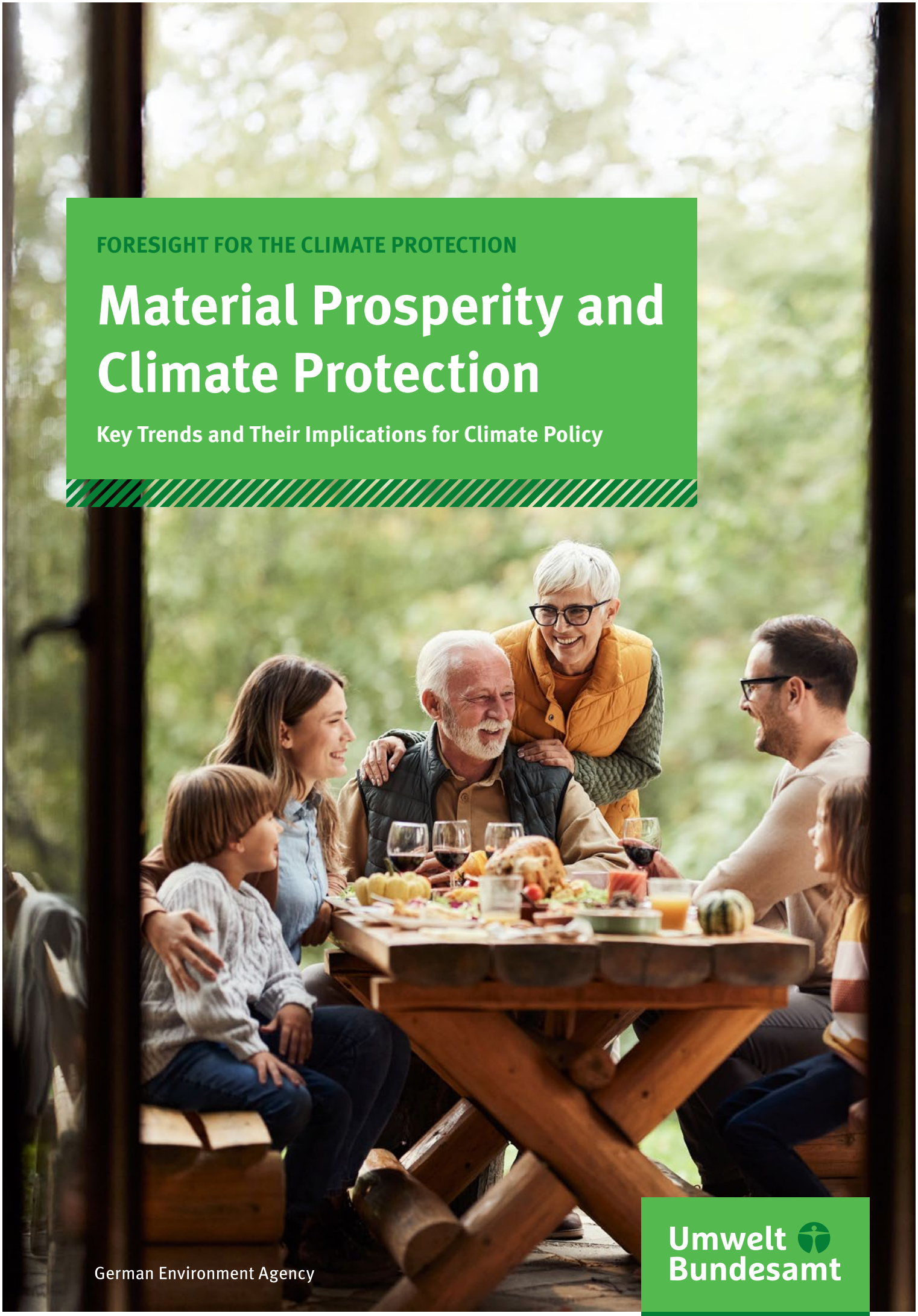
FORESIGHT FOR THE CLIMATE PROTECTION

Material Prosperity and Climate Protection

Key Trends and Their Implications for Climate Policy



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Foresight for the climate protection

MATERIAL PROSPERITY AND CLIMATE PROTECTION

Key Trends and Their Implications for Climate Policy

Klimascan project — results of an analysis of key trends and the opportunities and risks they present for climate policy

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Abbreviation	Explanation
BMWK	Federal Ministry for Economic Affairs and Climate Action, Berlin
GDP	Gross domestic product
CBAM	EU Carbon Border Adjustment Mechanism
EU	European Union
AI	Artificial intelligence
SME	Small and medium-sized enterprises
STEM	Science, technology, engineering and mathematics
GHG	Greenhouse gas
UBA	German Environment Agency, Dessau-Roßlau
USA	United States of America

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Abstract: Securing material prosperity — an emerging issue for climate protection

Macroeconomic stability is a key prerequisite for the success of the transformation to climate-neutral prosperity in Germany. This in-depth study therefore focuses on developments and trends in the economy and society that influence both material prosperity and the success of the transformation to climate neutrality. In the form of a strategic foresight, the study identifies political needs and options for action to ensure prosperity while advancing the transformation processes.

The brochure presents six major trends that influence both the political goal of maintaining prosperity and the success of climate protection policy. For each trend, the study describes key drivers and possible developments in the coming years, and highlights opportunities and risks for climate protection. In addition, possible futures for each trend are outlined in the form of scenarios to illustrate conceivable impacts up to 2040. The scenarios are not to be understood as forecasts, but rather as a way of summarizing the trends to stimulate reflection and discussion about the connection between securing material prosperity and transformation for climate protection and adaptation. The costs and challenges of climate change adaptation and mitigation are considered, as are the costs and impacts of residual climate change risks. The conclusion presents the resulting key action areas for linking the processes of securing and renewing prosperity with efforts to transform the economy and society on the path toward climate neutrality.

1. Material prosperity as an emerging issue for climate protection

Background

Macroeconomic stability is a key prerequisite for the success of the transformation to climate-neutral prosperity in Germany (BMWK 2023b). Economic stability and growth are currently enabling the necessary investments to be made in renewable energy, clean technologies and infrastructure. They are also strengthening innovation and competitiveness, stabilizing the labor market and establishing political and social acceptance, all of which are crucial to the implementation of climate strategies.

This in-depth study focuses on **developments and trends in the economy and society** that have a significant influence on the material basis of prosperity and macroeconomic stability, and that present opportunities or risks for climate protection and the success of the transformation. The six trends are:

1. Climate change as an increasing burden on the national budget
2. Growing pressure to invest in infrastructure
3. Increasing costs for citizens and business
4. Demographic change exacerbating tensions in the labor market and social system
5. Efficiency gains from AI as an opportunity for social and environmental transformation
6. Realignment of industrial policy in an increasingly uncertain world

The trends and their influence on material prosperity and the transformation were identified and analyzed in the Klimascan project.

The Klimascan project

The German federal government is aiming to achieve a 65 percent reduction in greenhouse gas emissions in Germany by 2030, an 80 percent reduction by 2040 and greenhouse gas neutrality by 2045. At the heart of this goal is the German Federal Climate Change Act (Klimaschutzgesetz, KSG), which sets binding national climate targets. To meet the requirements of the Act, the German federal government agreed on a comprehensive climate protection program in each of the years 2019 and 2023, containing measures for the energy sector, industry, buildings, transportation and agriculture. Further efforts are needed to accelerate the transformation in the area of climate protection across society as a whole.

The goal of the "Horizon scanning of developments relevant to climate protection" project (or "Klimascan" for short) is to identify signals indicating trends and developments that present new opportunities or challenges for climate protection or the transformation to climate neutrality, and to consolidate these trends into cross-departmental emerging issues that can be used to derive needs and options for action in climate protection policy. Part of the horizon scanning process was to search for early signals of social change. The signals were consolidated into trends, which were used to derive emerging issues for climate protection and climate protection policy. Finally, cross-departmental needs for action in climate protection policy were identified. In the individual project phases, employees from various federal ministries were involved in future and strategy workshops alongside experts.

The project was commissioned by the Federal Ministry for Economic Affairs and Climate Action (BMWK) in cooperation with the German Environment Agency (UBA), and was conducted by the Fraunhofer Institute for Systems and Innovation Research ISI in cooperation with the Öko-Institut and the New Climate Institute. The results will be published in the "Foresight for the climate protection" series by the German Environment Agency (UBA).

Structure of the brochure

Securing material prosperity in Germany in an era of polycrisis will be a major political and economic challenge in the coming decades. Which trends are bringing about a change in material prosperity while having a direct or indirect impact on climate protection? What are the resulting needs for action in terms of climate policy?

To answer these questions, this report first presents six trends that influence material prosperity while representing opportunities and risks for climate protection (section 2). The trends are also summarized in the form of mini-scenarios. Finally, the report presents the resulting overarching political needs for action in relation to ongoing climate protection policy and provides some initial ideas for shaping the discussion going forward (section 3).

2. What's new? Six trends relating to changes in material prosperity with an influence on climate protection

Maintaining prosperity and renewing it in a way that ensures climate neutrality in Germany will be key challenges in the coming decades. While the financial burden on private households is increasing due to price rises and growing pension entitlements, there is also an innovation and investment backlog in the area of infrastructure — plus a rise in government spending on security and defense, for instance. This illustrates in just a few examples that the pressure to take action in order to secure material prosperity is rising, but the financial resources available to the government are shrinking at the same time.

Against this background, this section describes six selected trends that will have a particular impact on the process of securing and renewing material prosperity in the coming years while potentially presenting opportunities or risks for the implementation of climate protection policy (fig. 1).

Figure 1: Trends with an influence on the material basis of prosperity and climate protection

Source: Fraunhofer ISI

In the sections that follow, each trend is supported with facts and figures. Some potential future development paths are presented and summarized in the form of a possible mini-scenario for the year 2040, and the associated potential opportunities and risks for climate protection are outlined.

2.1 Trend: Climate change as an increasing burden on the national budget

When analyzing the costs associated with climate change, it is important to distinguish between the costs of climate protection and climate adaptation measures on the one hand and the costs resulting from climate change on the other. The latter may include the direct costs of fighting wildfires, for example, or the resulting indirect costs due to the economic damage incurred. The consequential costs of climate change and the costs of mitigating climate change are an increasing burden on the national budget and could impair economic and political stability.

Current facts and figuresn

The level of investment required in climate protection and adaptation cannot be stated exactly; according to various studies, it could range from 400 to 860 billion euros by 2030. This sum covers measures for reducing greenhouse gas emissions, such as expanding renewable energy and improving energy efficiency, and adaptation measures designed to combat the unavoidable consequences of climate change (Fluchs et al. 2022; Heilmann et al. 2024).

If these investments are not made, then Germany will be threatened by high consequential costs of climate change. In 2000 and 2021, extreme events related to climate change caused at least 145 billion euros of damage in Germany, with over 40 billion euros of this figure attributable to the flooding in North Rhine-Westphalia and Rhineland-Palatinate alone (Flaute et al. 2022). The German federal government contributed 400 million euros to the approved emergency aid and provided up to 30 billion euros in reconstruction aid through a solidarity fund (Bundesregierung 2023). As another example, flooding in southwest Germany in early 2024 caused at least two billion euros' worth of damage (Krause 2024). It is unclear whether the national budget will be able to afford spending at this level in the future, particularly as demand will grow due to an increase in extreme weather events (Trenczek et al. 2022). The anticipated costs may reach 280 to 900 billion euros by 2050, depending on the intensity of the climate crisis (Flaute et al. 2022).

There are significant regional differences when it comes to the consequences and the consequential costs of climate change (Deutscher Wetterdienst 2023). Due to demographic aging and structural transformation, there are many regions — particularly those in rural areas — that have less money available for climate protection and adaptation measures. This is exacerbating existing disparities (Spellerberg and Kirch 2021). By contrast, urban centers and economically prosperous cities must come to terms with the consequences of climate change in the context of increasing immigration, overloaded infrastructure, sustainable urban planning and an urgent need to adapt (Schubert et al. 2023).

At least temporarily, the increasing level of spending on climate protection may lead to cuts in other areas, such as business development, security policy, industrial policy, agricultural policy or social policy. Germany is currently facing a financial black hole of 30 billion euros, with spending continuing to rise (Franke and Iser 2024). The dispute over the supplementary budget in 2023/2024 illustrated the challenge of guaranteeing climate protection measures without any additional sources of funding or any easing of the debt brake, which is governed under constitutional law (Bayona 2023; ZEIT Online 2024).

The necessary spending on climate protection and climate adaptation in Germany may be reduced by nearly 250 billion euros by 2050 through European cooperation (Mier 2024). Investment from the private sector and spill-over effects from investment in climate protection and transformation in other countries (such as the Inflation Reduction Act in the USA) will also impact the level of pressure on the German national budget in the future (Droste et al. 2023).

What's changing?

A higher level of investment in climate protection and adaptation is intended to reduce the long-term consequential costs of climate change. Climate protection measures are increasingly becoming a cost factor and a delay would drastically increase the consequential costs of climate change. In turn, the necessary increase in climate protection spending is competing for available public budgetary resources along with other spending requirements that are equally urgent. This competition for funding is impacting the acceptance of climate protection measures. At the same time, climate protection measures may offer the state new sources of revenue and new opportunities to make savings.

- Climate change as a cost factor is intensifying competition for funding

Measures for slowing down climate change and mitigating its consequences, as well as climate adaptation measures, are an increasing cost factor in Germany. They will increasingly tie up public resources and will vary in scale, depending on the region and the extent to which it is impacted. According to estimates, the cumulative consequential costs of climate change between 2022 and 2050 alone may reach 900 billion euros (Flaute et al. 2022). These costs are primarily attributable to crop failure in agriculture, damage to or destruction of buildings and infrastructure due to heavy rain and flooding, disruption to goods transportation and direct effects on health (ebd.). They do not take account of indirect impacts, including long-term health impairment in the population, permanent strain on ecosystems and loss of species diversity. The fact that costs are expected to continue rising will intensify the trend toward a competition for funding between climate protection spending and other state investments that are also on the increase; for example, in infrastructure (see section 2.2).

- The risk of a lack of support for climate protection among the population

As climate change continues, spending in Germany with the aim of protecting the public is likely to rise too, meaning the costs of adaptation will continue to increase. To absorb the impact of climate-related events, such as heat waves and flooding, different regions will need to take different climate adaptation measures, including flood defenses, special protection for public buildings like hospitals and care homes, preventive health care measures, and so on. In addition, financial support will be needed for households that are directly affected by the consequences of climate change — in the event of severe flooding, for example. As funding becomes tighter and measures become more urgent, there could be conflict over the distribution of resources, thereby directly impacting the population's support for climate protection measures. This will be especially true if people who find themselves in crisis situations triggered indirectly by climate change, such as unemployment or housing shortages, do not feel they have been given sufficient support and have the impression that not enough is being done about their own hardship. One consequence could be a rejection of climate protection or adaptation measures that do not directly improve personal hardships. The population's willingness to support climate adaptation measures is higher than it is in the case of climate protection measures, as the immediate benefit of adaptations is often more tangible and noticeable (Bechtel et al. 2022).

- New sources of revenue and austerity measures for the state

As the rise in spending on climate protection competes for funding with other growing forms of state spending and the state revenue falls, it may not be possible for the state to maintain funding for support payments at the same or necessary level in the long term. If the competition for funding in the context of a tight budget is to be eased, new sources of revenue for the state will need to be found. Carbon taxes and the expansion of emissions trading have already been implemented, and it is possible that additional taxes may be introduced or existing ones redesigned. In addition, the state may promote greater private investment in climate protection by offering incentives, thereby supporting government investment and reducing the pressure on the national budget. However, in view of the increase in government spending overall, these measures alone will not be enough. Additional cuts in other areas, such as social security benefits, will be unavoidable, and this may have major consequences for the economy and population — and for the scope to increase investments in climate protection and climate adaptation in the future.

What might climate protection as a cost factor look like in 2040?

By the year 2040, pressure on the national budget is significant because of the additional spending that has been driven by the impact of extreme weather events and preventive climate change adaptation. Social and structural policies provide some compensation and are leading to very different financial burdens in municipalities and regions. To fill investment gaps caused by limited state funding, there is a green growth imperative with different regional focus areas in economic and innovation policy. Subsidies are tied to climate-neutral innovations, fundamentally changing Germany as a center of commerce and industry. Spill-over effects from climate protection requirements in other countries have enabled small and medium-sized enterprises in Germany to maintain their position as leaders in certain areas despite the polycrisis; examples of this include AI-based, climate-neutral machinery and equipment. Carbon pricing to fund climate protection and adaptation and other government spending is largely accepted, provided the investment that this enables in key sectors and infrastructure brings tangible relief for people or improves their everyday lives. This is not the case everywhere, however, meaning regional differences in the impact caused by the consequences of climate change and the compromises made on social spending in the context of a competition for funding are affecting society's willingness to take collective responsibility for climate damage and transformation measures. Many municipalities have reached the limit of how much they can take in terms of their available space and funding, which means that public resentment can quickly become a political tool, particularly in the urban hinterland — calling the democratic system and social market economy into question. In certain regions that are particularly heavily impacted by climate change, approaches aimed at sufficiency in the context of climate adaptation are therefore implemented with government support, such as funding for local agricultural cooperatives. Since technological progress alone is not enough to make the transformation a success, climate protection and climate-neutral consumption are an overarching goal in education. A range of virtual applications is available to train climate-neutral behavior for specific target groups using real-time data.

What is the relevance for climate protection?
The burden on the national budget will continue to rise, meaning that new funding sources and mechanisms should be considered in order to stay on the path toward climate protection despite the polycrisis. In addition, measures to increase the effectiveness of climate protection at a regional and municipal level, for example, could be used to reduce funding gaps.

- Growth imperative and climate protection?

Growth is considered to be a guarantee of prosperity. In the face of climate change, the economic growth imperative should be tied to climate neutrality. Economic growth can ensure that the necessary funding is available for increasingly expensive climate protection, climate adaptation and damage recovery measures. It would also ease the competition for funding if more resources overall were available for climate-friendly technologies, infrastructure investment and social security benefits.

Economic growth also means that more could be invested in research and development, which would accelerate innovation and the implementation of climate-neutral solutions — provided that the funding goals are geared toward sustainability. This may include the development of renewable energy, energy-efficient buildings and low-emission forms of transport.

The current growth forecasts for Germany indicate that an era of continuous growth with externalized production costs and cheap fossil fuels is over (OECD 2020; Kurz 2023; SVT 2024). A period of economic decline is associated with beneficial effects on the environment, but also with additional socio-economic strain that makes the transformation process more difficult (ZDF 2023b). Rather than holding on to an economic paradigm that is outdated since it is no longer effective, what is therefore needed is an economic policy strategy that is less dependent on growth (Kurz 2023) and has a broader perspective of prosperity (Dirksen and Lima de Miranda 2023).

On the other hand, economic growth may also increase the environmental impact since a complete decoupling of growth and resources cannot be expected in practice (Parrique et al. 2019). However, it is possible to achieve a significantly more sustainable

approach to economic growth through targeted measures geared toward green growth. For this to happen, environmental costs will have to figure more prominently in economic decisions. In this way, increased (global) carbon pricing can help to ensure that growth does not run counter to climate goals.

The global dimensions of growth and the consequential costs of climate change must also be taken into consideration. As German industry is strongly focused on exports, and global value chains and raw material imports are interdependent, economic growth in Germany is closely tied to the economic performance of other countries and their willingness to export. Living standards in Germany are closely linked to those of other regions of the world through consumption and global value creation (Beckert 2024), and environmental pollution and the loss of biodiversity are not held back by national borders.

- Regional approaches for regional requirements

The regions of Germany have different natural resources, economic capacities and infrastructure requirements, all of which have an impact on their ability to implement climate protection measures, the urgency of these measures and the ability of the regions to adapt to climate change. While economically stronger regions are able to invest more in sustainable technology and infrastructure, economically underdeveloped regions face greater financial challenges. In addition, there are social conditions that need to be met to ensure the transformation is a success, such as participation in and acceptance of climate protection measures. At the same time, rural regions (which are often economically less developed) have more space available for expanding renewable energy infrastructure. These differences require tailored approaches that take account of the specific risks, requirements and possibilities in each region (Heyen et al. 2024).

The consequences of climate change increasingly mean that citizens are noticing visible and tangible changes in their local area. The extent to which people are impacted by and experience climate change affects how much climate protection and adaptation measures are accepted. Involving the local population can help in the development of tailored solutions that take account of the specific consequences of climate change (such as flooding risks) and the socio-economic conditions of the region. Participatory processes also promote understanding and acceptance of climate protection measures. For this reason, public participation in decision-making processes is particularly important to a successful municipal or regional transformation. Financial participation — in wind turbines, for instance — can also boost acceptance.

- Climate protection and adaptation costs are not consumer spending

If climate protection measures and other measures designed to make adaptations to expected changes in the climate are seen as long-term investments, their potential benefit becomes clearer, such as a reduction in the future damage caused by climate change, greater independence in the energy supply and other areas, the creation of jobs in green sectors and improvements in public health. This can help to convince political decision-makers and the public that this spending is worthwhile. Involving the public in the revenue generated from the investments — through wind farms, for example — will also increase acceptance and ensure a fairer distribution of the economic benefits. This will bring about more sustainable economic development that offers both environmental and economic advantages. As transparency in the communication of climate protection and adaptation measures is also important, presenting both the short-term and long-term benefits and drawbacks of climate protection spending and adaptation measures will promote understanding and a willingness to support such measures.

What are the starting points for climate protection policy?

Climate protection policy is increasingly finding itself in conflict with other interests. The shift toward an increased growth imperative that prevents competition for funding by boosting the budget is fraught with environmental and social risks. Compromises and cuts may be unavoidable and require compensation through social security benefits for vulnerable groups.

The goal of preventive climate protection policy and adaptation policy is to reduce or avoid the damage caused by climate change. This leads to the conclusion that preventive climate protection policy and adaptation policy help to maintain prosperity and that the national budget must be designed to ensure that

climate protection complements other political goals in the fields of industry, agriculture and social policy. Climate protection measures can then serve as connective solutions that link together the different action areas in the transformation. They can be seen as an investment in the future that is independent of growth and establishes synergies. Participation processes can increase transparency, and a clear presentation of measures as sensible investments in the future can highlight the long-term benefits.

2.2 Trend: Growing pressure to invest in infrastructure

Germany is facing major challenges when it comes to maintaining and modernizing its infrastructure. Investment in the renewal of outdated infrastructure and in the construction of new infrastructure is crucial to maintaining prosperity and achieving the socio-ecological transformation in Germany.

Climate change as an increasing burden on the national budget: opportunities and risks for climate protection

Opportunities

- Green growth through green innovation can be a catalyst for international competitive advantages for Germany as a center of commerce and industry.
- Investment in climate protection reinforces regional autonomy and technological sovereignty.
- Regional and local solutions in the field of renewable energy, for example, make the benefits tangible for companies and citizens, contributing to the acceptance of climate protection measures and investments.
- Climate protection can be boosted through measures to increase efficiency in consumption and through changes in behavior, such as using domestic appliances at staggered intervals to save energy (programming the washing machine to operate at night), riding a bike instead of driving a car in urban traffic or using public transport solutions instead of the car for commuting purposes.
- Greater evidence-based communication of the short-term and long-term effects of the climate crisis on the national budget can promote acceptance of the measures.
- Cooperation and coordinated implementation strategies with European and global partners will enable a more efficient and cost-effective implementation of the transformation.

Risks

- Competition for funding can result in compromises needing to be made in climate protection policy if other areas are deemed to be more urgent. This may lead to a loss of acceptance of climate protection measures, particularly if the cuts mean that less of the social burden is relieved.
- Abolishing subsidies that are harmful to the climate is necessary but is facing significant resistance from industry, households and political parties.
- If the investments are disconnected in time from the benefits of climate protection measures, this makes it difficult to communicate the need for the investments and reduces acceptance.
- Measures intended to increase sufficiency in consumption and changes in behavior are hard to communicate since most people do not wish to put constraints on their own lifestyle.
- The tight financial resources in municipalities reduce their ability to fund local climate protection and climate adaptation measures.
- In the green sectors of the future, a loss of competitiveness is a threat to Germany as a center of commerce and industry.

Current facts and figures

The urgency with which climate targets need to be met and political answers to other ongoing crises need to be provided is putting considerable pressure on public and private investment (Dullien et al. 2024). Areas such as transport, residential construction, energy and digital services are particularly affected. According to one study, 80% of German companies are hampered by deficiencies in infrastructure, compared with 60% in 2013 (Puls and Schmitz 2022). A survey has shown that more than two thirds of the industrial enterprises questioned have moved part of their value creation abroad, with just under 60% citing energy costs and a reliable energy supply as the primary reasons (Deloitte 2023). This underlines the urgent need for investment in infrastructure.

The investment backlog in Germany is exacerbated by high energy prices, inflation, privatization and unclear political messaging (Grömling 2023). Overall, inadequate investment in Germany over the years has led to a backlog of public projects in areas such as transport, education and social housing construction. The average gross public investment in Germany from 2010 to 2022 was 11.3% of GDP (Heine and Herr 2024). By contrast, investment over the same period was 13.83% in the EU and 17.06% in the USA. There are also considerable regional differences in Germany that are hindering its future viability (Hüther et al. 2019).

Germany's innovation ecosystem occupies tenth place in an international comparison (Frietsch et al. 2023). Germany is the global leader when it comes to the key technologies involved in production, and it holds leading positions in the circular economy and in energy technologies (ebd.). Its main shortcomings can be found in an institutional setting and in digital infrastructure. These deficiencies could lead to a decline in productivity and competitiveness (Wambach 2023). In addition, Germany and Europe are lacking national market leaders in many future sectors, such as cloud computing and microchip development (Heine and Herr 2024). Traditionally strong industries, such as the automotive industry, are losing ground to international competitors, particularly because of the switch to electric vehicles. There is a risk that Germany will be squeezed out by technological pioneers like the USA and emerging nations such as China and India.

What's changing?

The investment gap for infrastructure is continuing to grow, while the investment backlog is weakening the economy, reducing innovative strength and restricting financial possibilities in the area of climate protection.

- Lack of investment in dilapidated infrastructure

According to one study, a total of around 600 billion euros could rectify the significant investment backlog in German municipalities by the mid-2030s and achieve the progress that is urgently needed in multiple areas (Dullien et al. 2024). The study adds that around 200 billion euros of this should be invested in climate protection, with energy-efficient building renovations the single biggest item. Other investments relate to the expansion of electricity and hydrogen networks, heating grids and renewable energies, plus energy efficiency and innovation (ebd.). The study also allows 127 billion euros for transport routes and local public transport, including 60 billion euros to modernize the rail network, 28 billion euros to expand local public transport and 39 billion euros to maintain highways. In addition, 42 billion euros need to be made available for the education infrastructure and 37 billion euros for the construction of social housing to alleviate the housing shortage in cities (ebd.). A need for further investment in areas such as health, digital infrastructure and industrial conversions is also likely. Germany needs an investment offensive to resolve the ongoing investment backlog.

- Investment backlog putting innovative strength in jeopardy

A lack of investment in infrastructure will further weaken Germany's innovative strength and make it unattractive as a center of commerce and industry. This could make company relocations more common. According to a survey, around 45% of the companies questioned are worried that the country will become less attractive in the coming years; in mechanical engineering and the automotive industry, this figure is as high as 65% (Deloitte 2023). The main reasons for potential relocations are the lack of a reliable energy supply and high energy costs, lower wages abroad (ZDF 2023a), a shortage of skilled workers (Rusche 2023), better market access and growth, and less bureaucracy and regulation (Giersch and Kempf 2024). Overall, this is exacerbating the shortage of skilled

workers in Germany and making the country less attractive when competing for international skilled workers (Bertram 2024).

- Public purse under strain in the polycrisis

An enormous amount of investment is required to modernize outdated infrastructure — and this is coming at a time when considerable financial resources are needed to manage the polycrisis; in other words, the crises happening in parallel in the areas of defense and security, energy security, the climate crisis, demographic change and resource availability. The political answers and measures that are needed in parallel are putting considerable strain on the national budget, as well as on people and businesses. The situation is being worsened by dilapidated infrastructure and the need for reform. Investment in dilapidated infrastructure with a focus on climate protection would improve the future viability of this infrastructure.

How could the investment backlog be reduced by 2040?

By the year 2040, the investment backlog has gradually broken up. Germany has taken on the challenges of the polycrisis. With investments in the energy and transport transitions that promote innovation and are geared toward climate neutrality, and with a thorough dismantling of subsidies that are harmful to the climate, the economy and society overall have been made more resilient. Technological sovereignty through innovation has increased the security of infrastructure for communication, production, transport and logistics. It has not been possible to prevent long-term losses in productivity and competitiveness, but they have been reduced by focusing research and innovation investment on key technologies aimed at green growth. As a consequence, the structural transformation of the automotive sector has been accelerated at the cost of many jobs, and it has not been possible to increase social security benefits to the necessary extent. However, fewer companies have relocated from Germany than was previously feared, as the country is still attractive to international investors as a center of commerce and industry in 2040 since its infrastructure is more efficient than that of other industrialized nations. Despite this, there are regional differences when it comes to investment capacity, meaning government grant initiatives are needed in order to stabilize economically underdeveloped regions demographically and to ensure they are not locked out of the sustainable transformation. Challenges relating to the level of acceptance of climate-neutral innovations persist in these regions and can only be overcome to a limited extent through local profit-sharing initiatives in climate-neutral infrastructure and businesses. All of this means that, by the year 2040, Germany is still in the process of reinventing itself in terms of the diversity of its regions, its innovative climate protection policies and the reinforcement of its transformative resilience in the face of the polycrisis.

What is the relevance for climate protection?

This report focuses on securing material prosperity through investment in climate protection. However, in view of the trend toward an innovation backlog, it also looks at climate adaptation measures and other investments in the future (in infrastructure, for example), provided these are consistent with climate protection policy.

Investments in the transformation to climate neutrality are essential and must be made without delay to ensure Germany remains attractive as a center of commerce and industry and can follow a sustainable path to the future.

- Sustainable infrastructure as a factor in business location decisions

The pressure to invest must not lead to investments being made in technologies that are harmful to climate protection and may end up as stranded assets. Instead, resources should be targeted toward the development of modern, sustainable technologies that bring long-term economic benefits while also supporting climate targets and enabling Germany to uphold its role as a technology leader. In view of the path dependency of innovations, it is crucial that green technologies are developed and distributed more rapidly through timely funding, so that gray technologies can be replaced more quickly and further innovations can be accelerated through spill-over effects (Aghion et al. 2016). Above all, investment in renewable energy, digitalization, modern education infrastructure and sustainable transport systems are crucial to ensuring that the transformation to a climate-neutral economy

is accelerated and Germany can position itself as a leading center of innovation in the transformation.

- Sustainable infrastructure makes the state's capabilities tangible

Functioning, modern infrastructure would make everyday life considerably easier and contribute to an improved quality of life. The state's capabilities would be made tangible for its citizens. In addition, a more positive environmental footprint in combination with affordable climate protection in everyday life would relieve some of the burden that weighs on people's consciences, defusing some of the current resistance to climate protection policy.

What are the starting points for climate protection policy?

From a corporate perspective, investment in education, infrastructure and digitalization (Deloitte 2023), as well as reform in investment conditions (such as corporate taxes and excessive bureaucracy (Rusche 2023) in Germany are essential to the transformation and to maintaining Germany's position as a center of commerce and industry. This requires a budget that can withstand the pressure to invest, sets clear targets and does not rely on spending caps (InvestmentWeek 2024).

Growing pressure to invest in infrastructure: opportunities and risks for climate protection

Opportunities

- Efficiency gains achieved through modernization can reduce costs (such as heating costs) in the long term and alleviate the pressure to invest.
- A high level of pressure to invest in green technologies can promote the construction of climate-friendly infrastructure and prevent stranded assets.
- Clear political goals and framework conditions promote private investment.

Risks

- The pressure to invest and a shortage of budgetary resources make it more difficult to maintain consistent political goals while also holding back the transformation.
- The pressure to innovate and take action can lead to rash and incorrect decisions being made, or to paralysis in decision-making processes.
- Deregulation that promotes infrastructure investment can result in nature conservation requirements being dismantled in a blunt or undifferentiated way.
- Public initiatives and right-wing parties may block the expansion of renewable energy.

2.3 Trend: Increasing costs for citizens and business

The cost increases for citizens and the economy caused by inflation and the polycrisis impact prosperity by limiting purchasing power, investment and competitiveness, thereby putting social resilience at risk.

Current facts and figures

Inflation in Germany is an important factor in consumer behavior. The purchasing mood, measured by the consumer climate index, is at its most depressed since 2008 (GfK 2023). Consumers in Germany are more price-sensitive, primarily due to their fears about the future. According to estimates, up to 60% of German households need to spend their entire monthly income to cover the cost of living (Oxfam Deutschland 2023).

Rising costs also have an impact on poverty and inequality, which can be a risk to democracy. Although real-terms net household income has risen by an average of more than 30% since 1995, this rise is much lower in the bottom income deciles. At the same time, the low income rate has increased sharply since the 1990s, particularly up to the year 2015 (Grabka 2024). Since that point, it has stagnated or shows an inconsistent picture due to the different data sources. One possible trend resulting from the rise in income poverty can be seen in the increasing use of food banks. In 2022, food banks in Germany recorded a growth in demand of approximately 50% compared to the previous year (Oxfam Deutschland 2023). People on low incomes have been disproportionately affected by the COVID-19 pandemic and inflation (Priem et al. 2022), with these factors increasing the risk of poverty (MDR Aktuell 2022). This is particularly the case in the housing market, where over 10% of the population was deemed to be overburdened in 2021 (Statistisches Bundesamt 2022).

Rising costs, particularly for raw materials and energy, are increasingly paralyzing investment on the part of businesses, who are also struggling with growing interest rates (Deutschlandfunk 2024; Olk 2023). As well as this, companies are facing the additional cost of increasing carbon pricing (UBA 2023).

What's changing?

Price development and available incomes are having an effect on consumer behavior and social participation. Restrictions on consumption in relation to climate protection are affecting the acceptance of climate protection and climate adaptation measures.

- High prices are changing consumer behavior

High prices caused by inflation, rising energy prices and other economic factors are resulting in considerable changes in consumer behavior. People on low incomes in particular are increasingly cutting out any non-essential spending, such as vacations and luxury goods, concentrating instead on basic needs such as food, rent and energy, and are looking for cheaper alternatives (Umweltbundesamt 2020). These changes are having far-reaching consequences for various sectors. The market for luxury goods, restaurant dining and leisure activities is recording a drop in demand, as this spending is considered to be non-essential (Reiter 2024). Some 20% of Germans are tending to cut out non-essential spending (PWC 2023), including vacations (Emendörfer 2023). Higher-priced, sustainable products, such as organic food, are also seeing a drop in demand (Clement 2023). Large purchases or investments in more expensive goods are frequently being delayed or abandoned completely. Rising costs also affect investment decisions, such as energy-efficient renovations of private households or the purchase of electric cars.

- Income poverty and inequality negatively impact social acceptance of climate protection measures

Rising poverty and social inequality can reduce social acceptance of and support for climate protection measures (Umweltbundesamt 2020). If people feel that climate policy will exacerbate their already precarious financial position, this can generate resistance to the necessary reforms (Staude 2019).

In the future, low-income households in Germany will suffer much more severely from rising energy costs relative to their income than higher-income households, with the rise brought about by the increase in the carbon price (Bach et al. 2023). If the carbon price rises to 150 euros per tonne over the long term in the areas of heating and transportation, the poorest ten percent of households would need to spend around six percent more of their net income on heating and fuel (Fratzscher 2023). The

relationship between social justice and environmental sustainability is therefore increasingly being recognized as a critical factor in the success of climate protection initiatives (Stein 2021).

- Additional costs for business due to factors including increasing carbon pricing

Overall, most sectors appear to have a pessimistic view of the future, and anticipate a significant decline in investment due to the uncertainty surrounding raw material and energy prices (Grömling 2023). An overall decline in investment in Germany of 1% is predicted for 2025 (Volkery und Olk 2024).

Even if Germany emerges from its recession in the coming years and energy prices stabilize, the German and European economies will still need to shoulder the additional costs of new climate protection requirements, such as carbon pricing. The free allocation of emissions certificates is being gradually reduced and, with the EU Carbon Border Adjustment Mechanism (CBAM), the price of carbon will also send a clearer message to German industry. This will increase the pressure on German and European industry players to reduce their emissions so that they can avoid becoming less competitive. The result will be more pressure to accelerate the development of alternative production methods (Petersen and Wortmann 2023). At the same time, the growing requirements may also lead to a drop in the acceptance of climate protection among German businesses.

How might the burden of costs on citizens and businesses look in the year 2040?

By the year 2040, households and businesses are carrying a heavy burden of costs overall. Raw material prices are highly volatile, and Germany is massively dependent on raw material imports for a digital and sustainable economy, particularly for battery technologies and hydrogen technologies. A great deal of progress has been made in the switch to renewable energies and the strengthening of technological sovereignty, and there are various ways in which citizens and SMEs can participate in energy generation; for example, through wind energy cooperatives. However, Germany finds itself deep in recession. There are new business insolvencies declared every day, with many companies responding by relocating abroad. Price volatility is severe, causing uncertainty on the markets. Consumers are correspondingly price-sensitive, as this is where the biggest savings can be made. Fair-trade and organic products are widely available in the food sector, though standards are low. The majority of people's incomes is spent on living costs. In urban centers, the housing shortage of the 2020s is still unresolved, meaning that most residential buildings are still not climate-neutral and have not been renovated to achieve adequate energy efficiency. There are major income disparities in the population and most people have barely any way of saving money. District and community centers or living labs offer everyday support in relation to climate protection and climate adaptation, such as energy saving tips, repair workshops or ideas to help people achieve greater sufficiency in their lifestyle. However, there are also municipalities and districts in which there is a high level of dissatisfaction with politics, as radical parties dominate debates and political decision-making. It is not only here that municipalities must largely put their resources into social security benefits; climate protection is a low priority. However, there are also examples of the opposite trend: for example, in cities and in certain villages and smaller towns, in which cooperatives have been established based on the principles of the circular economy and sharing economy. The services on offer include climate-neutral forms of mobility, financial participation in local businesses, living and working in rural areas with co-working spaces and care work that is implemented on a collaborative basis.

What is the relevance for climate protection?

The success of climate protection policy depends on the extent to which people and businesses support the measures, whether they are perceived as socially just and the extent to which it will be necessary to go without certain things or lose prosperity.

- Support for climate protection depends on social justice and economic viability

The support and involvement of citizens and businesses is essential to climate protection in Germany.

If the level of acceptance dwindles because climate protection is not perceived as transparent, socially just or economically viable, this will make the transformation much more difficult. Compensation and offsetting are important to ensuring that politically influential groups are not given priority at the expense of vulnerable groups, particularly when it comes to the distribution of costs and benefits.

- Prices send a message that influences consumer behavior and investment

Prices and price volatility have a significant effect on consumer behavior and the investments made by citizens and businesses. When comparing renewable energy with fossil fuels, it is already clear that falling costs in areas such as solar energy are a more significant factor than price volatility. This is reflected in the increased expansion of renewable energy. However, high and fluctuating prices in other areas may continue to hamper sustainable consumption or investment. Climate protection measures must take account of this demand perspective if they are to be effective.

- Consider quality of life beyond the growth imperative

Post-growth approaches are playing an increasingly prominent role in climate-friendly lifestyles. If day-to-day habits (that is, behaviors and consumer decisions) are geared toward sufficiency, they can reduce emissions without resulting in a loss of wellbeing, provided that suitable incentives are in place (such as funding for balcony solar power systems), the right infrastructure exists (such as cycle paths and the availability of local public transport), and rules, standards and laws promote sufficiency as a social framework (Flipo et al. 2024). Political measures such as tax relief for low-emission households can also promote alternative ideals of prosperity and combine the traditional economic growth imperative with climate neutrality. The loss of purchasing power that exists today, and may continue to persist, could accelerate a shift away from materialistic values and help to establish a new definition of prosperity in parts of the population (Alexander-Haw and Schleich 2024). This cultural shift may bring about an increased acceptance of lifestyles and practices that consume fewer resources and generate lower costs.

- Awareness of examples of socially just climate protection activitiesn

Access to relevant information and education opportunities has been identified as highly relevant to the switch to climate-friendly lifestyles (Fuchs et al. 2024). People could be encouraged more to emulate successful examples of socially just and climate-neutral living if there is greater awareness of them (Wuppertal Institute 2022). There are many guides and tips already available — from insurers, associations and initiatives, for example — that are aimed at the relevant target groups. However, the provision of information is often inadequate when it comes to changing people's behavior. Information is more effective when it is combined with personal stories from people with whom the population can identify. In this context, gender roles have an impact on behavioral decisions; for example, with regard to energy consumption (Fuchs et al. 2024). Stories of successful changes in behavior can boost the motivation to tackle structural obstacles, such as a lack of time to try out new practices (ebd.).

What are the starting points for climate protection policy?

The role of the state is drawn from the need for redistribution, compensation and governance mechanisms. Climate protection measures can result in winners and losers, particularly when they are taken in conjunction with other crises happening in parallel. The state must ensure that the costs and benefits of these measures are distributed fairly so that widespread involvement in climate protection and the support of the public and business is guaranteed. This requires targeted political interventions to be made so that social inequalities are alleviated and acceptance of transformative measures is promoted.

Increasing costs for citizens and business: opportunities and risks for climate protection

Opportunities

- With a focus on green growth in economic policy, sustainable resources become cheaper and high-emission goods become more expensive, which can bring about an automatic controlling effect in relation to consumption.
- Rising prices can also mean higher state revenue, which can be used for climate protection/adaptation measures and/or climate premiums.
- Reducing the dependency on growth relieves the burden on citizens and may reduce wasted resources.
- Measures intended to relieve the burden on certain population groups (climate premiums, for example) can increase acceptance of climate protection.
- Greater attention can be drawn to positive examples of socially just implementation of climate protection through public involvement and citizens' initiatives. Further initiatives could be promoted by providing guides on how to initiate and implement them, and how to obtain startup funding.

Risks

- It will not be possible to maintain support for climate protection policies if businesses and citizens increasingly suffer from the consequences of price rises and price volatility.
- The transformation could be slowed down if protest movements become radicalized, as in the case of the farmers' protests.
- A loss of prosperity brought about by climate policies may be used as a political football in an effort to secure a political majority.

2.4 Trend: Demographic change exacerbating tensions in the labor market and social system

Demographic change, particularly in relation to the working population and the age structure of the population, is an important factor that influences the success of socially just and compatible climate protection policies.

Current facts and figures

Life expectancy in Germany has risen almost continuously over the last century. Since the 1970s, average life expectancy at birth has risen by around 2.5 years per decade (Wilke 2016). At the same time, the number of births per year in Germany has not been enough to offset the mortality rate since 1975 (Statistisches Bundesamt 2024). Despite increasing migration, demographic change is resulting not only in an aging population, but also in a potential shrinking of society. This has far-reaching economic and social implications.

The population figures and age structure determine the potential labor force available in an economy, and thus its growth potential. Germany's social security system is based on the pay-as-you-go model, and requires a sufficient number of contributors to fund pension insurance benefits, health insurance benefits and unemployment insurance benefits (Wilke 2016). A decline in the birth rate and an increasing life expectancy present challenges in this area, and migration to Germany may counteract the decline in the population.

Demographic change is contributing to a shortage of skilled workers in Germany. In 2023, there were around 570,000 job vacancies for which no suitably qualified unemployed person was available (Deutschlandfunk 2024). Trade professions and the STEM field have been particularly affected, along with production, manufacturing, construction, building services engineering and teaching (BMWK 2024). Today, migration is already necessary for filling job vacancies (WirtschaftsWoche 2023).

What's changing?

- Demographic change is putting increasing pressure on the labor market

By the year 2060, the labor force will have declined by 11.7 percent, from 45.7 million to 40.4 million (IAB 2023). According to estimates from the German Economic Institute (IW), there could be a shortage of 128,000 skilled workers by 2027 in digitalization professions alone (Burstedde and Tiedemann 2024). At the same time, digitalization is considered to be one solution to the shortage of skilled workers in certain sectors. The decline in the labor force has an impact on productivity, innovation and growth potential. Germany will be more reliant on immigration to reduce the shortage of skilled workers. However, while the influx from abroad will reduce the aging process and population shrinkage in Germany, it will not stop these in their tracks (Statistisches Bundesamt 2024).

- Demographic change can exacerbate generational conflict

The financial sustainability of the German pension system is fundamentally influenced by demographic factors. The question of how possible it will be to fund pensions in the future is linked to the rise in life expectancy and the associated longer payment period for pensions. There is a threat of generational conflict relating to the distribution of prosperity if older generations take up an ever greater proportion of total economic revenue (bpb 2022). An increasing trend toward poverty in old age is also possible (Niemeier 2020).

What might the effects of demographic development in Germany be in the year 2040?

By the year 2040, the decline in the labor force is very advanced, significantly hampering productivity and growth potential. Replacing skilled workers with technology such as AI and robots (in knowledge-based services, health care and production, for example), together with migration to Germany, has only offset demographic change to a limited extent. The requirements brought about by climate change are also increasing, along with the need to make adaptations, particularly in health care and in the workplace in general. Additionally, climate change is the key factor influencing the continuing rise in migration worldwide, including within Europe. Germany is still reliant on immigration to maintain productivity and security of supply, but this is being made more difficult by geopolitical conflicts and the geoeconomic isolation of resource-rich countries, as well as xenophobic tendencies in parts of the population, exacerbated by massive cutbacks in social security benefits. In order to prevent a collapse in the social security and pension system and an associated rise in protest movements that would put democracy at risk, measures to make Germany more attractive to skilled workers from abroad, such as welcome bonuses and job guarantees, are a top priority.

What is the relevance for climate protection?

Maintaining prosperity in the long term is linked to the development of the population and intergenerational equity.

- Transformation only works with a healthy labor market

The transformation in Germany can only succeed if the labor market can offer the right resources at an adequate level. A shortage of skilled workers can paralyze climate protection — for example, in efforts to expand renewable energy in general and solar energy in particular (Bertelsmann Stiftung 2023) — and in trade professions, construction and renovation. What matters is not just the number of skilled workers, but also their qualifications. Climate protection must be considered in relation to education and the changing labor market, and in the context of changes brought about by AI.

- Migration is an opportunity

Migration offers an important opportunity to solve the shortage of skilled workers. Immigration from abroad could ensure that the need for skilled workers is met in the transition to a low-carbon economy (Gençsü et al. 2020). However, targeted measures are needed to ensure successful integration into the labor market. This includes removing barriers to information and administrative hurdles, making visa processes easier and implementing comprehensive social and economic integration strategies (Gençsü and Scheiger 2021). Innovative training partnerships between countries — or between companies from different countries — could also contribute to the solution.

What are the starting points for climate protection policy?

German labor market policy and education policy offer important levers for ensuring that the labor market is better prepared for the necessary transformation, meaning climate protection policy is supported. Greater collaboration with the private sector may help to identify labor market requirements at an early stage and to develop targeted solutions. This would not only bolster the labor force, but also improve the integration of immigrants.

Demographic change: opportunities and risks for climate protection

Opportunities

- Demographic change and a decline in the working population can offset the negative growth triggered by structural change in certain sectors, thereby mitigating the consequences of the transformation. However, the decreasing number of trainees and skilled workers must also be focused on sectors and jobs with future viability.
- Migration to Germany will counteract the shortage of skilled workers and help to plug the funding gaps in the pension system.
- Systemic changes, such as demand for and requirements relating to residential spaces and
- housing structures caused by demographic shifts, offer opportunities for climate-neutral residential construction and renovation, as well as urban development and settlement development.

Risks

- An increasingly aging society will cause financial resources that are needed for the transformation to be tied up in social security and pension systems.
- The transformation will be slowed down by the ongoing shortage of skilled workers in the production and installation of climate technologies, such as renewable energy.
- Migration is necessary to prosperity, but this will be made more difficult by right-wing populist parties turning migration into a political tool, or by the inadequate implementation of initiatives such as a welcoming culture, integration opportunities and the removal of red tape.

2.5 Trend: Efficiency gains from AI as an opportunity for social and environmental transformation

The introduction of AI will bring about significant changes in the labor market, since it has the potential to make all business processes more efficient, leading to an increase in productivity. This is true of both the automation of repetitive tasks and the optimization of complex processes through machine learning and data analytics. The shift in value creation triggered by this will have a significant impact on the commitment to prosperity in Germany.

Current facts and figures

AI is undergoing rapid development. In 2019, only around 6% of German companies were using AI in areas such as production, services or internal processes (BMWK 2020). Since the introduction of generative AI for text processing and communication, it is now in widespread use (Schlude et al. 2023).

The role of AI in improving efficiency, and in the associated changes in the labor market in Germany, is multi-layered. On the one hand, automation is causing a decline in jobs in areas such as production (Müller 2020) and office work (Eloundou et al. 2023). On the other, AI is creating new fields of activity, though these require new and specific skills. For example, even the limited use of AI in Germany between 2016 and 2018 created an estimated 48 thousand new jobs (Klingbeil-Döring 2023). This underlines the need for retraining, education and further training in activities involving AI in all sectors.

Due to the high development costs of AI, the market is dominated and controlled by only a handful of companies (Bank and Duffy 2023). As such, the value creation and capital flows are concentrated in a few companies, most of which are based in the USA (Spinnler 2024). Their often aggressive behavior, acquisition of startups and exertion of pricing power put German companies and policymakers under pressure, particularly as the importance of AI in critical infrastructure is continuing to grow (Buchholz 2024).

What's changing?

- New business models and efficiency gains

AI helps companies to conserve resources and is increasingly being used in product development (BMUV 2021). AI and the associated opportunities relating to process automation, personalization of products and services, and market analytics are creating new business models, including personalized health services, entertainment services such as chats with avatars and real-time financial services (Abdelkafi et al. o.J.). One study has shown that 91% of AI decision-makers in companies believe generative AI results in efficiency gains, but only 27% of them anticipate significant increases in productivity (Industrie.de 2024). The efficiency gains achieved through AI may also have an effect on consumers; for example, in the AI-based automation of domestic appliances or vehicles, ensuring more energy-efficient usage times or driving behavior.

- Structural change and job losses

The further integration of AI into corporate processes will change the labor market. More than 60% of Germans worry that the use of AI puts their jobs at risk (Digital.Now 2023). The developments in and use of AI are also creating new fields of activity that require skilled workers to be found — for example, in the field of coding and software development for machine learning or in the analysis of large volumes of data. In the long term, AI could also bring about a post-work society, characterized by the declining importance of work activities in society and an increase in post-materialist attitudes (Burmeister et al. 2019).

- Direct and indirect resource consumption of AIKI

AI and the associated infrastructure are enormously resource-intensive. Data centers are already responsible for 2.5 to 3.7% of global greenhouse gas emissions (Kilgore 2024), and energy consumption in European data centers is set to rise by almost 30% by 2030 (Cho 2023). The International Energy Agency estimates that AI could cause electricity consumption to double by 2026 (IEA 2024).

What might the efficiency gains of AI look like in 2040?

By the year 2040, AI is highly likely to be a key factor in the economy and in growth. This is associated with a dependence on technology and on AI providers, who are still largely based abroad. Efforts to promote a national AI and data infrastructure to protect technological sovereignty are focused on the areas of energy supply and national security and defense. Due to the data and infrastructure monopolies, parts of the value chain are being relocated abroad. Various forms of AI taxation and automation in the economy are in the pilot phase and are still undergoing evaluation. In industry, efficiency has increased considerably through AI, meaning that climate protection requirements can be met, AI-based innovations largely meet the sustainability criteria and, above all, energy consumption is reduced. Since AI is perceived as a driver of unemployment, there is growing social resistance to the use of AI. However, the role of AI in everyday applications, such as news apps, navigation, advertising and social media, is lacking in transparency, meaning most people are not actually aware of the impact of AI on their lives. There is a public debate around whether Germany is already a post-work society, and what social values are emerging from this.

What is the relevance for climate protection?

AI is a key technology for climate protection and the transformation of society as a whole. However, the use of AI also poses risks to climate protection, particularly because of the resource consumption involved in manufacturing the necessary hardware and operating data centers, and the energy consumed during use. The efficiency gains may intensify usage, resulting in rebound effects.

- AI as a key technology for climate protection

AI offers considerable potential for climate protection by contributing to the optimization of energy efficiency, resource management and efficiency reduction, as well as better governance of climate protection (Erdmann et al. 2024). By scaling currently proven applications and technology, AI has the potential to achieve a 5 to 10% reduction in global greenhouse gas emissions by 2030 while also bolstering climate adaptation and social resilience (BCG 2023). Some 87% of managers believe AI has the capacity to address climate problems (ebd.). The positive impact of AI will be further enhanced if it leads to technological breakthroughs that benefit climate protection — in weather forecasts and climate analysis, for example (Deutscher Wetterdienst 2024).

- AI as a driver of unsustainable economics

The primary purpose of AI applications is not sustainability; rather, they are intended to be used as a way of increasing efficiency and cost-effectiveness — in unsustainable business models too. Moreover, digital business models based on AI are often drivers of increased resource consumption through information technology, data storage and data transfer. Products and services that claim to simplify processes and activities may also increase consumption and usage intensity or the use of devices. These rebound effects of new AI solutions may lead to higher energy consumption overall if the cost savings achieved through efficiency gains result in increased demand or if new, resource-intensive products and services are developed using AI. One example is predictive maintenance for production machinery, which is intended to achieve greater resource efficiency, reduce emissions and extend a machine's service life (Produktion.de 2024).

- High resource consumption of AI

The resource intensity of AI will continue to increase as it becomes more widespread. If AI is to become a key technology for climate protection, the energy requirements must be met in a sustainable way. Green AI initiatives already exist, including the Green-AI Hub. These take resource conservation and energy efficiency into consideration through measures such as locating data centers near wind farms.

- AI has a social impact

Due to the potentially great but still unclear structural impact of AI on value creation and the labor market, as well as its penetration into everyday life, the social consequences need to be taken into consideration at an early stage. As explained in Trend 3, social and economic disadvantages may lead to social tension, putting support for climate protection at risk. It is uncertain how AI will influence the distribution of prosperity.

What are the starting points for climate protection policy?

AI can help to drive the climate protection transformation in Germany if its strengths can be harnessed for the purpose of climate protection. For this to happen, companies in Germany must have access to more secure and transparent AI and to the associated new markets. The necessary regulations and legislation are under development with a view to regulating new forms of value creation and ensuring sustainability aspects are considered.

Efficiency gains through AI: opportunities and risks for climate protection

Opportunities

- General conditions for the secure and transparent use of AI can be shaped jointly by policymakers, business and society in a way that maintains national security, technological sovereignty, innovative strength and energy efficiency, thus securing prosperity.
- The resource savings and efficiency gains achieved through AI create financial possibilities that can be harnessed for climate protection.
- Climate protection demands complex, systemic approaches that often overwhelm existing governance structures. AI can be used to improve control over the governance of complex system transformations, in particular by processing large volumes of data and completing predictive evaluations of mechanisms of action in complex systems.
- The use of AI may speed up the transformation in ways such as accelerating the expansion of renewable energy and removing or simplifying bureaucracy and planning processes.

Risks

- The use of AI from providers based abroad involves an outward flow of data and value creation, which may weaken technological sovereignty, growth and innovative strength.
- The benefits of AI in climate protection are unclear, since the business models on which AI is based are often unsustainable.
- The efficiency gains achieved through AI may lead to increased demand, thereby increasing energy consumption in companies and among consumers.
- AI requires enormous resource consumption, which may offset any efficiency gains.
- Unequal distribution of prosperity and a loss of prosperity — for example, in the event of mass unemployment caused by the use of AI — may have a negative impact on the population's willingness to engage in the transformation.

2.6 Trend: Realignment of industrial policy in an increasingly uncertain world

Uncertain geopolitical and geoeconomic developments demand a realignment of industrial policy; in turn, this entails structural changes in the process of value creation in Germany. This has a direct impact on prosperity, transformations and climate protection.

Current facts and figures

The current geopolitical landscape is essentially characterized by conflicts and rivalries, such as the Russian war of aggression, the Middle East conflict, the systemic rivalry between the USA and China, and the rise of political populism (Grömling 2024). These developments are having significant impacts on the security of supply in various areas, including energy (BMWK 2023a), medications (Focus 2023) and technology such as computers and semiconductors (Matthes 2024). These uncertainties are leading to a re-evaluation of globalization and the German economic model, which is heavily reliant on global trade.

As a country lacking in raw materials, Germany relies on imports and is one of the world's biggest importing nations. In addition, around a quarter of German jobs are dependent on foreign trade, whether directly or indirectly (ebd.). The experience of interrupted supply chains during the COVID-19 pandemic highlighted the dependencies and vulnerabilities of the German economy, particularly with regard to imports of essential goods such as antibiotics.

Dependence on politically unreliable partners represents a high risk to stable and reliable supplier and trade structures. Germany sends most of its exports to full democracies (33%) or flawed democracies (50%), with only 12% going to authoritarian regimes, including China (Berlemann et al. 2023). On the import side, the most important partners are China, the Netherlands, the USA, Poland and Italy. Geopolitical shifts and new challenges are forcing Germany to re-evaluate its economic strategies and investigate the potential ways it can strengthen national resilience. The European single market and the bolstering of existing trade partnerships play a key role in this regard.

What's changing?

Industrial policy in Germany is increasingly geared toward reinforcing strategic autonomy and improving production conditions for energy-intensive industries and other industries that are relevant to climate protection (Hüther et al. 2023). This includes making state interventions to support competitiveness in spite of decarbonization and to secure domestic value creation by promoting green technology and innovation. As shown by the rising level of criticism, including from business, it remains difficult to strike a balance between providing the necessary government support and avoiding overstretching the role of the state.

- Greater focus on bringing supply chains back home

Geopolitical and geoeconomic conflicts are putting a greater focus on reshoring and friendshoring; that is, returning production processes to Germany or other friendly countries (Gajera 2023) with the aim of reducing dependence on potentially insecure supply chains. This is particularly true of critical areas like energy, raw materials and technical components, such as computer chips and batteries.

However, if parts of value chains are brought back home, this may also present considerable challenges to competitiveness and access to the global market (Fuest et al. 2022), and may mean structural upheaval for Germany as a center of industry and exports (DLF 2024). Unwinding global value chains would result in considerable economic costs for Germany. In the long term, measures such as reshoring and nearshoring could result in Germany's real-terms GDP declining by up to 9.9 / 4.2% (Dorn et al. 2022). The effects are also heavily dependent on economic development in other major economies, such as China, the USA, India and Russia.

- Investment backlog exacerbating business location factors

The trend toward an innovation backlog (section 2.2) is making Germany less attractive as a location for businesses based in the country and for foreign investors. Additional factors, such as bureaucracy, a sluggish digitalization process and a high tax burden, are seeing Germany slip further down the table in international comparisons of business locations (IMD Business School 2024). Industry must face geoeconomic challenges from this position of weakness.

What might industrial policy look like in 2040?

By the year 2040, German industry is characterized by its strong dependence on global trading partners and raw material imports. It has become more and more difficult to maintain partnerships in areas such as hydrogen and gas supplies. China has asserted its economic dominance over large parts of the Global South and is influencing markets and trade. The necessary infrastructure investments have been held back for much too long in favor of pension and social security benefits. The easing of the debt brake at the end of the 2020s means it has been possible to provide billions in support for the expansion of national security and reform of the health care system in the short term. However, this has not generated any growth effects. There has also been a prolonged "AI winter" due to several years of major cuts in public research funding and private investment, meaning the efficiency effects and boosts to innovation from AI have been missed. The Paris Agreement has fallen well short of its targets, and the green economy has failed to gather momentum. A decline in productivity, along with rising unemployment and inflation, have resulted in a loss of prosperity, bringing right-wing populist parties to power in most European countries. Their nationalist, isolationist policies have led to the breakup of the EU. The leadership in innovation for economies adapted to climate change now comes from countries in West Africa and South America. As part of an alliance with China, they are primarily investing in Northern and Eastern European regions. Climate neutrality is not the top priority, exacerbating the extreme consequences of climate change, such as drought and flooding. By the year 2040, there are several areas of Europe, including some in Germany, that have not only become impossible to farm, but have become uninhabitable due to climate change.

What is the relevance for climate protection?

In a global economy, climate protection must be implemented in close collaboration with partners worldwide, as this cannot be done on an isolated, national basis. Due to the need to secure technological sovereignty and competitiveness, it is also advisable to protect key technologies and processes in order to reduce dependencies.

- Climate protection made in Germany?

Reshoring and friendshoring reduce dependence on global supply chains, which are often associated with a high level of transport emissions. Transport routes can be shortened by locating production closer to the domestic market, meaning CO_2 emissions can be reduced. This practice also enables stricter controls for environmentally friendly production methods and standards; for example, in the area of electromobility for the transformation of key industries in Germany and Europe. At the same time, Germany remains heavily dependent on raw material imports that are critical to climate-related technological development and infrastructure (such as lithium and rare-earth minerals). This risk could be mitigated by boosting innovation in the circular economy. In addition, some of the rebuilding of infrastructure in war-torn regions could be supported with German climate protection technology.

- Fewer opportunities to influence global climate protection

If parts of supply chains are brought back home, and this is combined with a move away from multilateral and global approaches, Germany's influence on climate protection efforts in other countries may be reduced. If Germany increasingly concentrates its production and procurement domestically or in friendly countries, this will weaken its economic link with countries that have unfavorable or poor environmental standards. A retreat from these global trading partnerships may give these countries less incentive to adopt environmentally friendly practices. This may weaken global climate protection efforts and hold back progress overall. In the face of increasing geopolitical and geoeconomic conflicts worldwide, climate protection may become less of a priority as a foreign policy goal.

- The additional costs of structural transformation

It is a time-consuming and costly process to bring production stages back home and to prioritize domestic technological solutions in order to bolster technological sovereignty. It may lead to structural

deficiencies, a loss of efficiency, higher prices and, as a consequence, job cuts. Higher production costs and the associated price rises could increase the cost of living, causing dissatisfaction among the population. If these economic burdens are viewed as a direct consequence of climate protection measures, this could reduce the level of acceptance of environmental policy initiatives.

What are the starting points for climate protection policy?

Industrial policy is increasingly turning into climate protection policy, as shown by the example of the Inflation Reduction Act in the USA (Steitz and Sigl-Glöckner 2023). Germany and Europe must further integrate climate protection — as well as geoeconomic and geopolitical aspects — into their own industrial policy to maintain a position of future viability in the face of potential deglobalization. Their goals must be to maintain competitiveness in a "partnership of the many" and to promote a more sustainable and resilient economy in view of future crises.

Realignment of industrial policy to secure prosperity: opportunities and risks for climate protection

Opportunities

- Protecting new, decarbonized value chains may promote the modernization of the German economy, create jobs and make Germany an industrial pioneer once again.
- Promoting decarbonized production processes in the context of friendshoring may form the basis for the potential economic and political partnerships of the future — for instance, as part of a climate club.
- A climate club that goes beyond bilateral agreements and supports larger groups will make the partners more resilient to the unsustainable efforts of individual nations to gain economic power.
- Nearshoring may reduce transport emissions.

Risks

- Time and financial resources will be needed to bring parts of value chains back home and to pursue a policy of technological sovereignty, meaning the additional burden on the state will continue to rise for the time being.
- If supply chains are brought back home, and this is combined with a move away from multilateral and global approaches, Germany's opportunities to influence climate protection efforts in other countries or in global initiatives may be reduced.
- A geopolitical shift will bar Germany from accessing raw materials and resources that are essential to the success of the transformation.

3. Conclusion

The six trends described in this report will fundamentally shape the role of material prosperity and our understanding of it in the context of climate protection over the coming years. Maintaining material prosperity and implementing a socio-ecological transformation of our economy will largely form the basis for comprehensive climate protection. At the same time, a shift toward a new understanding of prosperity and economic systems can be observed.

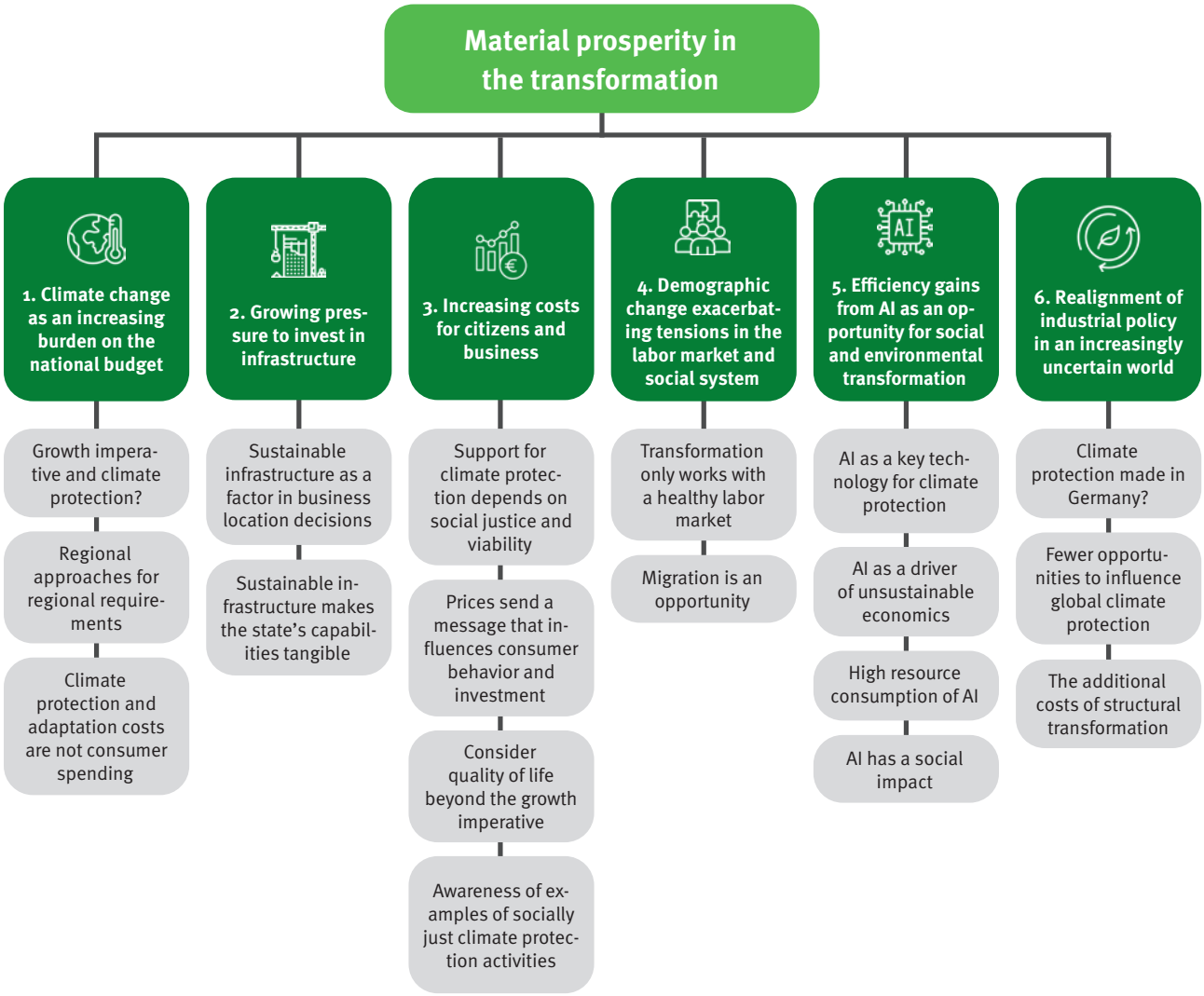
The level of support for drastic changes that can be anticipated will be influenced by key social questions and transparency. This also includes effects on social cohesion resulting from different population groups experiencing different levels of impact at different degrees of vulnerability: older and younger citizens, city dwellers and people in rural regions, and so on.

Fears over job losses and a loss of prosperity caused by rising prices and a higher cost of living reduce acceptance of climate protection measures and support for climate protection overall, as they may place an additional burden on households.

Ultimately, the goals must be to maintain competitiveness in an international "partnership of the many" and to promote a more sustainable and resilient economy in view of future crises.

Figure 2 summarizes the findings concerning the relevance of trends to climate protection policy.

Figure 2: Trends relevant to material prosperity and their relation to climate protection



Source: Fraunhofer ISI

Renewing prosperity means putting prosperity on a climate-neutral footing. What is important is that "this renewal goes hand in hand with a renewed participation in prosperity that will ensure decent work for future generations, strengthen common infrastructures and in which the burdens of the required change will be borne in solidarity" (BMWK 2023b). As such, renewal also means a fairer distribution of prosperity and burdens.

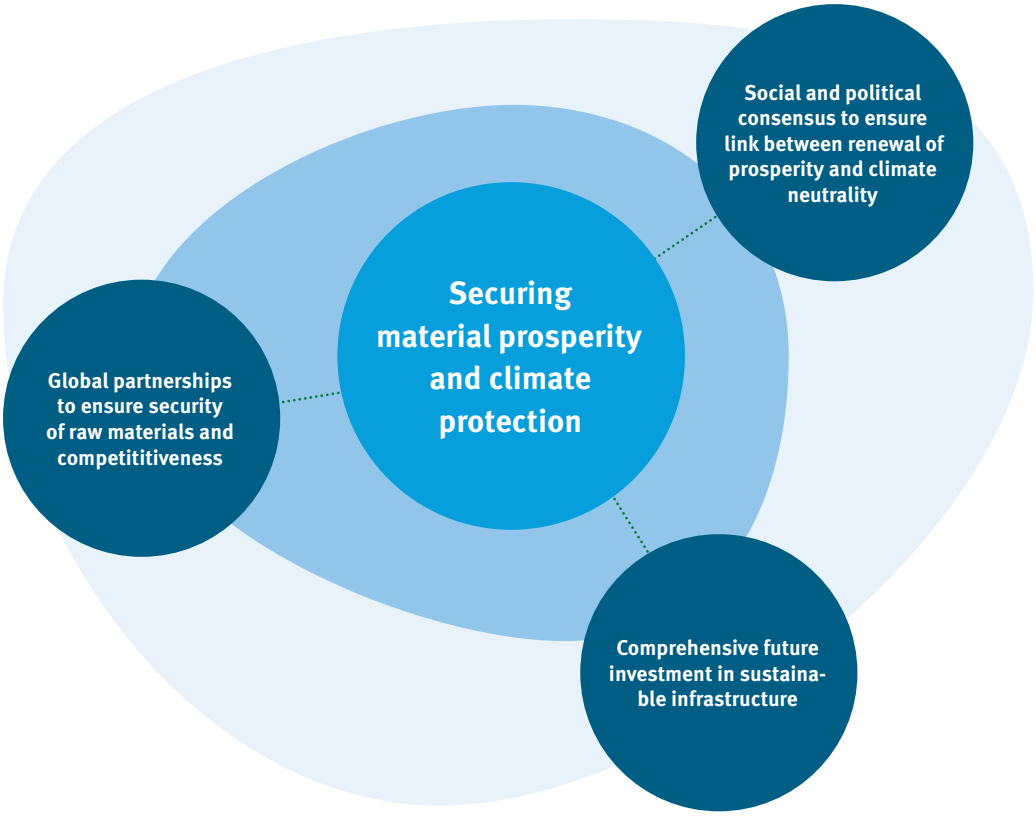
In view of the consequences of climate change that can already be felt today and represent a long-term threat, the renewal of prosperity can only be achieved through a transformation of the economy and society to climate neutrality. In order for this to happen, as the analysis of the trends has shown, three overarching goals must be brought into line and the action areas associated with them must be addressed (fig. 3):

1. Development of political and social consensus to ensure a close link between the renewal of prosperity and the climate-neutral transformation.

2. Adequate and comprehensive future investment in sustainable infrastructure.

3. Global partnerships to ensure security of raw materials and competitiveness.

Figure 3: Key action areas for securing material prosperity and climate protection



Source: Fraunhofer ISI

This illustrates that climate protection and climate adaptation can be consistently promoted even in economically weaker times, and may even help to bolster competitiveness and innovative strength. The modernization of the German economy through climate protection and climate adaptation is closely linked to the configuration of the future global economy and demands a broader understanding of economic growth. Green innovation is a central pillar in the bridge between economic growth and climate protection.

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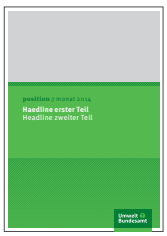

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