Systems and Innovation Research (ISI), 2016), https://ideas.repec.org/p/zbw/fisidp/52.html; Arie Rip, 'A co-evolutionary approach to reflexive governance - and its ironies', *Reflexive Governance for Sustainable Development. Incorporating unintended feedback in societal problem-solving*, 2006, 82–100, https://research.utwente.nl/en/publications/a-co-evolutionary-approach-to-reflexive-governance-and-its-ironie.

[77] Markus Grillitsch, Bjorn Asheim, and Michaela Trippl, 'Unrelated Knowledge Combinations: Unexplored Potential for Regional Industrial Path Development', *Papers in Innovation Studies*, Papers in Innovation Studies (Lund University, CIRCLE - Center for Innovation, Research and Competences in the Learning Economy, 10 July 2017), https://ideas.repec.org/p/hhs/lucirc/2017_010.html.

2.5. Assessing readiness to tackle challenges

In order to assess the readiness of a country to tackle challenges through economic policy, and in particular through industrial and innovation policies, we need to analyse the following areas:

- Market shaping policies: Industrial and innovation policy that invests in long-term dynamic efficiency (spillovers, crowding in private R&D) and changes in consumer behaviour (e.g., food, mobility);
- Directed finance: financial regulations and central bank activities that induce and mandate investment into societal transformation (such as green transition);
- Public procurement practices that help to pursue societal transformations.

Across these three areas there need to be mission-oriented public agencies that possess capabilities and capacities to solve problems and implement mission-oriented policies.

In what follows, we will apply this framework to Germany and assess what the strengths and weaknesses of Germany's current policies and institutions within challenge-driven policy are.

3. GERMANY AND CHALLENGE-DRIVEN FRAMEWORK

As outlined above, successful challenge-driven innovation policies need to rely on several key aspects in order to be effective responses to major social, environmental, and economic challenges. Rather than managing economies according to GDP growth rates, competitiveness indices or other macro indicators, industrial and innovation policies should both actively shape markets by confronting the direction of growth, and diffuse new and emerging technologies and practices across industries. As we argued in the introduction, Henry Ergas categorised Germany in his 1987 seminal article as focused on diffusion-oriented policy mixes, not mission-oriented ones.[78] While the latter are focused on radical technological breakthroughs, the former are focused on providing technology-related public goods such as education and basic research. In this section we provide an assessment of whether Germany has sufficient capacities and capabilities to deploy challenge-driven innovation policies.

3.1. Innovation and industrial policies in Germany

Following the end of WWII, Germany's innovation and industrial policies were mainly focused on rebuilding the manufacturing sector, and specifically those industries that had previously held competitive advantages. The approach of West Germany can be best described as one of

[78] Ergas, 'Does Technology Policy Matter?'

decentralisation and deconcentration,[79] and strongly focused on social balance.[80] First, the state shared decision-making with the governments of the federal states and power was thus decentralised. Second, large corporations and monopolies such as IG Farben and Vereinigte Stahlwerke (United Steelworks) were broken into several smaller enterprises with the aim to increase competition.[81] Third, a thick layer of institutions ensured that industrial development was accompanied by high wages and social balance.[82] The ordo-liberal approach of ensuring competition through small and medium-sized companies, with the state limited to providing the constitutional framework for markets to function properly was particularly influential in post-war Germany.

To this day, ordo-liberalism continues to be important in the debate around innovation and industrial policy. Germany's new industrial strategy *Nationale Industriestrategie 2030,* introduced in 2019, specifically refers to 'Ordnungspolitische Prinzipien'.[83] Similarly, Germany's Ministry for Economic Affairs and Energy aims to "foster Germany's innovation capacity by creating an environment that is conducive to investment and by providing funding programmes that are targeted to the needs of the market".[84] At the same time, however, there are more and more voices arguing against the ordo-liberal approach and instead for a more active use of industrial policies by the German state (see for example Wirtschaftsforum[85]). Even the *Nationale Industriestrategie 2030* calls for such active involvement of the state in the market to prevent disadvantages to the German economy and ensure national welfare.

Whereas innovation and industrial policies in the US rely heavily on the provision of venture capital to foster innovations and 'nudge' these in a particular direction, China is usually seen as an example of ambitious state-led innovation through long-term strategies. In the case of digital transformation for example, the US Commerce Department has provided up to 25 per cent of total funding for early-stage technology firms.[86] In contrast, across the Pacific, in the development of renewable energy, the government of China is the biggest domestic financier globally of investments and combines upscaling of green energy capacity with an industrial

[79] Schefold, 'The German Historical School and the Belief in Ethical Progress'.
[80] Wolfgang Streeck and Kozo Yamamura, *The Origins of Nonliberal Capitalism: Germany and Japan in Comparison*, New Ed edition (Ithaca, NY: Cornell University Press, 2005).
[81] Volker Berghahn, 'ORDOLIBERALISM, LUDWIG ERHARD, AND WEST GERMANY'S "ECONOMIC BASIC LAW"', *European Review of International Studies* 3, no. 2 (2015).
[82] Streeck and Yamamura, *The Origins of Nonliberal Capitalism*.
[83] BMWI, 'Nationale Industriestrategie 2030' (Berlin: Bundesministerium für Wirtschaft und Energie (BMWi), 2019).
[84] BMWI, 'Innovationspolitik', Bundesministerium für Wirtschaft und Energie, 2020, https://www.bmwi.de/Redaktion/DE/Dossier/innovationspolitik.html.
[85] 'Wege in Den Neustart – Weichen Für Die Zukunft Stellen'.
[86] Mazzucato, *The Entrepreneurial State*.

strategy.[87] Germany's innovation and industrial policies sit somewhere between these two extremes but feature important aspects of both approaches. While the public sector invests in R&D and industrial policies, private-sector initiatives are simultaneously supported through long-term lending to firms, and by private investment into R&D.

3.1.1. Knowledge-generation and stealth industrial policy

At first glance, Germany does not seem to be leading other advanced economies in R&D capacities, university research or high levels of human capital. In 2017, R&D expenditure as a share of GDP was around 3 per cent and thus lagging behind world leaders such as Korea with 4.3 per cent, Switzerland with 3.4 per cent, Sweden and Japan with 3.4 and 3.2 per cent respectively.[88] In terms of human capital, only around one third of 25-34 year-olds hold tertiary education qualifications in Germany, which is among the lowest levels in OECD countries.[89] Lastly, Germany's decentralised education system focuses mostly on inward-looking traditional academic disciplines and universities have much lower budgets than counterparts in the US or the UK.

Deeper investigation, however, reveals a more complex system of joint funding by Federal and Länder governments for basic research in universities, universities of applied sciences and non-university research institutions. While many of these investments are *technologieneutral*, with strong regional focus, these form what can be described as a 'stealth' industrial policy that tends to fly under the radar of domestic and international policy discussions.

Germany is unique in state-directed funding to non-university research institutions. In 2017, they were provided with a total funding of 6.82 billion euros.[90] The funding and promotion of applied science and non-university research was one of the key reasons why Ergas described Germany as relying on diffusion-oriented policy mixes[91] and this has scarcely changed over the past three decades. Hall and Soskice have compared innovation systems in terms of patent specialisations. Whereas the US holds patents disproportionally in sectors where radical inno-

[87] John Mathew and Hao Tan, *China's Renewable Energy Revolution* (Basingstoke: Palgrave Macmillan, 2015); Gregor Semieniuk and Mariana Mazzucato, 'Financing Green Growth', IIPP Working Paper (London: Institute for Innovation and Public Purpose, 2018).
[88] OECD, 'Gross Domestic Spending on R&D (Indicator)', OECD Science, Technology and R&D Statistics, 2020, https://data.oecd.org/rd/gross-domestic-spending-on-r-d.htm.
[89] OECD, 'Population with Tertiary Education (Indicator).', OECD Education Statistics, 2020, https://data.oecd.org/eduatt/population-with-tertiary-education.htm.
[90] EFI, 'Research, Innovation and Technological Performance in Germany 2019', Research, Innovation and technological performance in Germany: Report, No. 2019e (Berlin: Commission of Experts for Research and Innovation (EFI), 2019).
[91] Ergas, 'Does Technology Policy Matter?'

vation is needed, such as medical engineering, biotechnology and telecommunications, Germany focuses mostly on incremental innovation in sectors such as mechanical engineering, product handling or consumer durables.[92]

Research centres such as the Fraunhofer Gesellschaft or the Max-Plank Gesellschaft are at the core of this incremental approach to R&D and have been at the forefront of an ethos that sees research and innovation as an end in itself rather than just a means to economic growth.[93]

Table 1 provides an overview of the most notable non-university research centres in Germany.

Table 1. Research Institutes in Germany in 2019.[94]

Institute	Branches	Founded	Staff	Budget (in €)
Fraunhofer Gesellschaft	80	1949	28000	2,8 billion
Max-Plank Gesellschaft	88 (5 abroad)	1948	23767	1,8 billion
Helmholtz	19	1995	40000	4,8 billion
DLR e.V (German Aerospace Centre)	26	1907	9000	1 billion
Leibnitz Gemeinschaft	95	1990	20000	1,9 billion

Whereas the Max-Plank Gesellschaft and the Leibnitz Gemeinschaft focus on basic and fundamental research and science, the Fraunhofer Gesellschaft focuses on applied and contract research with a focus on developing new technologies. The Fraunhofer Gesellschaft was founded in 1949 to support the rebuilding of the German manufacturing sector and to provide a bridge from basic research to commercial technology. Today, the institute is the biggest non-profit organisation for applied sciences in the world and has contributed significantly to the innovation and success of the German manufacturing sector.[95] The impact of the Fraunhofer

[92] Peter Hall and David Soskice, *Varieties of Capitalism* (Oxford, UK: Oxford University Press, 2001); Streeck and Yamamura, *The Origins of Nonliberal Capitalism*.
[93] BMWI, 'Innovationspolitik'.
[94] Authors' summary based on annual reports of Fraunhofer Gesellschaft, Max-Plank Gesellschaft, Helmholtz, DLR, and Leipniz Gesellschaft.
[95] David Audretsch and Erik Lehmann, *The Seven Secrets of Germany* (Oxford: Oxford University Press, 2016).

Gesellschaft is particularly impressive when it comes to their contribution to transnational patent applications. In 2013, the Gesellschaft was responsible for 0.13 per cent of all new transnational patents, whereas all other research institutes including universities accounted for 0.4 per cent of global transnational patent applications.[96]

The Fraunhofer Gesellschaft can best be described as a public-private partnership, with 30 per cent of the budget coming from government funds and 70 per cent from contract research, which in turn is split into 50 per cent stemming from public contracts and 50 per cent from private industry contracts. The most important private-sector contractors are small and medium-sized companies, the so-called *Mittelstand*. Companies engaging with the Fraunhofer Gesellschaft have been found to benefit significantly through growth in turnover and productivity.[97] Comin et al. indicate that increasing the revenue from industry contract research by 0.9 billion euros (equivalent to the 35 per cent of the annual budget stemming from private contract research) would increase overall productivity in the German economy by 0.55 per cent.

Additionally, the system of government-supported research centres is accompanied by a dual system of education. First, Germany's universities can be divided into traditional universities and applied research *Fachhochschulen*. Second, Germany has an elaborate apprentice system with around 300 different specialisations. With 2.5 million apprentices,[98] there are nearly as many students in vocational training *Berufsschulen* as there are students enrolled at universities, 2.9 million in 2019. *Berufsschulen* and *Fachhochschulen* play an important role for local industries as they often form close relationships, resulting in mutually reinforcing benefits.[99] Whereas most German universities are located in metropolitan areas, many applied research universities are located in less populated areas and provide useful inputs for the local industries. They have thus become an important aspect of Germany's *Standortpolitik*.

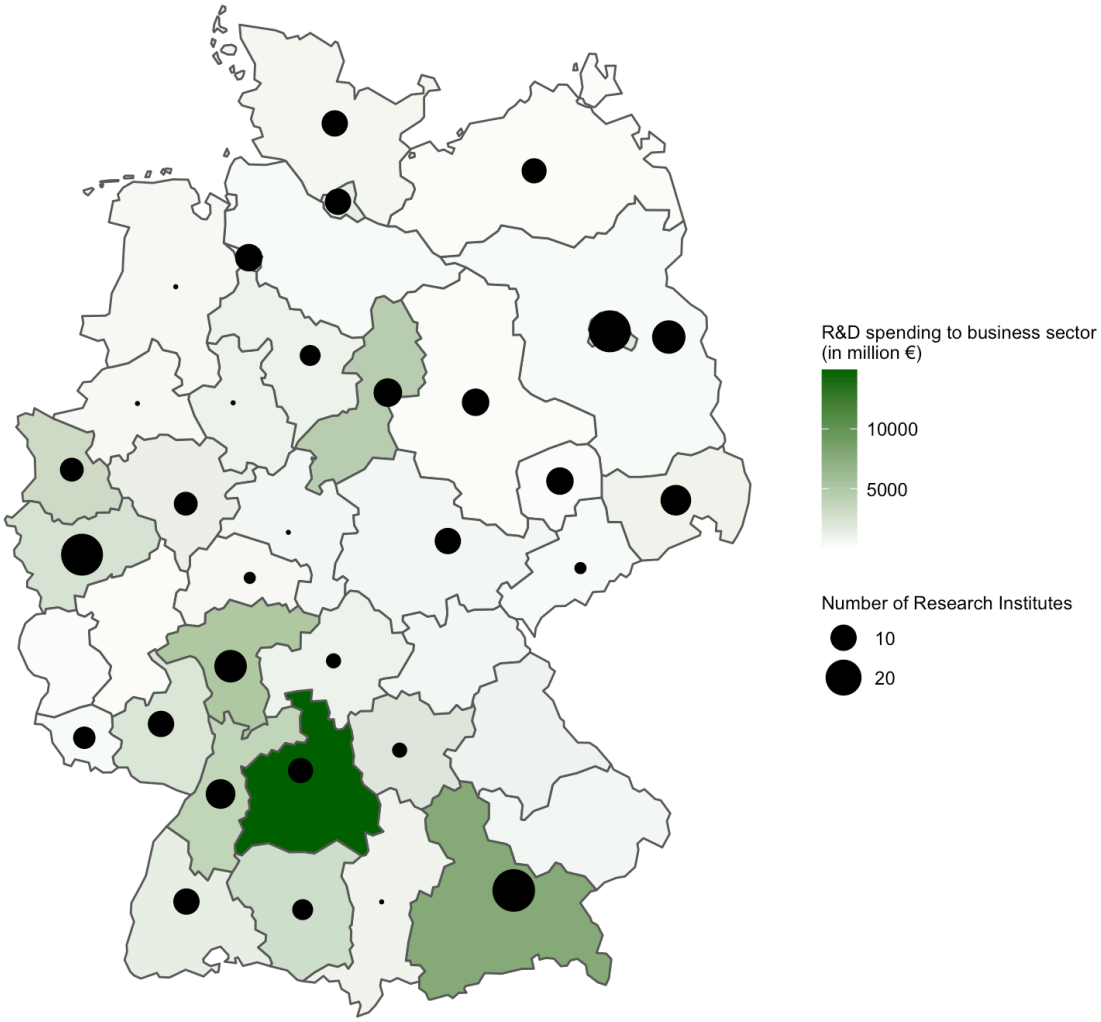
Roughly two-thirds of all R&D in Germany is funded by industry and this share has stayed stable in the last two decades. As with funding, so with jobs. Industry employs around 400 000 people in R&D while universities and public research institutions around 250 000.[100] More

[96] Rainer Frietsch et al., 'Beitrag der Fraunhofer-Gesellschaft zum deutschen Innovationssystem' (Fraunhofer Gesellschaft, 2016).
[97] Diego Comin et al., *Do Companies Benefit from Public Research Organizations? The Impact of the Fraunhofer Society in Germany*, ZEW. Discussion Paper (Mannheim: ZEW, 2019).
[98] DeStatis, 'Bildung, Forschung und Kultur', Statistisches Bundesamt, 2020, https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Bildung-Forschung-Kultur/_inhalt.html.
[99] Audretsch and Lehmann, *The Seven Secrets of Germany*.
[100] Ulrich Schasse et al., 'Forschung und Entwicklung in Staat und Wirtschaft: Deutschland im internationalen Vergleich', Research Report (Studien zum deutschen Innovationssystem, 2018), https://www.econstor.eu/handle/10419/175544.

then 80 per cent of the private sector R&D investments are done by large companies, mostly in car manufacturing and machinery, chemistry and electronics.[101]

Figure 3 shows the impact of the stealth industrial policy by looking at the regional number of research centres together with private investments in R&D. In terms of spending, there are clear concentrations in the west and south of Germany, which aligns with the strong presence of research centres in the areas of Stuttgart, Oberbayern (Munich), Cologne and their neighbouring areas.

Figure 3: German private R&D and number of research institutes, by NUTS2 region.[102]



[101] Schasse et al.

[102] Authors' elaboration based on R&D data from Eurostat and research institutes based on annual reports of Fraunhofer Gesellschaft, Max-Plank Gesellschaft, Helmholtz, DLR, and Leipniz Gesellschaft.

However, the regional clusters of research centres do not always match private R&D spending. In the east of Germany, where Berlin, Brandenburg, Leipzig and Dresden also host many research centres, the strong presence of private R&D spending is lacking. This indicates that there seems to be further unused potential for benefits from spillover effects and private-public linkages in certain areas, and shows that Germany was not able to fully extend its stealth industrial policy model following reunification.[103]

Overall, German public agencies in the STI field tend to be focused on generating new knowledge and its diffusion. The funding agencies tend not be focused on specific societal missions; they are by and large technology-neutral, and one of the key challenges Germany's relatively decentralised STI system faces is coordination.[104] Yet, at the same time many of these agencies play hugely important roles in the German economy. This is especially important when it comes to the coordination and collaboration between research centres and private spending on R&D.

Particularly since the late 1990s, the incrementalism in both education and industry has been counteracted by the federal government through its R&D institution building.[105]

3.1.2. Mission-oriented institutions and policies in Germany

Energiewende and KfW

A central pillar for a mission-oriented approach is the largest German state development bank *Kreditantstalt für Wiederaufbau* (KfW), which conducts industrial policy by providing credit to priority sectors. Measured in asset size, the KfW is more influential than its Chinese and Brazilian counterparts, CDB and BNDES.[106] Funded initially to channel funds from the Marshall Plan for reconstruction into the economy, the bank continues to work closely with the German government and finances initiatives by the BMWi (Federal Ministry for Economic Affairs and Energy) and the BMF (Federal Ministry for Finance). In the cases of achieving

[103] Erik Reinert and Rainer Kattel, 'European Eastern Enlargement as Europe's Attempted Economic Suicide?', The Other Canon Foundation and Tallinn University of Technology Working Papers in Technology Governance and Economic Dynamics (TUT Ragnar Nurkse Department of Innovation and Governance, July 2007), https://econpapers.repec.org/paper/tthwpaper/14.htm.

[104] Jakob Edler and Stefan Kuhlmann, 'Coordination within Fragmentation: Governance in Knowledge Policy in the German Federal System', *Science and Public Policy* 35, no. 4 (1 May 2008): 265–76, https://doi.org/10.3152/030234208X310329; Tilmann Rave, Ursula Triebswetter, and Johann Wackerbauer, 'Koordination von Innovations-, Energie- und Umweltpolitik', Research Report (Studien zum deutschen Innovationssystem, 2013), https://www.econstor.eu/handle/10419/156591.

[105] Weiss, *The Myth of the Powerless State*.

[106] Mazzucato and Penna, 'Beyond Market Failures'; Natalya Naqvi, Anne Henow, and Ha-Joon Chang, 'Kicking Away the Financial Ladder? German Development Banking under Economic Globalisation', *Review of International Political Economy*, 2018.

digital transformation as well as promoting renewable energies, the cooperation and coordination between the ministries of the federal government and the KfW were crucial aspects of the policy.

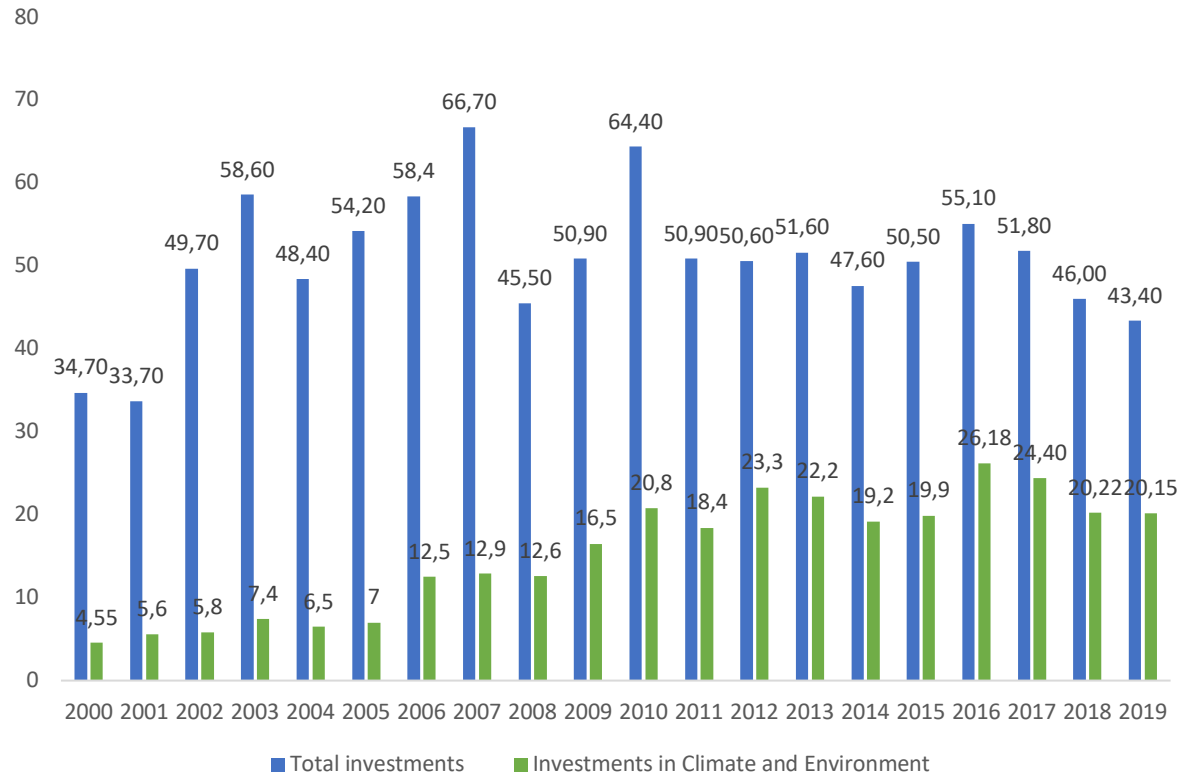
For example, while initially KfW's lending focused on the reconstruction of post-war Germany, today all investments must contribute to at least one of three pre-established missions, or 'megatrends': (KfW, 2016)

- Climate change and the environment: KfW finances measures to support renewable energy, improve energy efficiency, safeguard biodiversity and prevent and/or reduce environmental pollution. To address the special importance of this area, KfW has set an internal commitment to achieve that 35 per cent of all new financing activities are for environmental projects. The KfW has played an instrumental role in the systemic greening of the German economy through the *Energiewende* policy, which aims to combat climate change, phase out nuclear power, improve energy security by substituting imported fossil fuel with renewable sources and increase energy efficiency. The KfW 'Energy Transition Action Plan' was launched in 2011 and had invested over 100 billion euros by the end of 2016.
- Globalisation and technological progress: KfW contributes to strengthening the international competitiveness of German companies by granting loans in the following areas, among others: research and innovation, projects to secure Germany's supply of raw materials, and infrastructure and transport.
- Demographic change: KfW's objective is to address the consequences that result from a declining and ageing population, including the following focus areas: age-appropriate infrastructure, vocational and further training, family policy and childcare as well as corporate succession.

One of the major success stories of KfW and the mission-oriented approach in Germany is the transition of the energy system as part of the *Energiewende*. Rather than providing just the policy framework for the market to achieve greater use of renewables, the German state embarked on the bold mission of the *Energiewende*. Through the use of feed-in tariffs and the provision of subsidised long-term finance via the KfW, Germany has since the late 1990s created domestic demand to promote the use of renewable energies.

Figure 4 shows the dramatic increase of investments by KfW into environmental and climate protection since 2000.

Figure 4. KfW's domestic total and investments in environmental and climate protection (in € bn).[107]



Energiewende arguably created a global market for solar panels[108] and lead to increased innovation and investment into the green transition. In 2014 German businesses provided circa 50 per cent of all European corporate investments into energy-related R&D.[109]

In September 2010 the German government decided to phase out fossil fuels and instead promote renewable energies, where nuclear power was supposed to bridge the supply gap. However, following the Fukushima nuclear disaster, the government decided to abandon the idea of nuclear as a bridging energy and transition to renewables immediately.[110] While the decision to phase out nuclear power sooner than initially planned has led to a revival of coal usage, Germany plans to close all coal-fired power stations at the latest by 2038. This would mean

[107] Calculations by the authors, based on KfW's Geschäftsberichte (up to 2014) and Förderreporte (from 2015).
[108] Fagerberg, 'Mission (Im)Possible?'
[109] Umweltbundesamt, 'Innovationsmotor Umweltschutz: Forchung Und Patente in Deutschland Und Im Internationalen Vergleich', 2019, https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/2019-12-05_uib_06-2019_innovationsmotor-umweltschutz-2019.pdf.
[110] Karen Smith Stegen and Matthias Seel, 'The Winds of Change: How Wind Firms Assess Germany's Energy Transition', *Energy Policy* 61 (1 October 2013): 1481–89.

Germany will become one of the first economies to entirely depend on energy from renewables or natural gas.[111]

In 2011, KfW announced it would invest 100 billion euros over the following five years to support the innovation in clean technologies and promote the supply of wind and solar energy. By the end of 2011, KfW together with the World Bank was the most important promoter of renewable energies globally and had funded 46 per cent of the newly added electrical output in Germany.[112] To further support the innovation in clean technologies, Germany deployed demand-side policies to support economies of scale and boost the export of German renewable technologies to developing countries.[113] KfW's subsidiary for international project and export finance, IPEX, took on a central role in supporting German renewable firms' sales abroad. Over the years, KfW IPEX has become one of the global leaders in financing the deployment of wind and solar energy technologies.[114]

The *Energiewende* project has been hailed as "one of the most far-reaching attempts globally to initiate a policy-driven transformation of an entire economy through green industrial policy".[115] Whereas a key feature of Germany's approach was again the provision of credit through the KfW, the German state took on a much more active role by simultaneously deciding to phase out fossil fuels as well as nuclear power plants. But a key role was also played by social and community movements in urging the government to take bold action.[116]

The *Energiewende* can be described as a successful case where mission- and diffusion-oriented elements of innovation policy were combined. The cooperation between different ministries such as the BMWi, the BMF and the KfW provide a reliable institutional setting for challenge-driven innovation policies.

There is growing evidence, however, that the *Energiewende* has lost its momentum amid the multitude of policy support schemes and regulations.[117]

---

[111] ZEIT ONLINE, 'Klimaschutz: Bundesregierung zufrieden mit Kohlekompromiss', *Die Zeit*, 2019, sec. Politik, https://www.zeit.de/politik/deutschland/2019-01/klimaschutz-kohleausstieg-kommission-reaktionen-regierung/komplettansicht.

[112] KfW, 'Annual Report 2011', Geschäftsberichte (Frankfurt am Main: Kreditbank für Wiederaufbau, 2011).

[113] Naqvi, Henow, and Chang, 'Kicking Away the Financial Ladder? German Development Banking under Economic Globalisation'.

[114] KfW IPEX-Bank, 'Geschäftssparte Energie Und Umwelt', Geschäftssparten, 2020, https://www.kfw-ipex-bank.de/Internationale-Finanzierung/KfW-IPEX-Bank/Geschäftssparten/Energie-und-Umwelt/.

[115] Anna Pegels and Wilfried Lütkenhorst, 'Is Germany's Energy Transition a Case of Successful Green Industrial Policy? Contrasting Wind and Solar PV', *Energy Policy* 74 (2014): 522.

[116] Craig Morris and Arne Jungjohann, *Energy Democracy: Germany's Energiewende to Renewables* (Palgrave Macmillan, 2016).

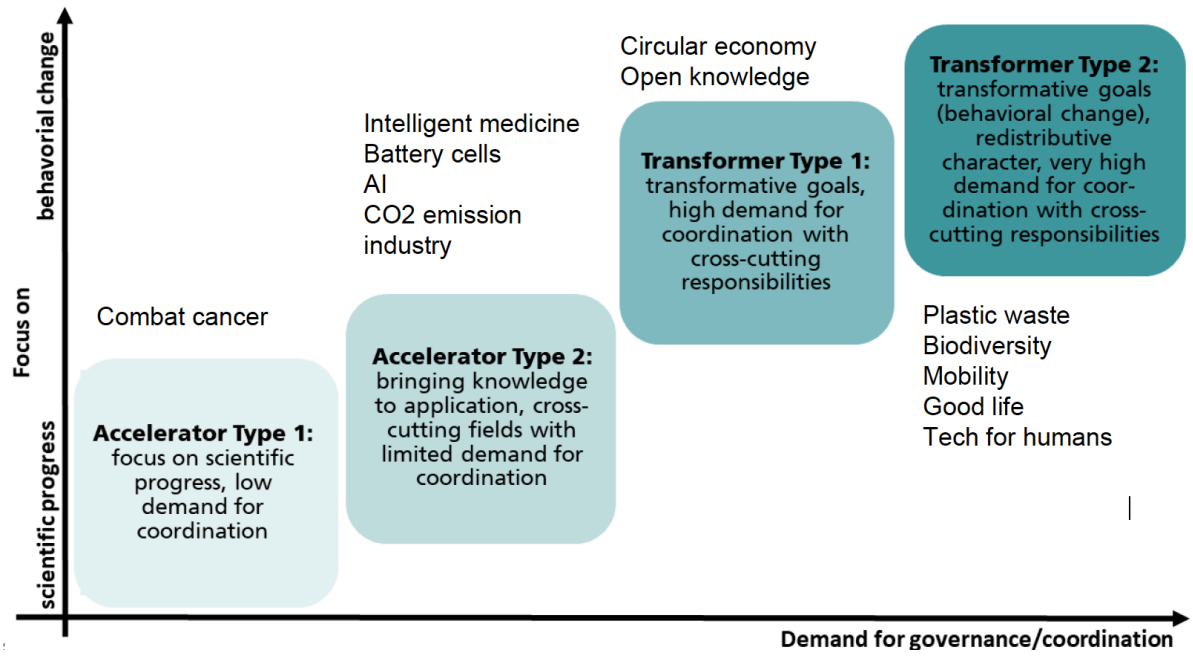
[117] Gatzen et al., 'Technologische Innovationen und neue Geschäftsmodelle für die Energiewende - Die Rolle der deutschen F&I Politik'.

High-Tech Strategy 2025

In 2018, the German government introduced a framework policy agenda called *High-Tech Strategy 2025*, which acts an an overall coordination strategy for German science, technology and innovation policy. Its aim, together with the federal states and the private sector, is to increase R&D spending to 3.5 per cent of the gross domestic product.[118] It can be argued that the strategy attempts to present German STI institutions and funding with socio-economic challenges. The strategy includes 12 missions,[119] and functions mainly as an interministerial coordination instrument in order to provide better alignment between the existing, largely diffusion-oriented STI and industrial landscape, and socio-economic challenges. Wittmann et al 2020 have created a typology of missions (depicted in

Figure 5 below) and divided the 12 missions defined in the strategy according to the typology.

Figure 5 Typology of missions, with mapping of German missions in High-Tech Strategy 2025.[120]



[118] BMBF, 'Research and Innovation That Benefit the People - The High-Tech Strategy 2025', 2018.

[119] Combating what?; digitally networking research and healthcare – for intelligent medicine; finding new sources for new knowledge; shaping technology for the people; ensuring good living and working conditions throughout the country; sustainable circular economies; preserving biological diversity; substantially reducing the plastic discharged into the environment; achieving substantial greenhouse gas neutrality in industry; developing safe, networked and clean mobility; putting artificial intelligence into practical application; and building up battery cell production in Germany (we use official English translations). More details available here: https://www.hightech-strategie.de/de/missionen-1725.html, includes detailed activities under each mission.

[120] Authors' elaboration based on Florian Wittmann et al., 'Developing a Typology for Mission-Oriented Innovation Policies', Working Paper (Fraunhofer ISI Discussion Papers - Innovation Systems and Policy Analysis, 2020), https://www.econstor.eu/handle/10419/215820.

A part of the strategy has been the establishment of new government agencies with a mandate to actively shape innovations in Germany. One of these new agencies, the *Agency for Innovation in Cybersecurity* within the Federal Ministry of Defence, was created with reference to the widely successful Defense Advanced Research Projects Agency (DARPA) of the US Ministry of Defence. With the establishment of this new agency for cybersecurity and IT, the Germany government aims to internalise the innovation of new technologies within the military, rather than relying on external partners. By doing so, the agency is an example of a typical mission-oriented agency with a mandate to innovate and develop new technologies. However, it is important to note that while DARPA has a budget of 2.95 billion euros for 2019 alone, the German government plans to spend 200 million euros over the next five years to launch the new agency.[121]

A second new agency which is worth noting is the *Agentur für Sprunginnovationen* by the Federal Ministry for Education and Research (BMBF) and the BMWi. Founded in 2019 as "SprinD GmbH" and based on a commission of representatives from science, economics and politics, the agency aims to support disruptive innovations in Germany. By helping entrepreneurs, the agency focuses less on research and development itself but tries to fast-track the market entry of promising products. Entrepreneurs continue to manage the development of the product and prepare the market entry, but do so as the head of a subsidiary within the agency.[122] Contrary to the *Agency for Innovation in Cybersecurity*, the *Agentur für Sprunginnovationen* follows an approach more in line with diffusion-oriented policymaking. Yet, by calling for submissions to innovation competitions such as a battery for the 21st century, lab-grown organ replacements or tackling the energy consumption of AI, the agency incorporates aspects of challenge-led policy frameworks.

Digital transformation

The case of digital transformation can be seen as a semi-failure in applying a more mission-oriented approach in Germany. When it comes to digital transformation, Germany is often argued to lack the same amount of venture capital available to start-up companies as in other

[121] Politico, 'Germany to Launch US-Style Agency to Develop Cyberdefense', 2018, https://www.politico.eu/article/germany-to-launch-darpa-style-agency-to-develop-cyber-defense/.
[122] BMBF, 'Agentur Für Sprunginnovationen', Bundesministerium für Bildung und Forschung, 2019, https://www.bmbf.de/de/agentur-fuer-sprunginnovationen-9677.html.

countries.[123] However, since the early 2000s' the KfW together with the federal and state governments have put in place a system of incentives for investors to consider venture capital funds. This has been done both directly through early-phase funds such as the High-Tech Gründerfonds (HTGF) and indirectly by the KfW as an investor for venture capital funds as part of the ERP Venture Capital Fund Financing programme. A recent analysis has shown that between 1992 and 2018, Germany raised nearly 20 billion US dollars in venture capital funding, making it one of the most venture-intensive countries in Europe.[124] Additionally, Germany is often argued to benefit from high VC investments in B2B business models in the areas of mobility, clean tech and other areas with high attention to social and environmental impacts.[125] However, despite these improvements in the availability of venture capital in B2B, especially to manufacturing firms, successes are far less known than the stars of Silicon Valley.[126]

Among other things, the High Tech strategy aims to promote key digital technologies that are essential to realise wide-ranging and disruptive innovations.[127] To achieve this goal, the German government is following two main approaches. On the one hand, the German state is trying to take an active entrepreneurial role in promoting innovation by launching specialised agencies such as the Agency for Disruptive Innovations For Civil Applications or the Agency for Innovation in Cybersecurity.[128] On the other hand, the KfW acts as an investor for venture capital funds with the aim to attract further institutional investors both within Germany and from abroad.[129]

In summary, in innovation and industrial policy Germany's strengths are in regional industrial alliances between various publicly funded research and educational institutions and industry. These alliances are oriented towards generating new knowledge and diffusing it among stakeholders. Such stealth industrial and innovation policies focus on incremental innovations and

[123] Ines Mergel, 'Digitale Transformation als Reformvorhaben der deutschen öffentlichen Verwaltung / Digital transformation as a reform project of Germany's public sector', *dms – der moderne staat – Zeitschrift für Public Policy, Recht und Management* 12, no. 1 (21 June 2019), https://budrich-journals.de/index.php/dms/article/view/33451; Wolfgang Sofka, Edlira Shehu, and Hristo Hriston, 'RIO Country Report Germany' (Joint Research Centre, European Commission, 2017), https://rio.jrc.ec.europa.eu/country-analysis/Germany/country-report.

[124] Susan E. Woodward, 'The American Role in European Venture Capital', SSRN Scholarly Paper (Rochester, NY: Social Science Research Network, 2019), https://doi.org/10.2139/ssrn.3320838.

[125] EY, 'Growth with Purpose: German Tech Start-Ups Changing Society' (Earnst & Young, 2019).

[126] Roland Berger, IE.F, and BVK, 'Venture Capital: Fueling Innovation and Economic Growth' (Roalnd Berger, the Internet Economy Foundation and the German Private Equity & Venture Capital Association, 2018).

[127] For an analysis of the High-Tech Strategy 2025 through missions lenses, see Wittmann et al., 'Developing a Typology for Mission-Oriented Innovation Policies'.

[128] EFI, 'Research, Innovation and Technological Performance in Germany 2019'.

[129] EFI, 'Research, Innovation and Technological Performance in Germany 2017' (Berlin: Commission of Experts for Research and Innovation (EFI), 2017).

is biased towards stable growth over a long period of time. Since the 1990s Germany has experimented with more mission-oriented approaches. KfW's role in realising the *Energiewende* serves as an example par excellence. Germany would benefit from an even stronger entrepreneurial approach in fostering technological innovations and building institutional and policy complementarities within its diffusion-oriented regional policies and federal level mission-oriented policies; agencies such as KfW and new specialized agencies.

3.1.3. New windows of opportunity: Coal-exit and COVID-19 recovery

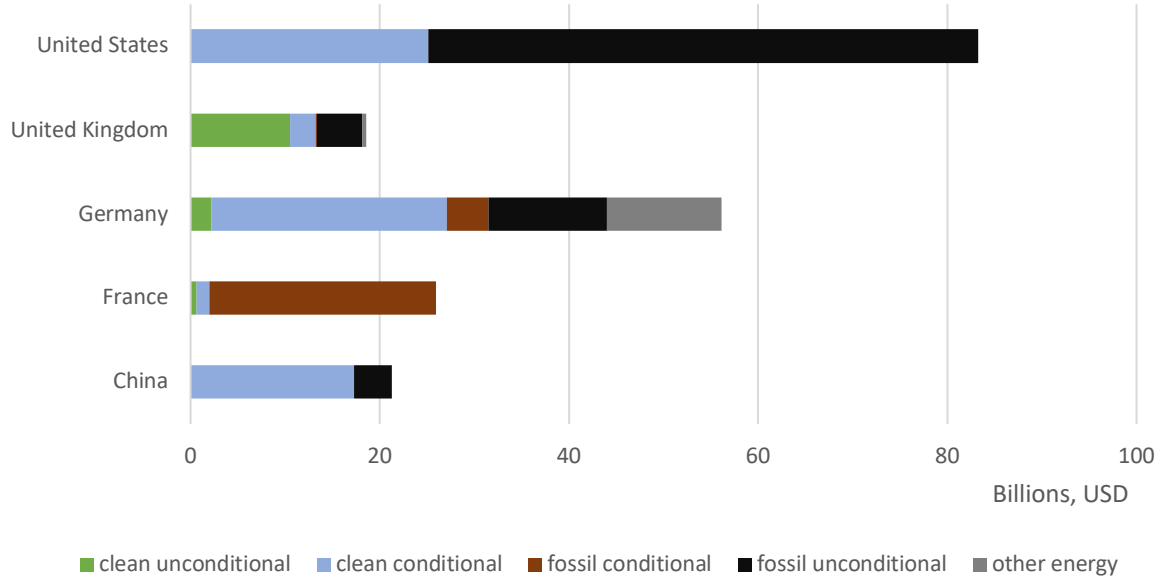
Beginning with the formulation of the new industrial strategy *Nationale Industriestrategie 2030* and with the *High-Tech Strategy 2025*, Germany has started to move away from mainly diffusion-oriented policies and capabilities towards actively seeking to shape markets. This has been reinforced by the impact of COVID-19.

In addition to *High-Tech Strategy 2025* and *Industriestrategie 2030*, the German government has taken a further market-shaping approach through the support of renewable energies and the decision to phase out coal-generated power by the end of 2038. In an important contribution to meeting Germany's climate targets, the *Bundestag* and *Bundesrat* passed legislation put forward by the government in July 2020. In order to support the regions that are expected to suffer from the phasing out of fossil fuels, the government pledged 40 billion euros to support structural change in those regions.[130] The *Kohleaustieg* will build on the stealth industrial policy described above and that has proven largely successful in the past: nurture infrastructure and strengthen existing or create new research and educational institutions. This can be seen as a case of planned complementarity between an overarching mission and diffusion-oriented policies and institutions.

As mentioned in the introduction, Germany's response to COVID-19 has been impressive and mission-oriented. Since the beginning of the pandemic in 2020, the German government has committed 50 billion euros to support different energy types through 18 new or amended policies.[131] Figure 6 shows the breakdown of these policies according to their type. Compared to other G20 countries, Germany has committed the most to clean energy (both conditional and unconditional) with a total of 24 billion euros, mostly through budget transfers within the mobility sector.

[130] Bundesregierung, 'Von Der Kohle Hin Zur Zukunft', *Aktuelles* (blog), 2020, https://www.bundesregierung.de/breg-de/aktuelles/kohleausstieg-1664496.
[131] Energypolicytracker, 'G20 Analysis', 2020, https://www.energypolicytracker.org/region/g20/.

Figure 6: COVID-19 recovery packages from a climate and energy perspective.[132]



This window of opportunity could be strengthened with a more mission-oriented approach to finance and procurement.

3.2. Directed finance in Germany

A typical example of challenge-driven policy is the global response to climate change. The Paris Agreement to undertake ambitious efforts to combat climate change by keeping global tempratures below a two-degree increase can only succeed if low-carbon technologies will be developed and deployed while unsustainable activities are suppressed. Achieving this will require a combination of disruptive adjustments from different actors. One topic that has received growing attention in the academic debate is the role of central banks and financial regulators in addressing climate-related financial risks.[133] Since the 1990s, central banks have narrowed their mandates to focus on price stability and limited their interventions to adjustments of the reference interest rate. However, since the Global Financial Crisis (GFC) of 2008, central banks have increasingly used a wider range of 'unconventional' measures, including quantitative easing[134] and various other short and longer-term liquidity programmes to stimulate the economy.

---

[132] Authors' elaboration based on data from EnergyPolicyTracker, available at https://www.energypolicytracker.org/region/g20/

[133] Emanuele Campiglio et al., 'Climate Change Challenges for Central Banks and Financial Regulators', *Nature Climate Change* 8, no. 6 (June 2018): 462–68, https://doi.org/10.1038/s41558-018-0175-0.

[134] Quantitative Easing involves large-scale purchases of financial assets, such as government and corporate bonds, which can help to provide additional stimulus to the economy when short-term interest rates are already close to zero Bundesbank,

The extensive use of these tools – often with sectoral conditions (e.g. certain re-financing lines offered by the ECB are only available to Eurozone banks if they commit to financing SMEs or other non-financinal corporations) – has raised questions about central banks' market neutrality and independence. Which in turn has led to suggestions that central banks might do more to direct finance towards green growth. This is especially the case since the post-crisis stagnation, together with an inability of governments to maintain public support for climate-aligned investment. Both have hampered the transition towards low-carbon technologies. With regards to low-carbon energy, the IEA estimates that investment would need to swell two-and-a-half times by 2030 (growing the share of low-carbon energy from 35 per cent currently to 65 per cent) in order to meet the long-term sustainability goals of the SDGs.[135] The ECB's overall QE purchases during 2017 amounted to around 730 billion euros. In comparison, the EU estimates that in order to meet recognised energy and climate targets, an investment of 170 billion euros is needed.[136] This shows that if public finance was directed towards environmentally friendly and climate aligned investment, it would have significant positive impact on achieving the goals of the Paris Agreement.

The expansion of central bank interventions into markets presents an excellent opportunity to re-channel financial flows more strategically towards greener, zero-carbon alternatives. The criteria used by central banks to purchase financial assets should be adjusted to incorporate the climate-related risk associated with the companies that are being financed (e.g. loans to fossil fuel companies would be classified as highly risky given the risk of stranded assets).[137]

Despite this large potential, research suggests that corporate bond purchases of the ECB mirror the investment choices of financial markets and thereby have so far mostly favoured large carbon-intensive companies.[138] This has been argued to be due to two main reasons. Firstly, large carbon-intensive companies have relatively stronger credit ratings, and secondly low-carbon firms are often simply too small to issue corporate bonds. As a result, the quantitative easing

---

'Quantitative Easing', Glossar, 2020, https://www.bundesbank.de/dynamic/action/de/startseite/glossar/723820/glossar?firstLetter=Q&contentId=652692..

[135] IEA, 'World Energy Investment 2019' (Paris: International Energy Agency, 2019).

[136] Campiglio et al., 'Climate Change Challenges for Central Banks and Financial Regulators'.

[137] Pierre Monnin, 'Integrating Climate Risks into Credit Risk Assessment - Current Methodologies and the Case of Central Banks Corporate Bond Purchases', SSRN Scholarly Paper (Rochester, NY: Social Science Research Network, 20 December 2018), https://doi.org/10.2139/ssrn.3350918.

[138] Stanislas Jourdan and Wojtek Kalinowski, 'Aligning Monetary Policy with EU's Climate Targets' (Veblen Institute for Economic Reforms and Positive Money Europe, 2019); Sini Matikainen, Emanuele Campiglio, and Dimitri Zenghelis, 'The Climate Impact of Quantitative Easing', 2017, https://doi.org/10.13140/RG.2.2.24108.05763.

by central banks can mean that market participants will flock to these carbon-intensive corporate bonds and thereby perpetuate the current carbon lock-in of the economic system.[139] To prevent this undesired consequence, it has been suggested that central banks should either recalibrate quantitative easing purchases to exclude carbon-intensive financial assets or run a parallel green quantitative easing programme to mitigate the effect.

In the Eurozone, the central banks of Belgium, Finland, France, Germany, Italy and Spain conduct bond purchases on behalf of the ECB. This is done by each national bank in their respective area of operations. This means the German Bundesbank for instance acquires bonds from companies in Germany and the Netherlands, the Banque de France purchases bonds issues by French companies and so forth. While the purchases enter the balance sheet of the respective national bank, the coordination is incumbent upon the ECB. As a result, any financial gains or losses are distributed across all national banks of the Eurosystem according to the capital key of the ECB.[140] The quantitative easing programme is further divided into four subprogrammes: Corporate Sector Purchase Programme (CSPP), Public Sector Purchase Programme (PSPP), Asset-backed Securities Purchase Programme (ABSPP) and Covered Bond Purchase Programme (CBPP3).

Following Campiglio et al., the CSPP of the ECB can be assessed to analyse the extent to which national banks within the eurozone are trying to exclude carbon-intensive financial assets or run a parallel green quantitative easing programme.[141] While detailed information of the carbon footprint of the various bond issuers is not available, the ECB publishes data on the distribution of CSPP holdings across economic sectors. Jourdan and Kalinowski found that the majority of bond purchases are issued by companies operating within the most carbon-emitting sectors: extraction and distribution of fossil energy sources, car manufacturing and equipment, and utilities.[142] While this distribution concerns the Eurozone as a whole, the fact that the German Bundesbank is simply carrying out the quantitative easing programme on behalf of the ECB means that the distribution for Germany alone is likely to be similar.

To further analyse the portfolio of the quantitative easing programme of the German Bundesbank, we manually grouped all CSPP holdings by the Bundesbank as of April 2020.

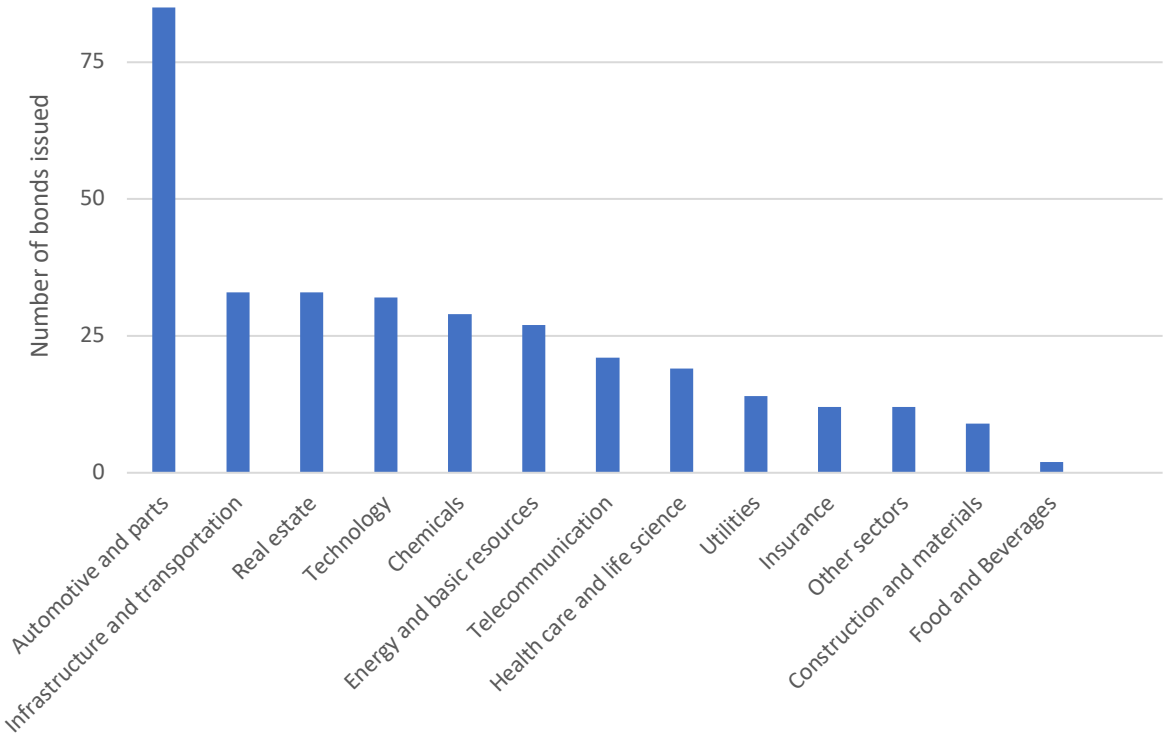
---

[139] Campiglio et al., 'Climate Change Challenges for Central Banks and Financial Regulators'.
[140] Bundesbank, 'Eurosystem Kauft Unternehmens-anleihen', Bundesbank Aufgabenbereiche, 2016, https://www.bundesbank.de/de/aufgaben/themen/eurosystem-kauft-unternehmens-anleihen-664916.
[141] 'Climate Change Challenges for Central Banks and Financial Regulators'.
[142] 'Aligning Monetary Policy with EU's Climate Targets'.

Figure 7 shows the distribution across sectors. From a total of 325 holdings, 26 percent were from automotive firms. While the automotive industry is among the highest polluters, investments can of course contribute to the research and development of electric engine technologies. Nonetheless,

Figure 7 shows that a majority of the bond purchases by the Bundesbank under the quantitative easing programme are within automotive, infrastructure and transportation, chemicals; and energy and basic resources, which are all usually understood to have a high carbon intensity.

Figure 7. CSPP holdings of the German Bundesbank, by sector.[143]



With regards to Germany using directed finance as a means to achieve strong societal missions such as the *Energiewende*, the potential of a quantitative easing programme remains largely unused. However, given that the Bundesbank executes the quantitative easing programme on

[143] Authors' elaborations, based on data from the ECB available at https://www.ecb.europa.eu/mopo/implement/omt/html/index.en.html#cspp

behalf of the ECB, the de facto power of the Bundesbank is relatively small. Nevertheless, Germany's influence on the ECB, as the largest Eurozone member in terms of population and GDP, is significant. At the very least, it would seem appropriate for the Bundesbank to actively review its asset purchase criteria to examine the extent to which climate-related financial risks are properly integrated in its collateral and asset-purchase programmes.[144] Central banks should be leading by example and their actions can have major market shaping impacts.

Central banks could also coordinate their policies more closely with industrial policy, for example by purchasing green bonds from development banks, green banks or similar public intermediaries such as the European Investment Bank. These intermediaries could then finance lending for green infrastructure investments or green loans for small and medium-sized companies. Green refinancing where central banks offer favourable interest rates for refinancing of green lending is another option, particularly in the Eurozone area.

From a regulatory perspective, there has been much focus on how to calculate the risks to the financial sector posed by climate change. However, there is huge uncertainty around such risks, meaning a precautionary approach – assuming a worst-case scenario – is preferable.[145] The capital adequacy risk weights on lending to unsustainable activities need to be made prohibitively high. Quantitative credit guidance policies, for example quotas for green versus brown lending, could also be used.[146]

When looking at bank lending to enterprises in Germany, Figure 8 shows there is a trend of the share of bank lending moving away from the productive sectors into the service sector and financial institutions. The increase in bank lending for the service sector could be argued as an expected process of deindustrialisation at the income level of a country such as Germany. However, the lending to other financial institutions is more problematic as this does not increase the productive capacity of the economy.[147] As a result of this trend, the share of lending going to the manufacturing sector in Germany represents less than 10 per cent.

---

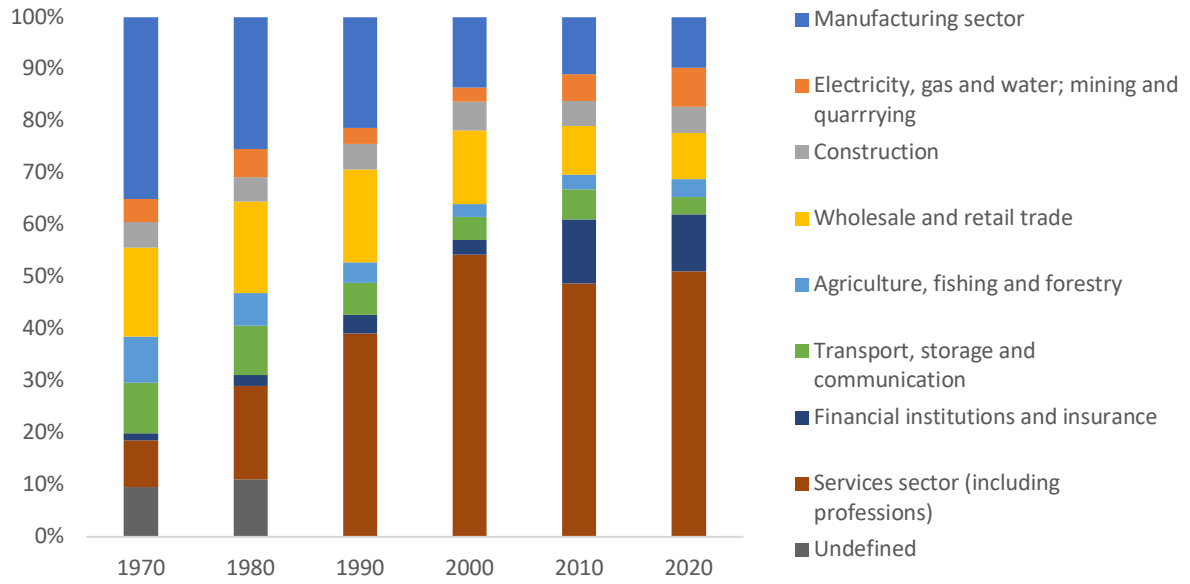
[144] Hugues Chenet, Josh Ryan-Collins, and Frank van Lerven, 'Climate-Related Financial Policy in a World of Radical Uncertainty', *UCL Institute for Innovation and Public Purpose*, UCL Institute for Innovation and Public Purpose (IIPP) Working Paper Series: IIPP WP 2019-13, 23 December 2019, https://www.ucl.ac.uk/bartlett/public-purpose/publications/2019/dec/climate-related-financial-policy-world-radical-uncertainty.

[145] Chenet, Ryan-Collins, and van Lerven.

[146] Dirk Bezemer et al., 'Credit Where It's Due', *UCL Institute for Innovation and Public Purpose (IIPP) Working Paper Series* IIPP WP 2018-11 (30 November 2018), https://www.ucl.ac.uk/bartlett/public-purpose/publications/2018/nov/credit-where-its-due.

[147] Mariana Mazzucato and Laurie Macfarlane, 'Patient Strategic Finance: Opportunities for State Investment Banks in the UK' (London: UCL Institute for Innovation and Public Purpose, 2017).

Figure 8: Share of bank lending in Germany by industry sector, 1970–2020.[148]



If we look at the German banking system in general then with the exception of KfW, "green finance has not yet become a systematic, structured, and integral part of the banking business models and strategies in Germany."[149] The majority of Germany's conventional banks have largely ignored environmentally friendly business opportunities. As Schäfer argued in 2017, "there are currently 113 investment funds that have a climate link in their investment strategies. They represent a volume of assets under management (AuM) of about 7.5 billion euros."[150] However, climate risk exposure assessments seem to be slowly gaining grounds in Germany. Albeit non-binding, Germany's Federal Financial Supervisory Authority (BaFin) has recently published good practice guidelines that German banks can refer to when addressing their sustainability risks.[151]

3.3. Green Public Procurement in Germany

We will look at green public procurement (GPP), sometimes also referred to as sustainable public procurement (SPP), as the proxy for how procurement practices in Germany are supporting tackling grand challenges and consequent missions. GPP is the process whereby public organisations buy goods, services and utilities not solely based on the best prices available but

[148] Authors' elaboration based on data from the Bundesbank, available at https://www.bundesbank.de/en/statistics/banks-and-other-financial-corporations/banks/banking-statistics-793848
[149] Henry Schäfer, 'Germany: The "Greenhorn" in the Green Finance Revolution', *Environment: Science and Policy for Sustainable Development* 60, no. 1 (2 January 2018): 18–27, https://doi.org/10.1080/00139157.2018.1397472.
[150] Schäfer.
[151] BaFin, 'Guidance Notice on Dealing with Sustainability', Bundesanstallt für Finanzdienstleistungsaufsicht, 2019, file:///Users/kenohaverkamp/Downloads/dl_mb_umgang_mit_nachhaltigkeitsrisiken_en.pdf.

also incorporating environmental aspects into their award criteria.[152] Public authorities in the EU spend around 2 trillion euros each year on these purchases, which amounts to 14 per cent of GDP. Given this enormous purchasing power, GPP holds large potential to decarbonise the economy. In contrast to emission trading schemes with prices too low currently to effect a low-carbon transition, GPP offers a significant and immediate way forward.[153] As a positive spill-over effect, GPP has the potential to initiate the development of lead-markets for climate-friendly technologies and provide incentives for green innovation.[154]

In the EU, all public procurement has to follow the regulatory framework which harmonises the rules across member states in order to level the playing field for businesses therein.[155] When it comes to environmental aspects of public procurement, the European Commission advocates for environmental considerations, but so far has fallen short of introducing clear environmental criteria for the public procurement of contracts.[156] Nonetheless, the regulatory framework allows for the inclusion of environmental aspects through two main channels. First, through considerations in the award procedure (either as award criteria or as technical requirements). Second, through the considerations of costs imputed to environmental externalities, as part of the concept of life-cycle cost.[157] In 2016, Germany changed its national laws to better enable public clients to include strategic goals, such as environmental requirements, in the award criteria of the bidding process.[158] This means German public authorities can actively practice GPP by including environmental requirements in their tenders.

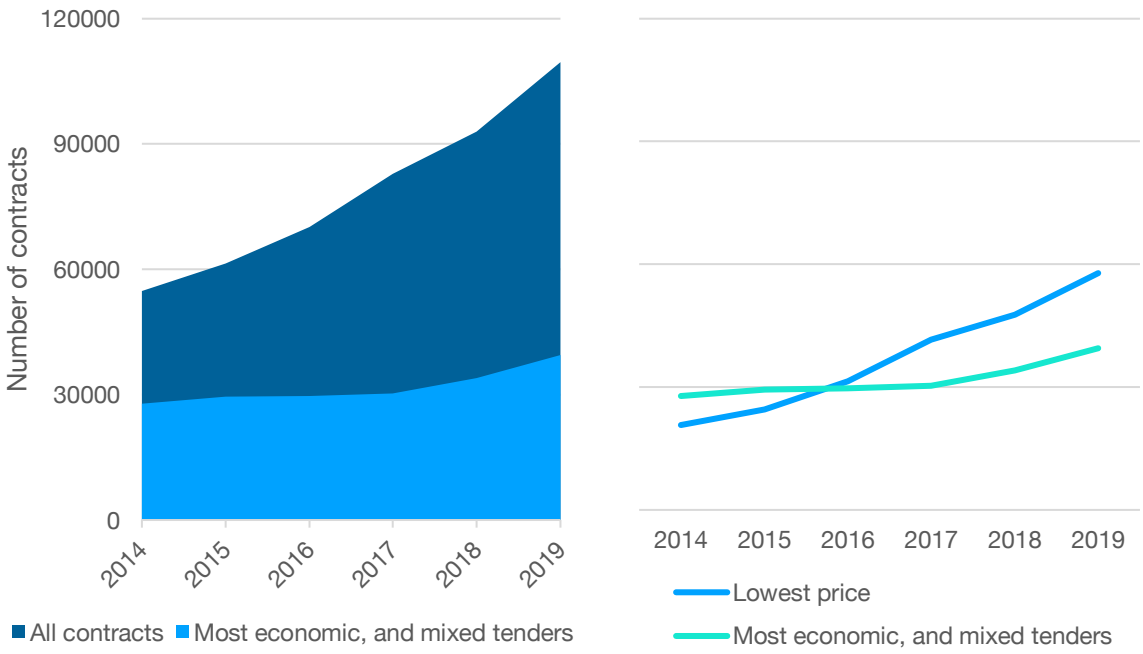
Incorporating environmental requirements in the award criteria becomes possible when the so-called "Most economically advantageous tender" (MEAT) approach is used. Contrary to the lowest-price criterion, the MEAT method allows selectors to take both total cost of ownership and environmental considerations into account in the competition. By using the MEAT criteria, public authorities can evaluate different environmental technologies and their respective costs, which provides greater flexibility and ultimately more decision-making power than specifying

---

[152] UNEP, *Global Review of Sustainable Public Procurement* (Nairobi: United Nations Environment Programme, 2017).
[153] Olga Chiappinelli and Vera Zipperer, 'Using Public Procurement as a Decarbonisation Policy: A Look at Germany', *DIW Economic Bulletin* 7, no. 49 (2017): 523–32, https://www.econstor.eu/handle/10419/172946.
[154] Cf. Lember, Kattel, and Kalvet, 'Quo Vadis Public Procurement of Innovation?'
[155] European Commission, 'Making Public Procurement Work in and for Europe', Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions (Strasbourg, 2017).
[156] European Commission, 'Public Procurement for a Better Environment', Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions (Strasbourg, 2008).
[157] Chiappinelli and Zipperer, 'Using Public Procurement as a Decarbonisation Policy'.
[158] Bundesregierung, 'Gesetz Zur Modernisierung Des Vergaberechts (VergRModG)', in *Bundesgesetzblatt Jahrgang 2016, Teil I, Nr. 8* (Bonn, 2016).

technical requirements within a lowest-price tender. Additionally, a combination of technical requirements and environmental award criteria is also possible. While technical requirements are difficult to track on an aggregated basis, the award criteria are usually specified in the European TED database on government procurement in the European Union, which holds information on all public tenders for each EU member state.[159]

Figure 9. Public procurement contracts in Germany, 2014-2019.[160]



As can be seen from
Figure 9, the share of public tenders in Germany that used either the MEAT or mixed award criteria remains relatively low. Furthermore, the relative share of these public tenders has become smaller in recent years as the share of other types of contracts, most specifically based on lowest-price criteria, has risen. It is important to clarify that lowest-price tenders can incorporate environmental aspects through specified technical requirements. The share of tenders that potentially do have GPP elements incorporated may therefore be underestimated. Nonetheless, the trend in
Figure 9 indicates that the potential for GPP through the award criteria in public tenders is not fully used in Germany. Using a similar approach, Chiappinelli and Zipper conducted a keywords search on the text-based information on award criteria present in the TED database.[161]

[159] European Union, 'Tenders Electronic Daily', OJ S Current Issue, 2020, https://ted.europa.eu/TED.
[160] Authors' elaborations based on data from EU-TED database (available online)
[161] 'Using Public Procurement as a Decarbonisation Policy'.

Their results show that in 2015, only 2.4 per cent of all public contracts awarded in 2015 in Germany included environmental criteria for public procurement.

Overall, these results show that utilising public procurement to initiate grand societal transformations in Germany has barely begun. While Germany has formulated ambitious decarbonization goals at the federal level, this does not seem to be matched at the state and local level where a number of challenges and barriers remain to GPP. These include an unwillingness to implement GPP on the presumption that it is usually more expensive and thus a burden on the budget.[162] Furthermore, local authorities may not see the need to consider GPP due to the lack of transparent consistency across all levels of government. This is particularly important in Germany, where 75 per cent of all public procurement (excluding social security funds) is done at the local level, which is one of the highest shares in OECD countries.[163]

4. DISCUSSION AND RECOMMENDATIONS

The European Innovation Scoreboard ranks Germany in 2019 as a strong innovator (but not a leader) in the EU.[164] The ranking has remained essentially the same since the Scoreboard's inception in 2011. This seems to echo academic and policy consensus about Germany: while its innovation performance remains strong, the country is also standing still. This paradox comes about because the strong performance relies on a public policy and financial eco-system that mainly focuses on the diffusion of knowledge and innovations rather than - with the exception of KfW and *Energiewende* - investing in transformational changes or addressing societal challenges.

The industrial policy of post-WWII Germany, dressed in ordo-liberal rhetoric, was built on strong regional clustering of knowledge and educational institutions around existing industrial bases.[165] Such a stealth policy and its public-private alliances have been complemented by federal mission-oriented initiatives and institutions, most notably KfW in energy transition. Further, recent strategic initiatives such as the *High-Tech Strategy 2025* and *Nationale Industriestrategie 2030*, introduced in 2018 and 2019 respectively, seek to go beyond market fixing and lay groundworks for a more activist state. We can trace changes to ordoliberal principles to the mostly successful *Energiewende* policies during the 2000s, continued in current plans

[162] Chiappinelli and Zipperer.
[163] OECD, 'Government at a Glance' (Paris: OECD, 2019).
[164] The interactive scorecard is available here: https://interactivetool.eu/EIS/index.html.
[165] Wolfgang Neumann and Henrik Uterwedde, *Industriepolitik: Ein deutsch-französischer Vergleich* (Springer-Verlag, 1986).

for the coal-exit. With the handling of COVID-19, Germany has taken another step; it is at the forefront of taking bold policy action reshaping the economy in the face of the pandemic.
Innovation and industrial policies serve ideally two overarching purposes. First, the generation and diffusion of new knowledge and routines. Second, to solve the main socio-economic challenges of society (co-shaping the directionality of growth). Germany's post-WWII economic policy model excelled in providing relatively stable dynamics of knowledge-generation and diffusion. Consequently, the international competitiveness of German firms increased. The economic policy model rested on the assumption that large segments of society will enjoy the fruits of that growth. Over the last decades, this compact has come apart; inequality is one of the significant challenges for Germany. The climate emergency and COVID-19 have, furthermore, questioned whether diffusion-oriented policies are enough to provide resilience to German society.

From our discussion above, we can draw the following conclusions:
First, Germany has a formidable array of science, technology and innovation (STI) policies and agencies that tend to focus on diffusion of knowledge and innovation, with the notable exception of KfW. This also means, however, that Germany has significant public and private resources focused on industrial upgrading. As Weiss has argued, however, these institutional strengths combined with incremental technological development by the large and dominant industrial actors, can act as fetters when the ecological and techno-economic paradigms are changing.[166] Accordingly, these STI institutions are at the moment not focused on solving specific challenges and are insufficient for building the dynamic capabilities needed to implement mission-oriented policies set out in the *High-Tech Strategy 2025*.
Second, the financial sector, including the Bundesbank activities in supporting the economy through the ECB, supports carbon lock-in rather than transformative goals as set out in the *High-Tech Strategy 2025* and coal-exit.
Third, the significant public funds being spent on procurement help only minimally with tackling such transformative challenges as climate emergency or inequality.
Fourth, Germany's relative weakness in digital transformation, coupled with sustainability blind spots in financial structures and procurement practices, show that German economic policies are not well aligned with the 'smart green' techno-economic paradigm, despite the successes of the *Energiewende.*

[166] Weiss, *The Myth of the Powerless State*.

Fifth, compared to public and private investments into R&D that amounted to 104 billion euros in 2018, Bundesbank activities through its QE and public procurement funds deploy more than 500 billion euros annually that could be – but is not - focused on societal transformation goals such as missions set out in *High-Tech Strategy 2025* and coal-exit.

German policy makers should use the unique window of opportunity in the COVID-19 aftermath and changed economic policy consensus for more directed investments by both public and private sectors. In order to achieve this, Germany requires a new economic policy model that is explicitly aiming to shape markets for more sustainable and equitable growth. A market shaping policy framework relies on complementarities and balance between diffusion-oriented policies and those focused on solving specific socio-economic challenges (missions). The innovation mandate must be worked into financial regulations, procurement and broader economic policy-making institutions, such as the central bank.

In the case of Germany, applying a market-shaping policy framework means building on the country's existing strengths in knowledge diffusion through both public and private actors, and strengthening emerging mission-oriented policies and institutions, as has partially happened in its responses to the COVID-19 pandemic.

The report shows that Germany has vast potential to direct its financial sector and public finance (in particular, public procurement) towards its missions set out in *High-Tech Strategy 2025.* We argue that in addition to better coordination of its existing industrial and innovation policies, these are the areas where Germany needs to build more robust dynamic capabilities in its public organisations. The financing and financial structure of an economy are not neutral; the type of finance received affects the types of investments made and the type of economic activity. In particular, there is an essential difference between types of finance that are conducive for investment in the real economy and speculative finance which prioritises low-risk, short-term capital gains through the trade of existing assets. As innovation is a collective, uncertain, and cumulative process, it requires long-term, committed, patient finance. This is often lacking in today's financial sector, and it is increasingly hard to find among corporates.

Fundamentally, Germany's innovation, industrial, financial, and procurement policies should complement each other and go beyond independent initiatives and discrete approaches. Markets will not find a green and inclusive direction for innovations on their own. There is not yet a ready-made route that will make multi-directional, experimental, green and inclusive innovation profitable. Only when there is a stable and consistent direction for investment will regulation and innovation converge along a green and inclusive trajectory. The transition must be underpinned by long-term, patient finance which is willing to take risks, and able to mobilise

and crowd in other investors. To avoid innovation continuing along a high-carbon path paved with increasing inequality, and to actively turn our backs on stagnant innovation landscapes; public policies must ensure that investments into low-carbon and inclusive innovation are rewarded. This can be done by using the full and coordinated array of government instruments to 'pick the willing': those organisations prepared to take on the difficult investment required for a green and inclusive transition. The government cannot micromanage this process, as that would stifle innovation, but it can set a clear direction, make the initial high-risk bold investments which draw private actors later on, and reward those who are willing to invest and innovate.

Germany has a unique window of opportunity to build on its strengths and initiate transition towards a new economic model that tackles sustainability and inequality directly. Specifically, the report recommends that building public-sector capabilities and institutions in the following areas are crucial for implementing a challenge-driven economic policy framework:

- Coordination capabilities between federal missions (including coal-exit strategy) and regional industrial and knowledge clusters that are today supported by mostly mission-neutral policies and instruments. The current missions framework set out in the *High-Tech Strategy 2025* focuses largely on interministerial coordination and the creation of new mission-oriented initiatives. However, it is important to co-opt existing industrial and knowledge clusters into mission planning, design and implementation as otherwise the missions may remain wishful thinking.
- Capabilities to set the direction for the financial sector to invest in missions, in particular towards the green transition of the economy. Today, central bank operations are by and large both technology- and mission-neutral. We suggest Germany should either recalibrate quantitative easing purchases to exclude carbon-intensive financial assets or run a parallel green quantitative easing programme to mitigate the effect.
- Local authorities' capabilities to utilise procurement and regulatory practices for achieving missions, in particular, to decarbonise the economy. While Germany has formulated ambitious decarbonisation goals at the national level, this does not seem to be matched at the state and local levels where several challenges and barriers to utilising procurement for missions remain.