



BCG

Expert report for



CLIMATE PATHS 2.0

A Program for Climate and
Germany's Future Development

October 2021

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Our diverse, global teams bring deep industry and functional expertise and a range of perspectives that question the status quo and spark change. BCG delivers solutions through leading-edge management consulting, technology and design, and corporate and digital ventures. We work in a uniquely collaborative model across the firm and throughout all levels of the client organization, fueled by the goal of helping our clients thrive and enabling them to make the world a better place.

CLIMATE PATHS 2.0

A Program for Climate and Germany's Future Development

Summary of Findings

With the Climate Change Act of 2021, the German federal government has again significantly raised its climate protection targets, underlining the country's ambitious commitment to limiting the effects of climate change. The study "*Climate Paths 2.0*" proposes a program that would achieve 2030 climate protection targets in all sectors (total emission reduction of 65 percent compared to 1990) and set the important course toward greenhouse-gas (GHG) neutrality in 2045. The program simultaneously aims to preserve Germany's competitiveness and industrial strength and allow a socially balanced distribution of costs. Climate Paths 2.0 was developed and validated in a comprehensive bottom-up process with the German industry. More than 150 experts from BCG, the Federation of German Industries (BDI), and around 80 companies and associations were involved from March to September 2021.

Much is uncertain regarding technological advances, costs, and social acceptance of individual climate protection measures. Climate Paths 2.0 shows an economically cost-efficient strategy from today's perspective, primarily pursuing a national angle.¹ Effective climate protection is of course a global endeavor demanding both long-term, internationally comparable goals and stronger global, or at least pan-European, governance. In addition, future technological developments, for example influenced by global investment programs in technologies such as hydrogen, social preferences, or a desirable stronger international coordination than what is currently in place, can lead to other long-term technology paths.

The core findings of the Climate Paths 2.0 study are summarized in this document.

Climate Paths 2.0 at a glance

1

Germany must undertake the greatest transformation in its post-war history. Legally mandated **GHG neutrality by 2045** requires a fundamental restructuring of our energy system, international energy supply, building and vehicle stock, infrastructure, and large parts of industry.

2

The immediate changes required in this decade are drastic. To achieve the legally set **climate target for 2030**, Germany needs to largely eliminate investment in fossil technologies within the next nine years—and in some sectors right away. In addition, coal-fired power generation must fall much faster than previously planned.

3

Implementing climate protection measures requires **additional investments** of about €860 billion by 2030, or about €100 billion a year—almost 2.5 percent of Germany's gross domestic product (GDP).

4

Achieving the 2030 target requires almost cutting emissions in half compared with 2019, a goal **current climate policy** will not achieve in any sector. Without a change in direction, Germany will reduce annual emissions only by about 184 Mt CO₂e—half as much as necessary. Critical decisions and changes in direction are required, beginning in the legislative period starting in the fall of 2021. If these decisions and changes are delayed, either Germany will no longer be able to achieve the climate targets or doing so will require significantly higher investments.

5

Implementation of the required climate-protection measures is complex from both a political and a regulatory perspective; simple answers fall short. Germany needs a **broad mix of instruments** that includes both overarching and sector-specific measures. These enforce rapid infrastructure development, make the use of fossil fuels more expensive, and help lower the cost of renewable technologies. To set the course for GHG neutrality in 2045, the regulatory framework will also need to build support for the substantial investments required among citizens and businesses.

6

Climate Paths 2.0 proposes a **Program for Climate and Germany's Future Development** involving about 20 instruments that can drive forward the development of sustainable infrastructure, significantly accelerate the conversion of energy, transport, and heat to renewable sources, and initiate the transformation of Germany's industrial base toward GHG neutrality.

The rising costs of CO₂, energy, and materials will add financial burdens of about €15 to €23 billion for companies in 2030.² **Maintaining industrial competitiveness** requires reliable compensation instruments for the most affected sectors.

7

8

Implementing the climate protection measures will add an additional financial burden of €20 to €30 billion in 2030 for private households that do not (or cannot) switch to low-emission technologies. To ensure that the burden is shared fairly, **social compensatory measures** are necessary.

9

Government support for the transformation and balancing the shared burden for private households and companies will require **additional annual public spending** of €47 to €50 billion in 2030 and a total of €230 to €280 billion between 2021 and 2030. Spending will have to be financed through cuts to the federal budget, levies, taxes, or new debt.

10

Germany's national endeavor can only have a major impact on global climate change if it brings international followers and partners on board. This is all the more reason for Germany to strongly endorse a **European and internationally coordinated climate policy**. In addition, Germany should work toward a significantly more open setup of EU state aid law, thus enabling government support for climate transformation.

11

The next federal government must set the course on climate quickly. Germany needs both more effective and better coordinated **political governance** at the federal and state level and a substantial acceleration of planning and approval procedures.

12

Achieving Germany's legal climate target is a massive undertaking for society at large, which requires an immediate course correction already in the first months of the new legislative period. At the same time, successful implementation of the comprehensive modernization program described here offers a **historic opportunity** for Germany to transform into a climate-neutral industrial country and to make an ambitious contribution toward limiting the effects of climate change, thereby securing the prosperity of this and future generations.

OUTLOOK

Climate-neutral Germany in 2045

CCS infrastructure
for transport and storage
of CO₂ on land and at sea

Approx. 305 TWh PtL demand
for net-zero emissions in air and maritime
transport, in chemicals, and in remaining
combustion engines on the road;
thereof approx. 295 TWh in imports

> 480 GW wind and PV
Expansion from around 110 GW
in 2021 to the limits of potential
in order to meet approx.
990 TWh of electricity demand

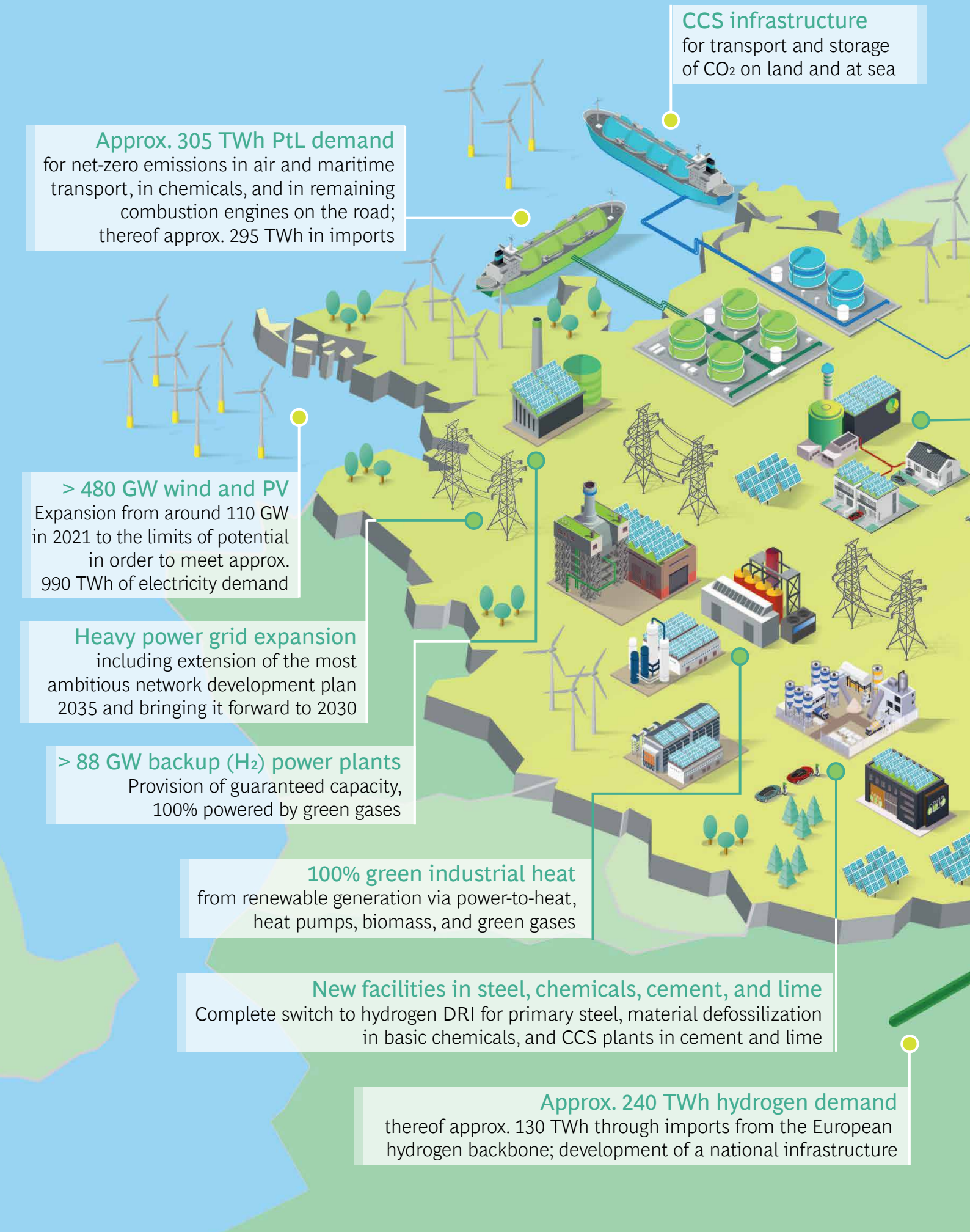
Heavy power grid expansion
including extension of the most
ambitious network development plan
2035 and bringing it forward to 2030

> 88 GW backup (H₂) power plants
Provision of guaranteed capacity,
100% powered by green gases

100% green industrial heat
from renewable generation via power-to-heat,
heat pumps, biomass, and green gases

New facilities in steel, chemicals, cement, and lime
Complete switch to hydrogen DRI for primary steel, material defossilization
in basic chemicals, and CCS plants in cement and lime

Approx. 240 TWh hydrogen demand
thereof approx. 130 TWh through imports from the European
hydrogen backbone; development of a national infrastructure





100% GHG-neutral air transport

Conversion to 100% green fuels and alternative powertrains

59 Mt negative emissions

through biomass CCUS and direct air capture, additional 11 Mt CCUS for fossil process emissions in building materials

100% green district heating and neighborhood solutions

4M buildings connected

Comprehensive modal shift

Rail transport performance grows by 50% for passengers and 70% for freight compared to 2019

Decarbonization in road transport

39M battery-electric cars, accounting for over 85% of the vehicle fleet; 480K battery-electric and 115K hydrogen-powered trucks

Nationwide charging/H₂ infrastructure

to enable ramp-up, early expansion to 9M private and 6M public charging points already by 2030

Sustainable agriculture and forestry

More efficient land and fertilizer use, creation of carbon sinks through LULUCF

2.1% energy-efficient building renovation rate

Building renovations to an average of approx. 70 kWh/(m² a)

100% green building heat

including 15M heat pumps

1

Germany must undertake the greatest transformation in its post-war history. Legally mandated GHG neutrality by 2045 requires a fundamental restructuring of our energy system, international energy supply, building and vehicle stock, infrastructure, and large parts of industry.

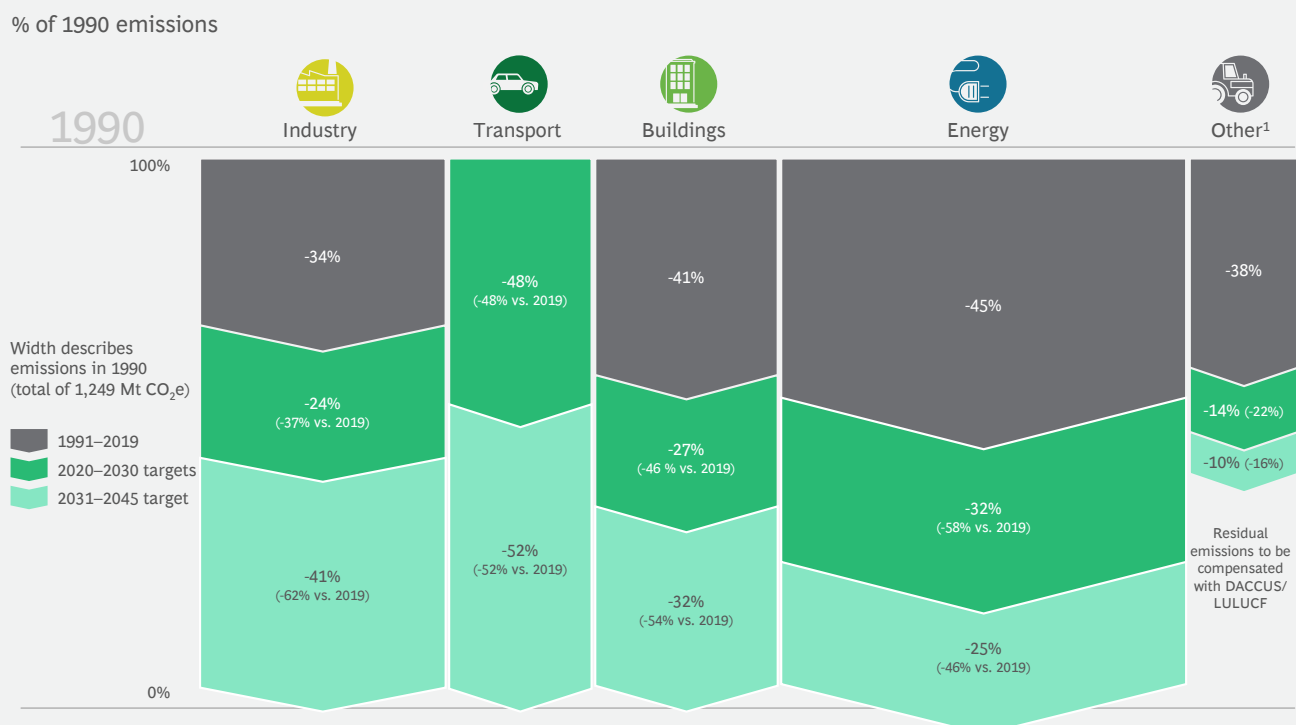
The new Climate Change Act specifies GHG neutrality in Germany by 2045, requiring the country to replace a significant part of its fossil fuel base, expand renewable electricity generation to the limits of its capacity, and build completely new infrastructures. This transformation must take place in just 24 years—a single generation of assets. It is a national transformation project of historic significance.

The GHG neutrality target sets a very narrow framework for permissible measures, demanding an outright renunciation of fossil fuels and raw materials—up to and including nonenergetic use in chemistry. A surprising number of the necessary solutions are already clear and technologies known.

To achieve the industry climate target, heat generation must become completely renewable within just one asset generation. Industrial heat production—in 2019 almost entirely dependent on fossil gas—must be fully converted to electricity, biomass, and green gases in all industrial sectors. The steel, lime, and cement industries, which currently account for more than half of Germany's industrial emissions, will have to completely replace a substantial part of their assets. In steel production, only hydrogen-powered plants for direct reduced iron may be used instead of blast furnaces. The chemical industry must electrify or replace every steam cracker and convert core processes such as the synthesis of ammonia and methanol to alternative production routes via carbon-neutral hydrogen. All fossil

Climate Change Act: Sector targets for 2030, GHG neutrality in 2045

EXHIBIT 1 | Relative emissions development in Germany by sector 1990–2045



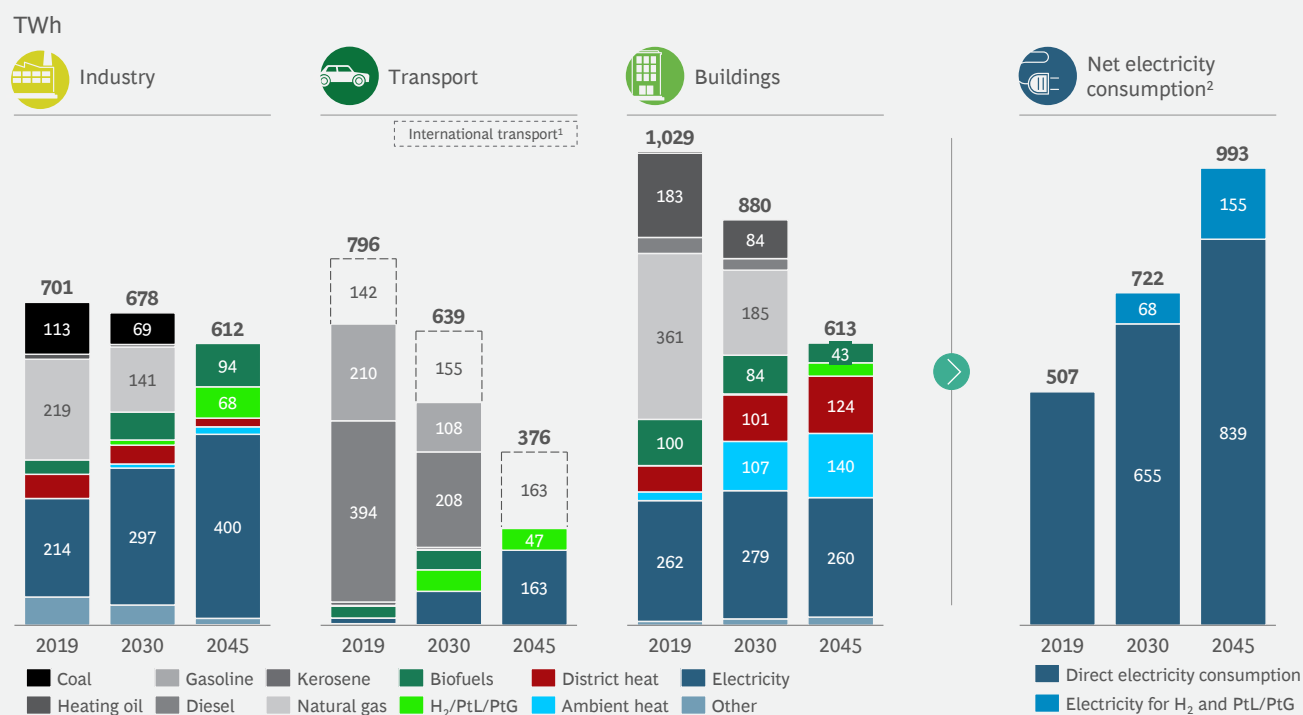
1. Agriculture, waste management, and other

Note: Transport in 2019 largely stable compared to 1990; bioenergy with carbon capture, utilization, and storage (BECCUS) is displayed as negative emissions in the industrial and energy sector; DACCUS = direct air carbon capture, utilization, and storage; LULUCF = land use, land-use change, and forestry

Source: German Environment Agency (2021) *GHG emissions data*; BCG analysis

Electricity is the transformation's central energy carrier

EXHIBIT 2 | Final energy consumption and net electricity consumption



fuels in nonenergetic use must be replaced by recycled or synthetic hydrocarbons. In the cement and lime industries, carbon capture plants must be built, and the captured emissions permanently stored or non-energetically bound (carbon capture, utilization, and storage [CCUS]). Finally, circular economy practices must be further adopted, saving considerable primary resources, and reducing emissions, especially for plastics and metals. In some energy-intensive industries, technical issues still need to be solved to achieve zero emissions; for example, in the use of inert anodes in aluminum production.

In the transport sector, the vehicle fleet will be almost completely replaced with alternative drive systems by 2045—in particular, with battery cars for passenger transport and a mix of battery and hydrogen trucks for freight. A nationwide infrastructure of charging stations and hydrogen filling stations will need to be installed. All remaining combustion engines in road, rail, air, and maritime transport must be completely converted to green fuels, especially synthetic fuels. In the 2045 target scenario, synthetic fuel consumption alone equals more than one-sixth of today's total transport fuel consumption.

To achieve a climate-neutral building sector, energy demand in existing buildings must be significantly reduced and completely converted to renewable energies. This means energy-efficient building renovation must almost double, from approximately 1.1 percent fully renovated building space per year in 2019 to 2.1 percent by 2045. Building stock must also be upgraded for the use of renewable heat, and almost every building in Germany must be supplied with a new heating solution. Heat pumps in less densely populated areas and district heating or neighborhood connections in urban areas are particularly suitable.

Electricity will become the central energy carrier of the upcoming transformation. New consumers such as battery-electric vehicles, heat pumps, industrial power-to-heat plants, carbon capture, emerging industries such as battery production, and the domestic production of green hydrogen will double net electricity consumption, from 507 TWh in 2019 to 993 TWh in 2045. To meet this demand, German electricity production must almost double in less than 24 years and at the same time become completely carbon-neutral by 2045. Renewable energies must be expanded to their potential limits, additional flexibly dispatchable power plants (or storage) built to ensure security of supply.

These power plants must be operated exclusively with green gases by 2045. Along with a greatly expanded and digitized grid infrastructure, this represents the German electricity system's largest construction and conversion project ever.

Agricultural emissions must be significantly reduced through more efficient land use, new processes in fertilizer application, and a reduction in emissions from livestock; for example, through less meat and dairy consumption or the use of methane-inhibiting feed additives.

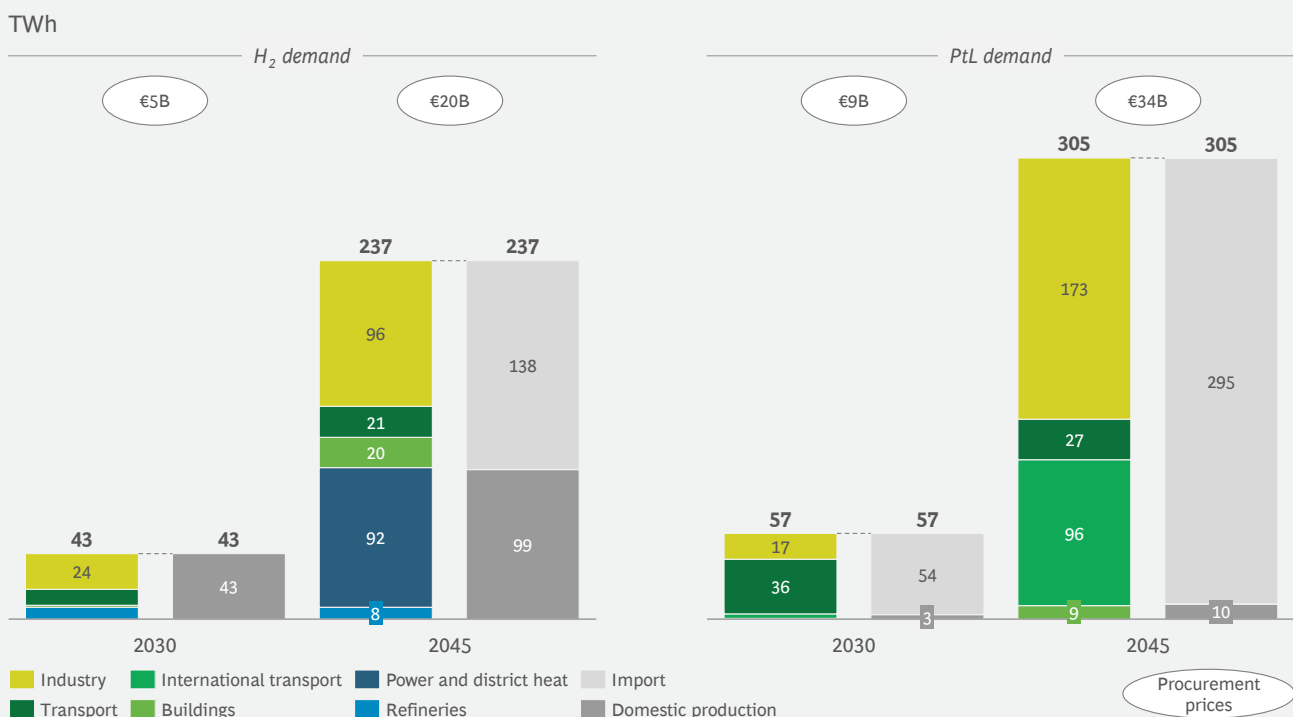
Germany will have to import prodigious quantities of renewable energy carriers. The country will require an estimated 237 TWh of carbon-neutral hydrogen in 2045, of which more than half will have to be imported from regions like Southern Europe and North Africa, which can be connected through its own pipeline infrastructure. Germany will also need 305 TWh of synthetic hydrocarbons for use in transport and basic chemicals ("e-fuels")—also largely imported.

Especially in agriculture and waste management as well as in individual industrial processes, unavoidable residual emissions will remain in 2045 (59 Mt CO₂e in the target path). Compensating for these will require negative emissions. This especially includes the building of natural sinks (land-use, land use change, and forestry [LULUCF]) as well as the capture and permanent storage of CO₂ from biomass combustion (bio-energy with carbon capture, utilization, and storage [BECCUS]) from air (direct air carbon capture, utilization, and storage [DACCUS]).

The measures outlined here indicate a cost-efficient trajectory toward GHG neutrality in 2045 from today's point of view. However, after 2030, uncertainty increases regarding the development of international climate ambitions, energy carrier prices, and future technology learning curves. The speed of implementation and pressure to change mean that everyone in Germany—residents and businesses alike—will experience a direct impact. To react flexibly to technological uncertainties and possible barriers to implementation and acceptance, Germany must also remain open to new developments; for example, increased availability of low-priced carbon-neutral hydrogen.

Industry, transport, and energy sectors drive H₂/PtL demand

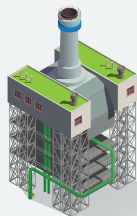
EXHIBIT 3 | H₂ and PtL demand by sector and application 2030–2045



Note: H₂ = hydrogen from electrolysis of renewable energies (during the transition—before 2040—purchase of blue hydrogen is also conceivable); PtL = renewable synthetic fuels made of green hydrogen (especially synthetic crude, methanol); international transport = sea and air transport departing from Germany; import of fossil energy carriers amounted to €91B in 2019
Source: BCG analysis

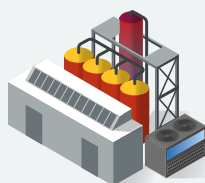


Industry



Replacement of blast furnaces with 10 Mt production capacity

through plants for direct reduced iron (approx. 30% of primary steel production)



100% fossil-free heat in almost every reinvestment

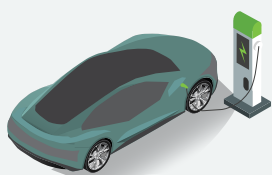
Avoidance of natural gas, oil, and coal where possible



Emissions reduced six times faster than the last 20 years

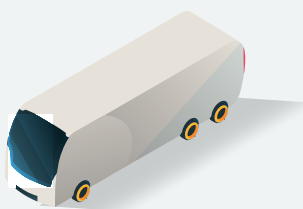
Annual reduction 2020–2030 compared to 2000–2019

Transport



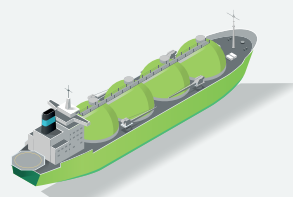
Extensive electrification of new passenger cars by 2030

Approx. 90% fully electric new registrations



Approx. 70% GHG-neutral new truck registrations

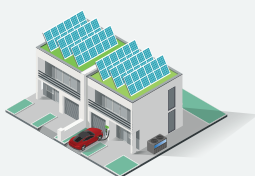
Today: de facto zero



Over 3 Mt imports of synthetic fuels in 2030

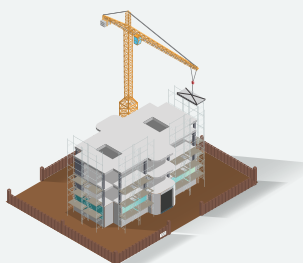
Today: de facto zero

Buildings



“Approx. 70% more energy-efficient renovations from 2023 on”

Acceleration from 1.1% p.a. to 1.9% p.a. in 2030



Renovation to have energy consumption

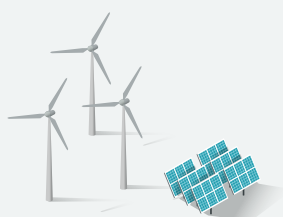
70 kWh/(m² a) in fully renovated buildings (approx. 50% of current average)



As of 2023: No new oil and gas boilers wherever possible

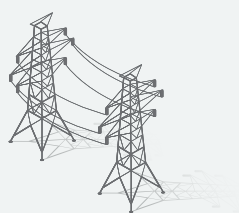
Installation of heat pumps, district heating, or similar with every reinvestment if possible

Energy



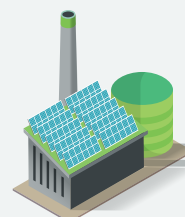
Doubling of wind and photovoltaic expansion

+65 GW total wind (offshore and onshore) by 2030



Acceleration of network expansion and flexibilization

NEP 2035 brought forward to 2030, digitalization in the distribution grid, demand-side flexibilization

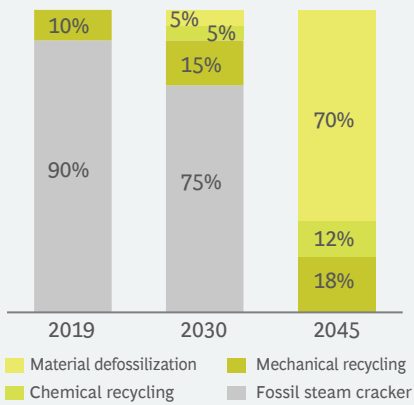


+43 GW gas by 2030, required for coal phase out

For security of supply (gas 2019: 31 GW)

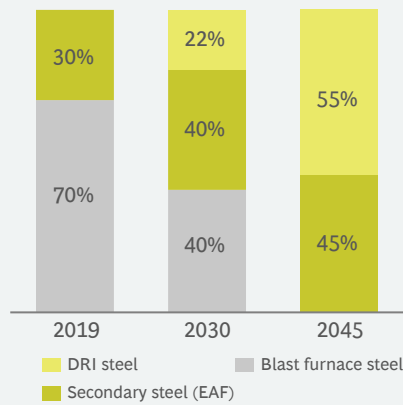
Petrochemicals

Share of production



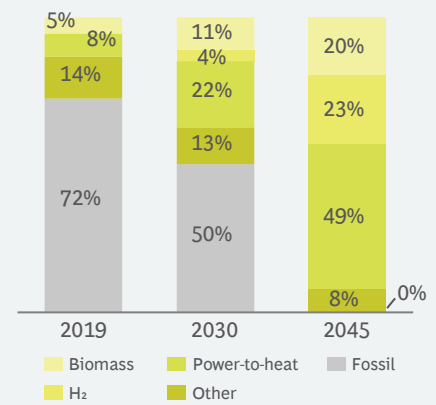
Steel

Share of production



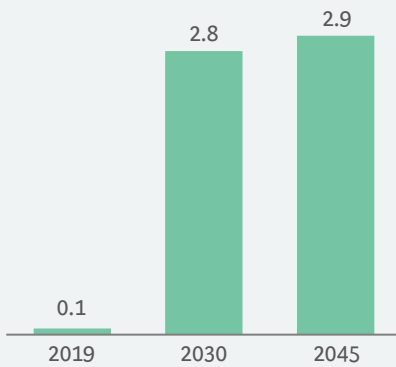
Process heat mix

Share of heat consumption



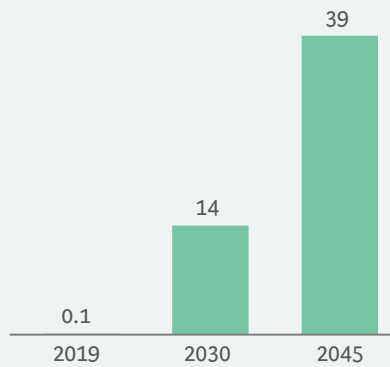
New EV registrations

M fully electric vehicles



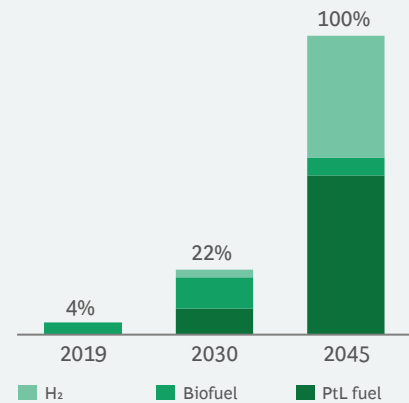
EV fleet

M fully electric vehicles



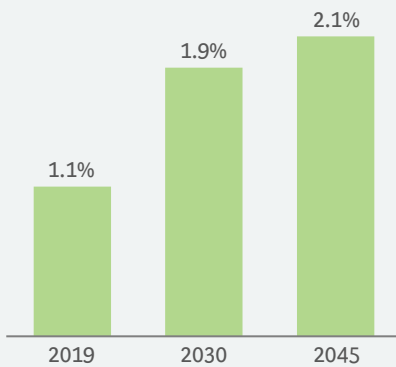
Green fuels

Share of remaining fuels



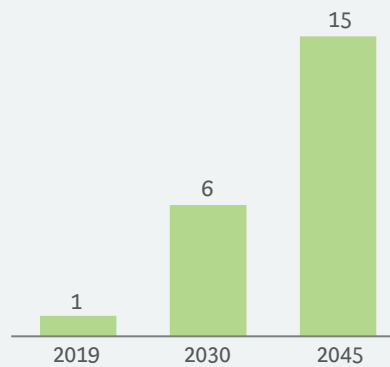
Energy-efficient renovation

Renovation rate p.a.



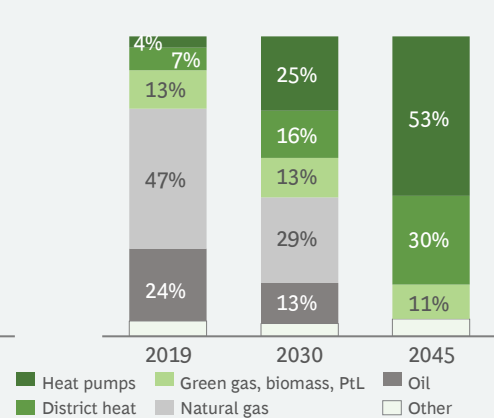
Heat pumps

In M



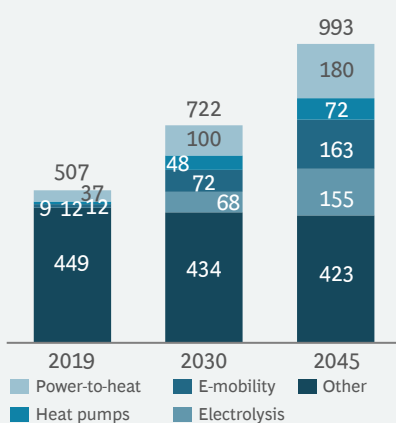
Building heat mix

Space heating, hot water consumption



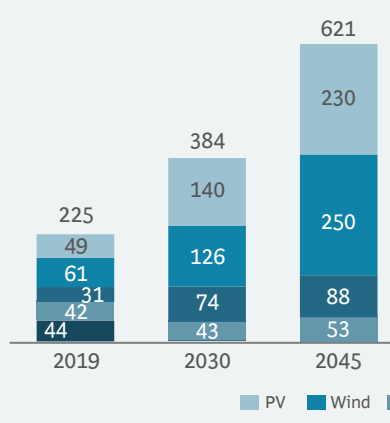
Electricity consumption

TWh



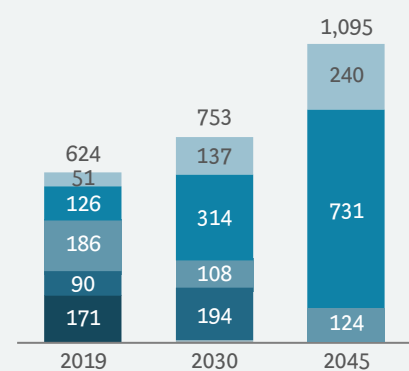
Installed capacity

GW



Net electricity generation

TWh



What needs to happen by 2030 to achieve climate targets

2

The immediate changes required in this decade are drastic. To achieve the legally set climate target for 2030, Germany needs to largely eliminate investment in fossil technologies within the next nine years—and in some sectors right away. In addition, coal-fired power generation must fall much faster than previously planned.

The technological path to achieving the mandated 2030 climate target is clearer than the longer-term path to 2045 but incredibly narrow. Germany must almost halve its emissions in less than ten years, largely with technologies that are already on the market. At the same time, this target is so ambitious that most sectors will have to devote a substantial proportion of all reinvestments to making the necessary changes.

Germany is facing a decisive decade in which climate change will finally reach “every citizen.” Over the next nine years, millions of people will have to make different choices than in the past—for example, when it comes to the use of electric vehicles and renewable heat. The country must also invest billions in the construction of new infrastructure and set the course for achieving zero emissions by 2045.

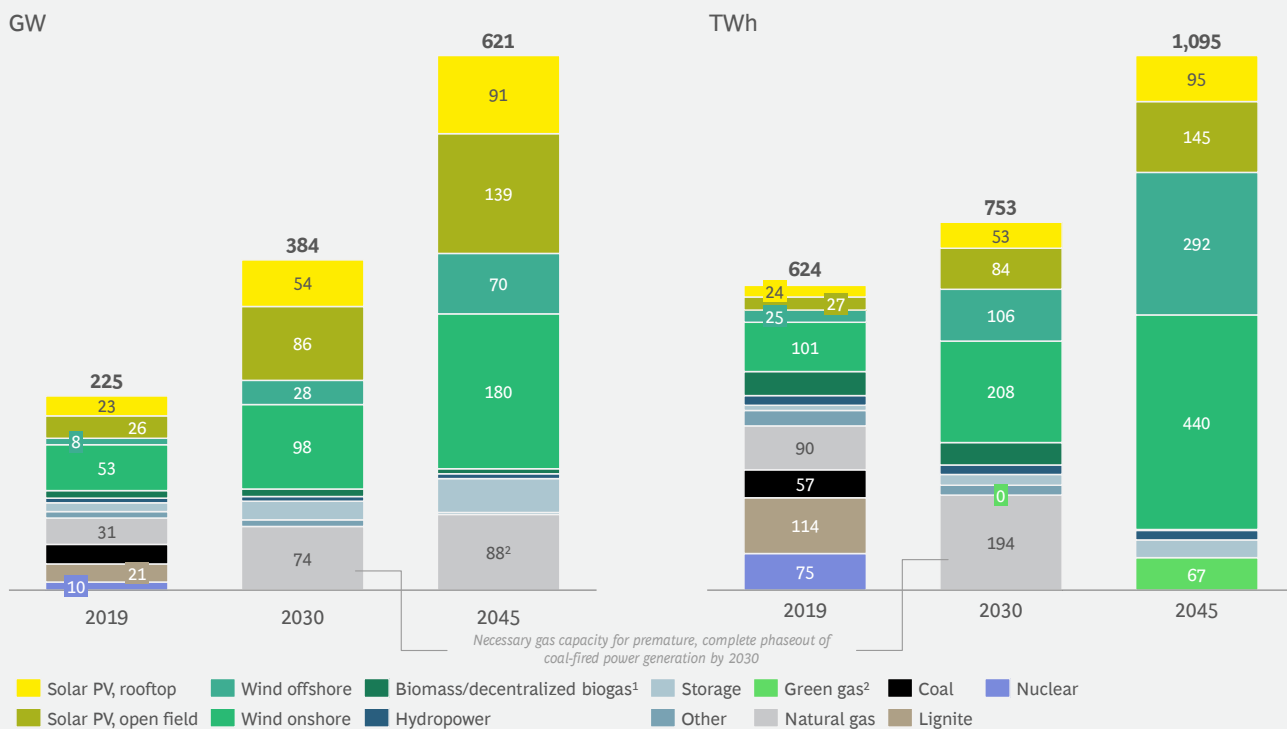
In the industrial sector, the legislated 2030 climate target requires fossil technologies to be abandoned wherever possible when investment decisions are made. This means, for example, that almost every investment in a heat generator must include conversion from currently mainly natural gas to power-to-heat, biomass, or green gases. This does not apply in cases where either infrastructure or technologies are not yet available; for example, for some high-temperature processes. By 2030, the steel industry will have to replace a third of its blast furnaces with plants for direct reduced iron. The chemical industry will have to convert some processes to carbon-neutral hydrogen, and electrify the first steam crackers. In cement and lime, the first pilot projects for the capture and storage of CO₂ should already be underway. At the time of publication, several of these technologies are not yet reliably available at industrial scale or are not yet used in Germany.

In transport, new vehicles must already be largely converted to alternative drive systems by 2030. In the target path, by 2030, 9 out of 10 newly registered passenger cars are fully electric (2.8 million out of a total of 3.1 million new registrations, 14 million in stock) and more than 7 out of 10 new truck registrations have a battery or fuel cell drive (63,000 out of 83,000 new registrations, more than 200,000 in stock). Achieving this will require an extensive, coordinated investment in nationwide charging infrastructure and hydrogen filling stations along all major traffic routes within the next nine years. Massive greenhouse gas reductions are also required in the vehicle fleet. The target path anticipates more than 3 Mt of synthetic fuels already imported for this purpose, bringing the quota of green fuels to more than 20 percent of fuel consumption.²

In the building sector, investment behavior needs to change even faster. Starting immediately, every new building should be equipped exclusively with completely locally emission-free heating solutions. The annual renovation rate must already increase significantly in the short term—by at least 70 percent by 2030 (gradual increase to 1.9 percent in 2030 compared to 1.1 percent in 2019)—while simultaneously increasing the depth of renovation (on average approx. 70 kWh per square meter per year for residential buildings in 2030). Wherever possible, even in existing buildings, every heating replacement should include a conversion to heat pumps, district heating, or at least a hybrid heat solution with a high renewable share. The target path for 2030 calls for building stock to include 6 million heat pumps and more than 2 million connections to district and area heating solution.

Strong increase in renewable power generation already before 2030

EXHIBIT 4 | Net generation capacity and net electricity generation in the target path



1. Solid biomass and decentralized conversion of biomethane into electricity (currently) in Renewable Energy Act (EEG)-funded plants 2. Green hydrogen, PtX, biomethane in gas-fired power plants

Note: Net electricity generation describes all domestic electricity generation except for the power plant's own consumption

Source: BCG analysis

The implementation of these measures requires both a significant buildup and integration of new infrastructure as well as the supply of extensive volumes of renewable energy carriers in all sectors.

The German electricity system faces an unprecedented turning point in this decade. It must meet a more than 40 percent increase in electricity demand by 2030 while simultaneously reducing its absolute emissions by almost 60 percent. To succeed, it must double its annual expansion of renewable energies. To achieve the mandated climate target, coal-fired power generation will phase out by 2030 under the assumptions made, in parallel to the end of nuclear energy and well before the recently agreed-upon coal phase out. Taking these capacities off the grid while maintaining a secure electricity supply will require the addition of more than 40 GW of new ("H₂-ready") gas-fired power plants—the largest expansion of thermal power generation capacity in Germany to date. Electricity grid infrastructure expansion must be radically accelerated. One key step

will be to expand the Federal Network Agency (BNetzA) Network Development Plan (NEP)'s currently most ambitious expansion path, and bring it forward by five years (from 2035 to 2030). Additionally, at the level of the electricity distribution networks, extensive investments in flexibilization and digitization are required for the system integration of the many new electricity consumers from the industry, transport, and building sectors.

In this decade, the hydrogen economy must also grow significantly. Implementation of the measures envisioned on the 2030 target path already creates demand for 43 TWh of carbon-neutral hydrogen, considerably more than anticipated in the current national hydrogen strategy. To transport it from the North Sea coast to major industrial centers, Germany must start building its own hydrogen grid infrastructure. At the same time, decentralized hydrogen production must be established at locations without an infrastructure connection for early projects.

3

Implementing climate protection measures requires additional investments of about €860 billion by 2030, or about €100 billion a year—almost 2.5 percent of Germany's gross domestic product (GDP).

Implementing the climate protection measures will require investments of €860 billion between 2021 and 2030. Around half of this is accounted for by the energy sector, especially for the expansion of renewable energies and power grids. At approximately €220 billion, transport accounts for the second largest share, mainly for infrastructure and vehicles with alternative drive systems. The building sector needs to invest around €175 billion, and the industrial sector €50 billion. While the industry sector requires the lowest investment volume, it bears the highest net additional costs for switching to renewable energy carriers and new processes.

The scale of this investment endeavor is historically large. On average, the annual investments required to achieve the climate target amount to around €100 billion, or just under 2.5 percent of Germany's gross domestic product (GDP).

The implementation of climate protection measures will result in net additional costs of €16 billion across all stakeholders in 2030. However, the actual financial impact is higher: Measures with additional costs (e.g., decarbonization of industry, use of green fuels, or development of a nationwide charging infrastructure) will add up to €41 billion in 2030. At the same time, electromobility will lead to savings totaling €25 billion.

Classification of different cost perspectives

Additional investments include all capital expenditures that must be incurred beyond the preservation of the existing plant base, made to implement technical climate protection measures. This includes both direct additional investments in more expensive equipment or systems (e.g., the cost difference between an electric car and an equivalent combustion vehicle) and the resulting investments in infrastructure (e.g., additional charging and distribution grid infrastructure). Values shown are real 2019 prices; they are neither annualized nor discounted.

Additional costs reflect the annual additional expenditure required to implement the technical climate protection measures from the perspective of the respective business decision-makers. They include all investments (annualized over the lifetime of the respective plants), financing costs with actor-specific real interest rates, and the sum of both saved and additional energy and operating costs including actor-specific taxes and levies effective at the time the study was prepared.

The **regulatory gap** describes the remaining surplus investment and additional cost gap between the current policy path (existing regulation) and the target path (achievement of the legally set climate target) to be addressed by additional policy instruments.

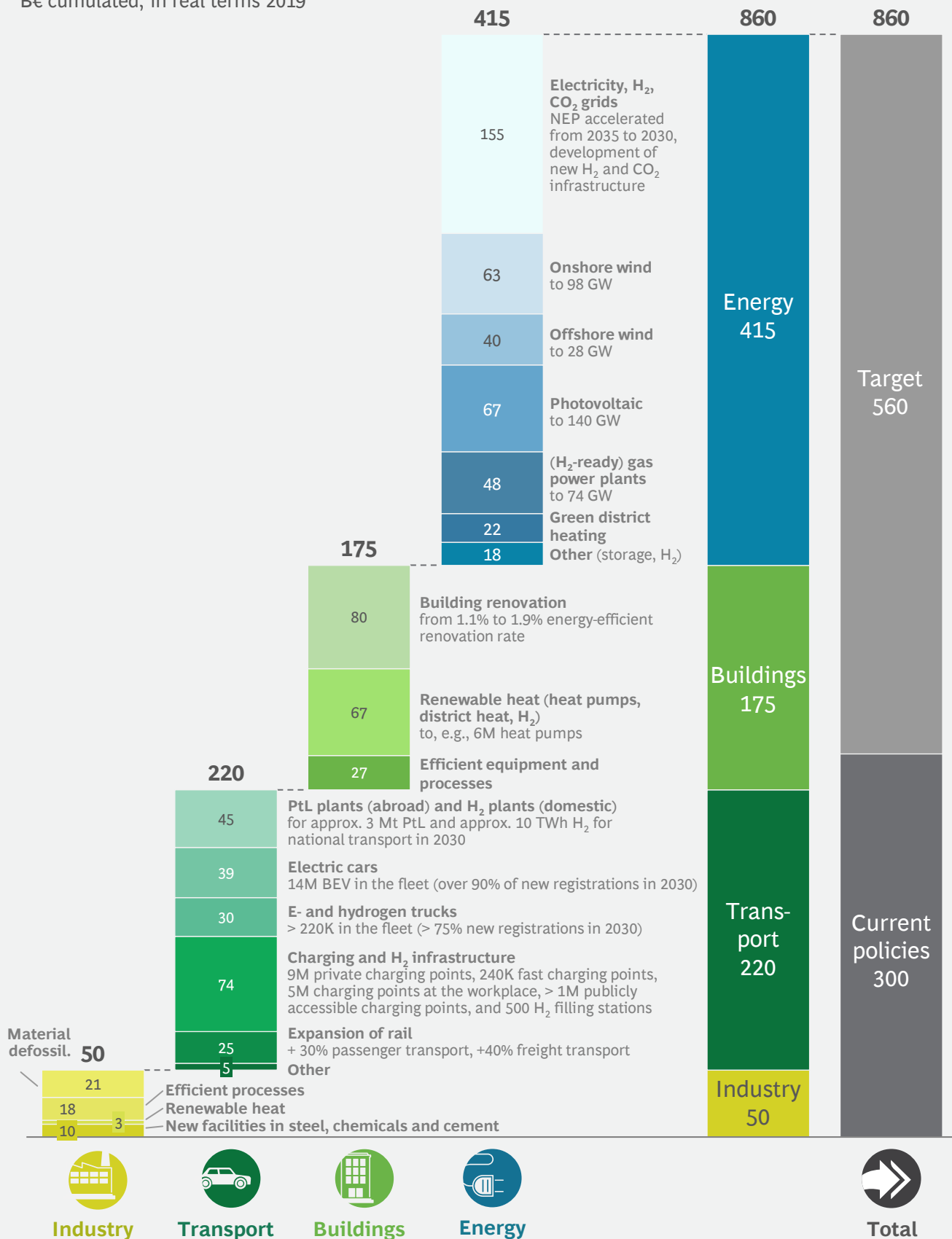
Additional financial burdens describe the actual annual increase in spending by private households and businesses resulting from the introduction of all policy instruments compared to 2019. These arise from additional costs caused by the regulatory requirements for climate protection measures (e.g., additional expenditure on green fuels when a quota is introduced) or from policy instruments themselves (e.g., carbon pricing of fossil fuels), but not borne by the state.

The public sector's **fiscal burden** describes the differences in the balance of additional revenues (e.g., from carbon pricing), expenditures (e.g., grants and subsidies), and loss of revenue (e.g., from taxes on fossil fuels) caused by the implementation of climate protection measures compared to 2019. It contains all the main effects of the instruments proposed in Climate Paths 2.0 for climate protection, the financial relief for companies, and social compensation.

€860B additional investments in climate protection by 2030

EXHIBIT 5 | Cumulative additional investments 2021–2030

B€ cumulated, in real terms 2019



Note: In the case of renewable heat and alternative powertrains in transport, the additional investments describe the acquisition costs compared to conventional technologies; cumulative additional investments do not include investments in projects under construction that will be initiated before 2030 but will not go into operation until after 2030
Source: BCG analysis

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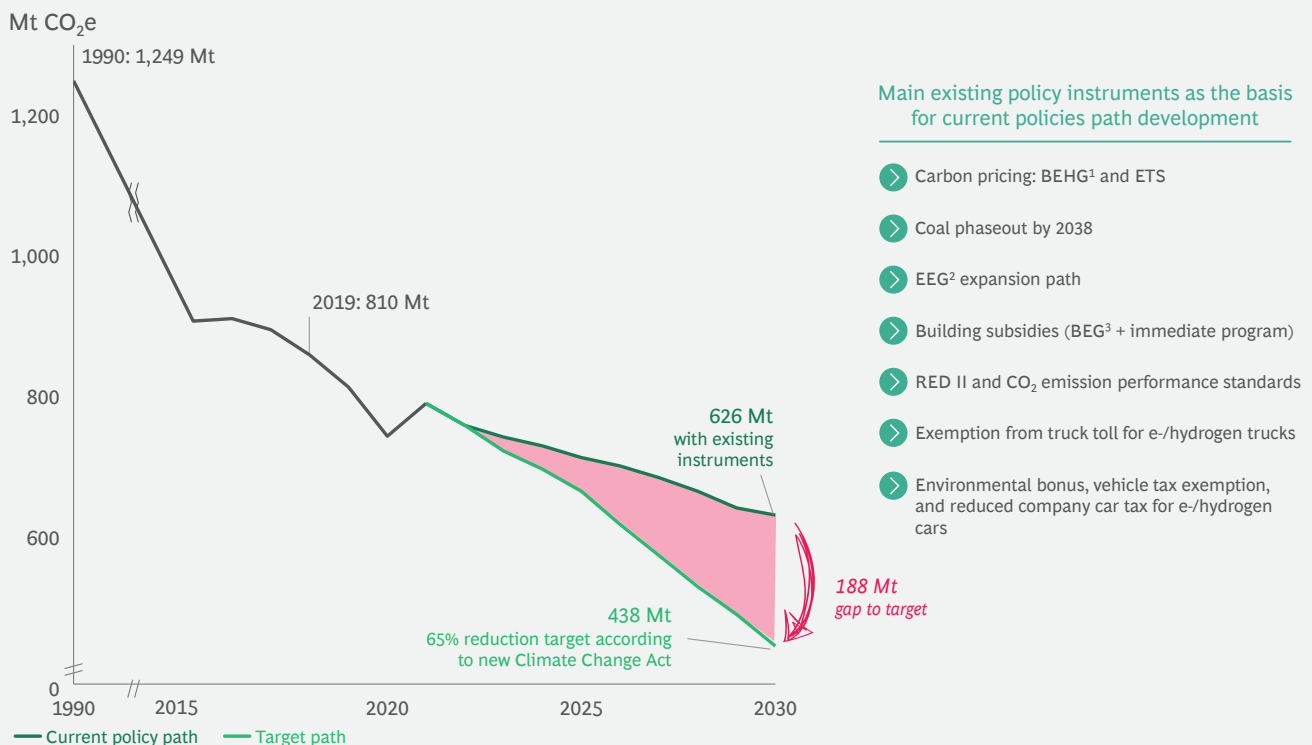
Achieving the 2030 target requires almost cutting emissions in half compared with 2019, a goal current climate policy will not achieve in any sector. Without a change in direction, Germany will reduce annual emissions only by about 184 Mt CO₂e—half as much as necessary. Critical decisions and changes in direction are required, beginning in the legislative period starting in the fall of 2021. If these decisions and changes are delayed, either Germany will no longer be able to achieve the climate targets or doing so will require significantly higher investments.

Germany is subject to increasingly ambitious European climate regulation in several sectors, for example through the European Emissions Trading System (ETS), CO₂ emission performance standards, and Renewable Energy Directive. In July 2021, the European Commission developed a comprehensive set of regulatory proposals, bundled in the “Fit for 55” package. If this were implemented, Europe would probably have the most ambitious CO₂ regulation in the world. But it would still be insufficient to achieve Germany’s mandated national climate target; current national regulation also falls short.

In the industrial sector, investment incentives in low-carbon technologies were insufficient at all levels at the time when the study was prepared. Investments in most decarbonization technologies—such as new processes, green hydrogen, and renewable heat—are often more expensive for these companies than investments in conventional technologies, so uneconomical without additional incentives. The industrial sector will reduce its emissions by 17 Mt CO₂e in the current policy path by 2030. A gap of 52 Mt CO₂e remains to achieve the target, the largest of all sectors in relative terms.

188 Mt CO₂e emission gap in 2030 with current instruments

EXHIBIT 6 | GHG emissions in Germany 1990–2030



1. BEHG = Fuel Emissions Trading Act 2. EEG = Renewable Energy Act 3. BEG = Federal Funding for Efficient Buildings

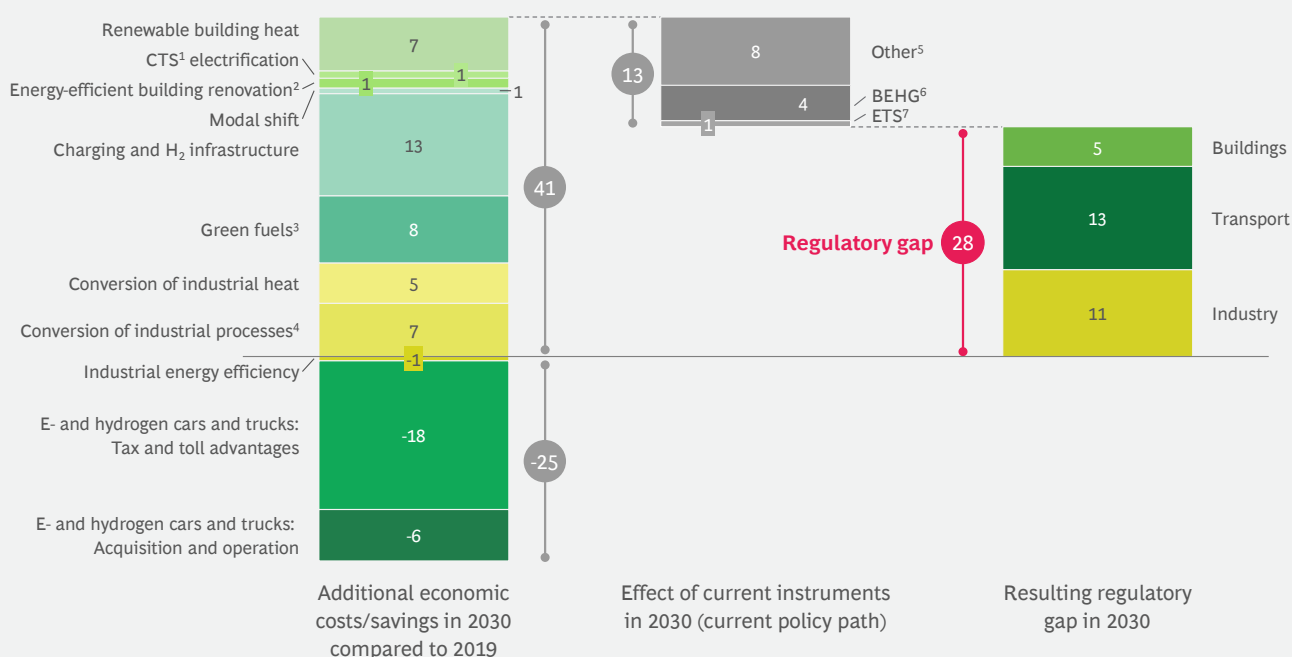
Note: 2021 emissions based on Agora Energiewende analysis

Source: German Environment Agency (2021) GHG emissions data; Agora Energiewende (2021) Abschätzung der Klimabilanz Deutschlands für das Jahr 2021; BCG analysis

Regulatory gap of €28 billion in 2030

EXHIBIT 7 | Stakeholder perspective: Additional costs of climate protection measures in 2030

B€ p.a., in real terms 2019



1. Electrification of devices and processes in commercial, trade, and services (CTS) 2. Incl. building automation and efficient new construction 3. Biofuels, carbon-neutral synthetic fuels, green hydrogen 4. In steel, chemical, cement 5. Especially in transport: RED II, environmental bonus, and CO₂ emission performance standards 6. BEHG price of €80/t CO₂e in 2030 7. ETS price of €90/t CO₂e in 2030 (for emissions beyond free allocations)
 Source: BCG analysis

The decarbonization of the transport sector has received a noticeable boost from instruments such as purchase premiums and carbon prices on gasoline and diesel. However, the current funding volume and regulatory context are not sufficient to stimulate the necessary market ramp-up. Nor is the expansion of charging infrastructure—currently the biggest hurdle for car buyers—sufficiently accelerated. For green fuels, quotas are already twice as high in Germany as in the European Renewable Energies Directive (RED) II. Yet they are still not enough to stimulate investment in future-ready power-to-X (PtX) fuels. Under current policies, traffic emissions will be reduced by 47 Mt CO₂e by 2030. This reduction misses the German sector target by 32 Mt CO₂e.

In the building sector, more comprehensive state support will accelerate the refurbishment of existing buildings, but not enough to achieve the sector target. Simultaneously, CO₂ prices in the national emissions trading scheme (Fuel Emissions Trading Act [BEHG]) make the use of oil and gas boilers more expensive but the difference is still too low to encourage the switch to other energy carriers in existing buildings. Following current policies, emissions will be reduced by 17 Mt CO₂e by 2030, leaving a gap of 39 Mt CO₂e relative to the 2030 target.

The energy sector has the largest absolute target gap of all sectors. With the ETS, the Act to Reduce and End Coal-Fired Power Generation (KVBG), and the Renewable Energy Sources Act (EEG), the most important policy instruments have already been established. However, their current ambition level falls well short of the new legal climate target. In addition, faster climate protection in the German energy sector is failing due to slow implementation. In particular, the expansion of low-carbon generation capacities—renewable energies and dispatchable gas-fired power plants to secure them—and power grids is not pursued with sufficient ambition. Although emissions will fall by 93 Mt CO₂e by 2030 on the current policy path, a gap of 57 Mt CO₂e remains.

Overall, Germany's total emissions under current policies, i.e., assuming the continuance of current political conditions, will fall by 184 Mt CO₂e from 2019 to 2030. Without any course correction, Germany will miss its 2030 target by 188 Mt CO₂e.⁴

Many of the technical measures to close this emissions gap led to an economic cost gap for stakeholders—i.e., companies and private households—that must be offset by new policy instruments.⁵

Overall, the additional costs of climate-protection measures add up to €41 billion in 2030. And measures that already bring net savings to stakeholders still require regulatory action to overcome other implementation hurdles; for example, a lack of infrastructure or high initial investments.

Existing regulation—such as carbon pricing in the BEHG, support measures like federal funding for efficient buildings (BEG), purchase premiums for vehicles with alternative powertrains, or regulatory requirements such as the RED II and CO₂ emission performance standards—will cover only €13 billion of these €41 billion in 2030. That leaves a regulatory gap of €28 billion in 2030, which must be closed with new or more ambitious climate protection instruments.

The industrial sector has a regulatory gap of up to €11 billion in 2030. Apart from energy efficiency, few climate protection measures pay off economically under existing regulation. Across all industrial branches, the sometimes considerable additional cost gap between fossil and renewable technologies must be filled. Basic industries such as steel, chemicals, and building materials are facing an enormous investment challenge. To avoid “investment leakage” in these industries—the outflow of new investments abroad—they need support for early investment projects in new technologies.

In transport, climate protection measures actually result in net savings of €3 billion in 2030. Vehicles with alternative drive systems will yield full cost advantages of €24 billion in 2030 under the given regulation. Here, however, the higher purchase price of electric vehicles and additional infrastructure development costs are slowing down substitution with alternative powertrains. Green fuels account for a total of €8 billion in additional costs compared to fossil gasoline and diesel. Here, long-term demand and investment security must be created for producers of synthetic fuels.

After deducting the effect of current policy instruments, the transportation sector has a regulatory gap of €13 billion in 2030.

In the building sector, there is a regulatory gap of €5 billion in 2030, mainly due to the often uneconomic switch to renewable heat. Building renovation triggers relatively low additional costs, as this is typically annualized over a 30-year time horizon. However, it requires significant initial investments, for which the existing support is inadequate. There is also considerable system inertia to be overcome, stemming from a lack of transparency, high investment costs, and long payback periods, along with a lack of pressure to act on the part of many owners. In addition, craftsmen’s availability imposes capacity restraints.

The energy sector, in addition to facing significantly more ambitious targets for renewable energies and for grids, must also overcome considerable operational obstacles to implementation (e.g., land designations, streamlining of approval procedures, bundling of competences). It also needs new incentives for the construction of new gas-fired power plants and to provide demand response programs for greater flexibility among electricity consumers.

All this requires determined political decisions in the coming legislative period. The overarching objective must be the economically efficient achievement of the legally set climate targets for 2030 and 2045. To this end, measures must be stimulated as far as possible in accordance with usual asset lifetimes and reinvestment cycles. If the right course is not set now, it will have to be done later at a significantly higher cost.

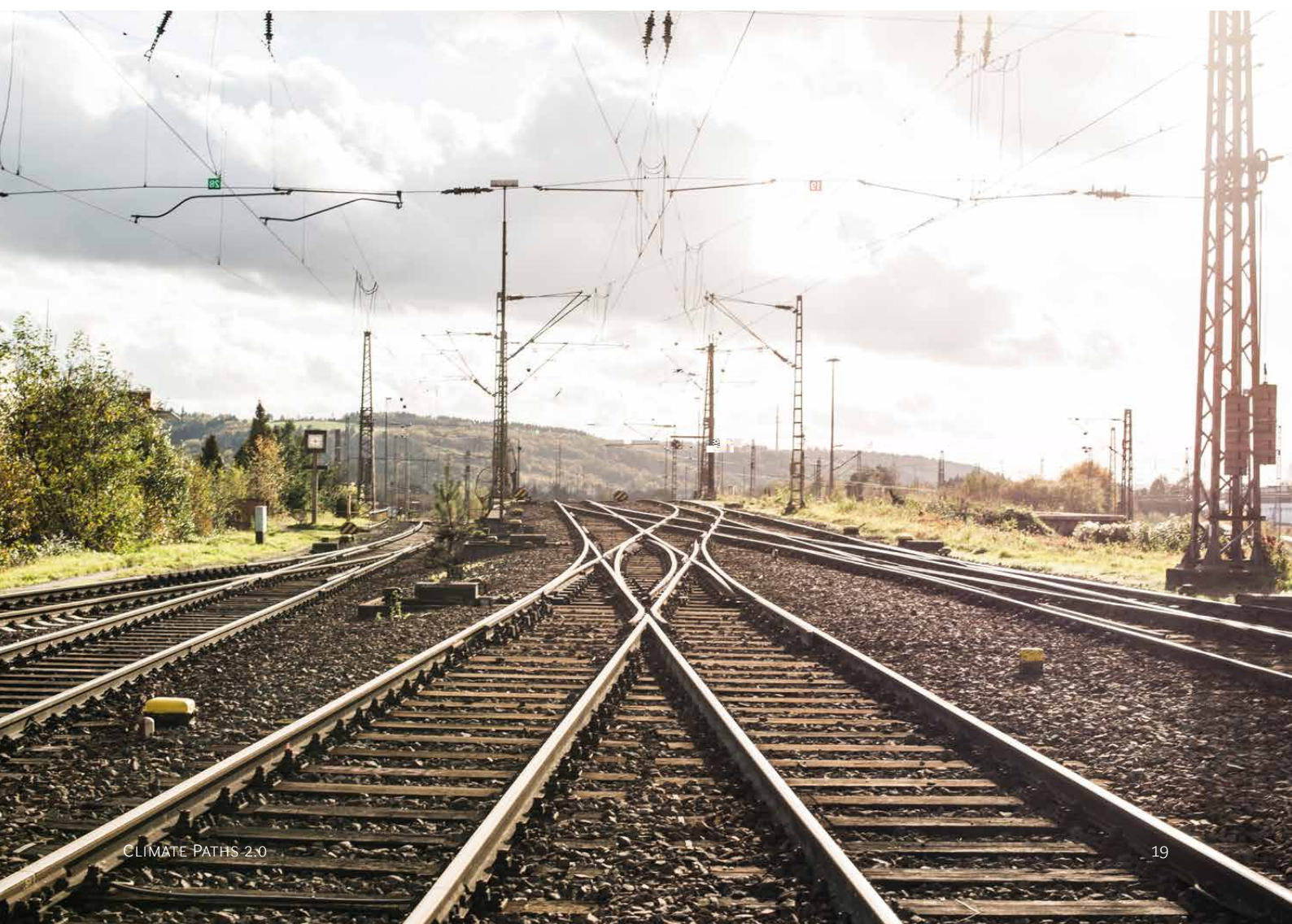
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Implementation of the required climate-protection measures is complex from both a political and a regulatory perspective; simple answers fall short. Germany needs a broad mix of instruments that includes both overarching and sector-specific measures. These enforce rapid infrastructure development, make the use of fossil fuels more expensive, and help lower the cost of renewable technologies. To set the course for GHG neutrality in 2045, the regulatory framework will also need to build support for the substantial investments required among citizens and businesses.

In principle, the state has various regulatory approaches at its disposal, namely (carbon) pricing, subsidies, and regulatory law. Standing alone, none of the three can ensure achievement of the legal climate target in an economically cost-efficient manner and without financial distortions.

Meeting the climate target efficiently, fairly, and with the fewest undesirable consequences for citizens and companies requires a balanced mix of regulatory approaches based on observed, sector-specific obstacles.

This also means that governance with cross-sectoral instruments alone is unrealistic. The implementation hurdles to be overcome are specific to each sector, and green technologies are available at different levels of maturity and with very different avoidance costs. Nevertheless, in light of the legal climate target that is already very high in the short term, very ambitious measures must be implemented simultaneously in all sectors. For this reason, strongly sector-specific political governance is needed to efficiently and effectively meet the climate target.



A Program for Climate and Germany's Future Development

Additional instruments to existing regulation



Industry



Transport

Overarching instruments

Make use of fossil fuels less attractive

EU ETS, higher carbon pricing in non-ETS sectors (where enforceable), energy taxes based on energy content and sustainability level

Incentivize switch to electricity

Reduction of electricity prices for renewable heat applications in the industry and building sector

National infrastructure program

Expansion of power grids, district heating, and rail; development of national infrastructures for e-mobility, hydrogen, and CO₂

National biomass strategy

Redistribution into large-scale industrial and district heating plants (in the future BECCUS), phase out of subsidies for use in buildings and decentralized power generation

Sector-specific instruments

Carbon contracts (CCfDs)

Promotion of green products and heat

Investment incentives

for renewable industrial heat

Efficiency standards and subsidies

Increase and accelerate depreciation

Green lead markets

e.g., through quotas

Charging/H₂ infrastructure subsidy

Investment grants for ramp-up

Purchase incentives for electric cars

to align acquisition costs

Carbon-based truck toll

in addition to toll exemption for e/H₂

PtX quotas and auctions

Investm./planning security in ramp-up

Research

Research and innovation agenda

Fundamental climate research, targeted investments in game-changers (batteries, quantum computing, etc.), accelerated scaling (high-temperature power-to-heat, CCUS, etc.)

Compensation and financing

Carbon leakage protection allocations, CBAM, exemptions, hardship funds, EPC

Social compensation

Basic provisions, hardship funds, (partial) elimination of the Renewable Energy Act levy, etc.

Funding sources

Combination of savings, levies, taxes, and debt to finance fiscal burdens of up to €50B per year in 2030

Political process

Climate governance

Stronger bundling and more central coordination of political responsibility, monitoring of leading indicators, acceleration of procedures, capacities for states/municipalities, etc.

Broad societal consensus

Consensus on infrastructure expansion, fair burden-sharing, etc., spanning multiple legislative periods



Buildings



Energy

Municipal infrastructure planning
for planning security at all levels

Mandatory renovation schedules
Building-specific zero-emission path

Modular building subsidies
for renovation and energy carrier change

Renewables req. in new buildings
100% GHG-neutral heat at installation

Renewables offensive
Area quotas, faster procedures, etc.

Accelerated grid expansion
Faster procedures at all levels

Flexibilized electricity consumption
Digitalization, market incentives, etc.

Central capacity market
to ensure security of supply

6

Climate Paths 2.0 proposes a Program for Climate and Germany's Future Development involving about 20 instruments that can drive forward the development of sustainable infrastructure, significantly accelerate the conversion of energy, transport, and heat to renewable sources, and initiate the transformation of Germany's industrial base toward GHG neutrality.

A comprehensive climate program must be able to achieve the new mandated climate target in this decade and set a robust course for GHG neutrality within 24 years at the latest. It must simultaneously maintain prosperity, growth, and employment, optimize economic efficiency, protect the industry and its economic strength, and ensure a balanced sharing of social costs—all without disproportionately burdening the state budget.

The following mix of instruments aims to achieve this combination of objectives in the best possible way and thus represents a balanced mix of (carbon) pricing, subsidies, and regulatory law.

The use of fossil fuels must become less attractive in all sectors. To this end, the EU ETS should be reformed, and a robust carbon price ensured for all non-ETS sectors (transport, buildings, small industrial plants)—ideally EU-wide through the “New ETS.” Following the July 2021 European “Fit for 55” proposal, the Energy Tax should also be reformed. It should harmonize specific taxes based on energy content and allow a differentiation between sustainable energy carriers such as electricity, e-fuels, and biofuels on the one hand and fossil fuels on the other.^{6,7}

Renewable electricity is the most important energy carrier for climate transformation. For applications that will be electrified in the future—including all direct or indirect heat applications—it must be exempt from levies.

The climate transformation demands a historic infrastructure program in this decade. Massive investments in power grids, rail, and district heating are pending. In addition, completely new infrastructure must be built for e-mobility, hydrogen, and CO₂.

Sustainable biomass is a limited resource. For this reason, a strategy is needed that prioritizes it for those sectors where it is used most efficiently and where it can contribute most to the long-term generation of negative emissions required after 2045—especially in large-scale industrial plants and district heating.

The industrial sector's greatest need is much more public ramp-up support. Adequate funding programs and climate protection contracts (carbon contracts for difference [CCfDs]) should assist companies with the construction and operation of carbon-neutral plants. Over time, this can be partially replaced by establishing green lead markets; for example, by quotas for increasing green steel and cement. In addition, an electricity price levy exemption will in most scenarios make the switch in operation to power-to-heat economical for the majority of companies.

In transport, the government should comprehensively promote infrastructure development and minimize the acquisition cost disadvantage of battery cars by continuing existing purchase premiums. In freight transport, the introduction of a powertrain-oriented CO₂-based truck toll in combination with substantially more expensive diesel fuels would significantly accelerate the drive change. To give producers of PtX fuels investment security, it is necessary to create a reliable market through technology-specific quotas, while also establishing a public double auction mechanism.⁸

Overcoming the inertia in the building sector will primarily require a lot of public funding, but also significantly more transparency and pressure. Mandatory preparation of renovation plans would educate building owners on necessary measures and available subsidies. A generous modular funding program would help them to handle the massive investment. A charge on fossil fuels and subsidization of electricity will make renewable building-heat sources more attractive. In new buildings, where the installation of fully renewable heating solutions is already economical, an obligation should be implemented in a timely manner. Similar “backstop” solutions could later be added as a last resort if stakeholders do not react sufficiently to price signals and subsidy offers.

Achieving the climate target in the energy sector demands a multilevel paradigm shift. To start, Germany needs a national renewable energy offensive—with nationwide mandatory land quotas for wind and photovoltaics (PV), significantly higher renewable energy tender volumes, and rapid planning, approval, and objection practices. Procedures for planning and approving electricity transmission networks also need to be substantially accelerated, and geared toward long-term needs. Stimulating the construction of new (H₂-ready) gas-fired power plants will mean establishing a central capacity mechanism. A regulatory framework must also be created to digitize distribution grids, along with market-based incentives for more consumer flexibility. Irrespective of this, the accelerated phasing out of coal-fired power generation will significantly increase the transformation pressure on affected regions. Politicians should strive to provide a social cushion.⁹

Achieving zero emissions by 2045 can be further facilitated by accelerating the development and scaling of next-generation green technologies. In addition to technology-open fundamental research, Germany should focus its national innovation agenda on ramping up the most promising green technologies, including potential “game-changers.”



7

The rising costs of CO₂, energy, and materials will add financial burdens of about €15 to €23 billion for companies in 2030. Maintaining industrial competitiveness requires reliable compensation instruments for the most affected sectors.

A holistic climate and industrial policy must not only reduce emissions but also avoid unfair competitive disadvantages for German industry that may lead to a transfer of production (carbon leakage) or investment activity abroad (investment leakage). Both would generate higher foreign emissions and be harmful to the climate. To prevent this, new green plants must become internationally competitive, while old emitting plants must be protected from competition-critical burdens on the path to climate neutrality.

The government must actively support industrial sector transformation as described above. Companies with existing plants face additional costs of €15 to €23 billion in 2030 due to rising ETS, BEHG, electricity, and material prices, depending on the carbon price. These are particularly competition-critical for emission- and electricity-intensive industries. Targeted compensation instruments would limit competitive disadvantages for German industry and ensure companies have the capital they need for transformation.

To protect the ETS industry, the system of free allocation of allowances should be perpetuated and further developed until an effective alternative is available. Such an alternative could be an effectively designed EU Carbon Border Adjustment Mechanism (CBAM) in the future. This will require testing and refinement of the proposal currently under discussion. There should also be compensation for exports. Competitive disadvantages—in particular for processors of CO₂-intensive materials—should be prevented by extending a CBAM to other sectors and intermediates. Finally, the risk of misuse should be minimized by introducing a reliable carbon footprint certification method.

Companies in non-ETS industries can suffer intra-European competitive disadvantages due to carbon prices in the BEHG and need carbon leakage protection. The federal government should work toward extending the European New ETS to non-ETS industries or allow individual sectors to voluntarily switch to the ETS. Alter-

natively, robust carbon leakage protection in national emissions trading would become necessary in the long term. A carbon cost limit by way of a hardship fund as a proportion of gross value added would also be conceivable to avoid disproportionate burdens, and government subsidies for transmission grid charges could provide further relief.¹⁰

Electricity-intensive companies in industries such as aluminum, zinc, copper, and electrical steel face possible production cost increases of up to double-digit percentages—due to rising electricity costs as nuclear and coal-fired generation are phased out. Energy-intensive industries like aluminum and zinc are potentially among the hardest hit by the transformation. A partial remedy could be provided both by increasing planning security by combining existing exemptions into a single instrument (“supercap”) and by transferring electricity price compensation to direct electricity purchase agreements for renewable energies (power purchase agreements [PPAs]). Nevertheless, there remains a significant electricity price risk that cannot currently be addressed by instruments that comply with EU state aid law.

Also, the material cost risk for processors (e.g., foundries) is difficult to address at the affected companies directly. At least until an effective CBAM exists for such products as well, material cost risks should be tackled upstream (e.g., through support instruments for steel producers).

8

Implementing the climate protection measures will add an additional financial burden of €20 to €30 billion in 2030 for private households that do not (or cannot) switch to low-emission technologies. To ensure that the burden is shared fairly, social compensatory measures are necessary.

Effective climate regulation will also add noticeable financial burdens to private households. Those who are unwilling or unable to switch to green technologies are particularly affected, as they do not benefit from public support measures but nevertheless experience rising carbon and electricity prices. In 2030, private households that do not switch to green technologies would have to bear an additional burden of €20 to €30 billion, while private households that switch would be in a better financial position.

Private households with low incomes would be particularly affected by these additional financial burdens, as they spend a higher share of their income on electricity

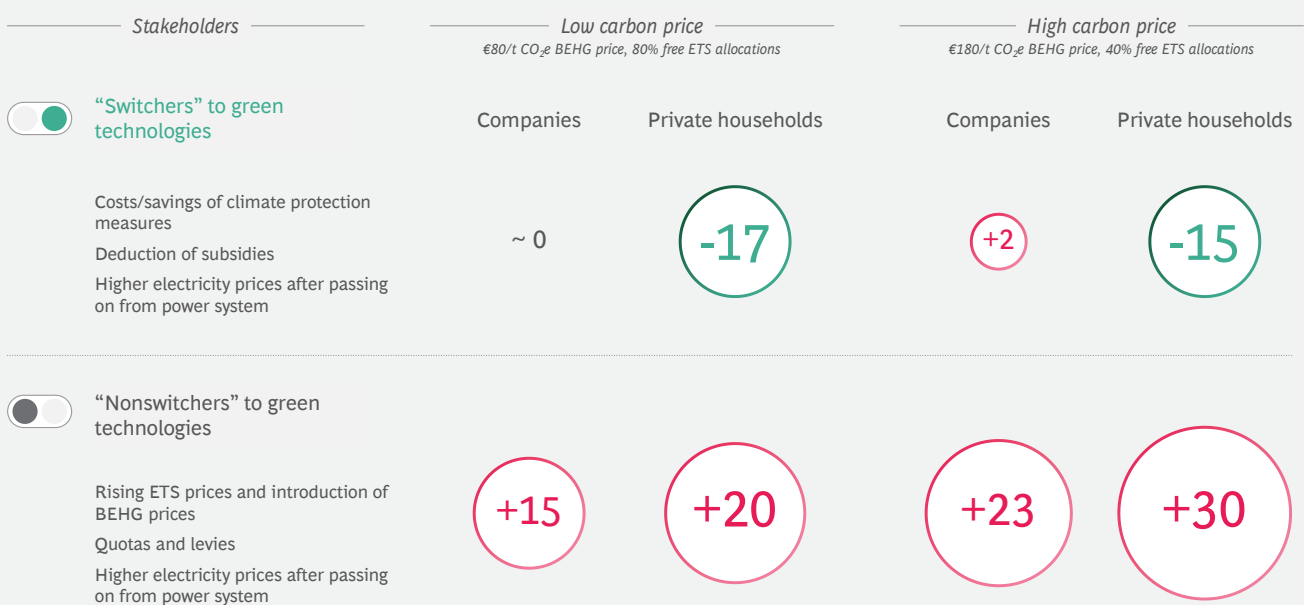
and heating (albeit a lower share on mobility). They face additional financial burdens amounting to 1.5 to 2.3 percent of their household income as a result of climate protection measures. On the contrary, private households with high incomes face additional financial burdens amounting to only 1.1 to 1.7 percent.

In the interest of fair burden sharing, additional financial burdens should be cushioned by social compensatory measures—for example, public cofinancing of grid expansion, elimination of the EEG levy, or an increase in low incomes inside and outside the basic security.

Climate program burdens users of nongreen technologies most

EXHIBIT 9 | Annual additional financial burden of the climate program for companies and private households in 2030

B€, in real terms 2019

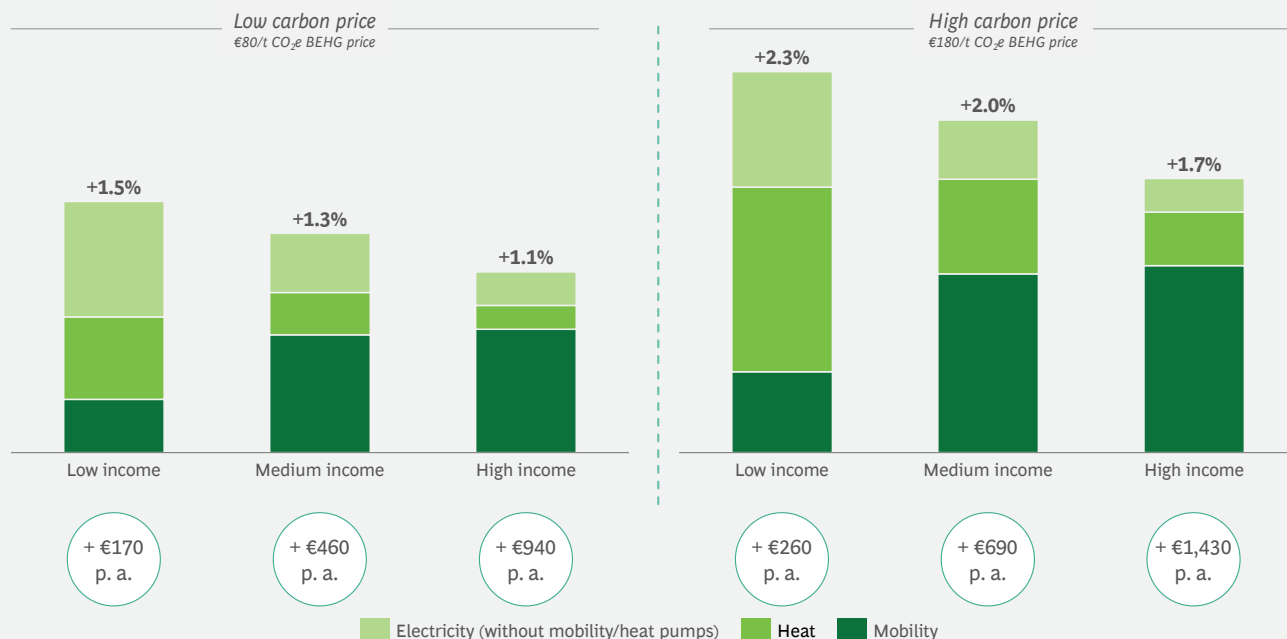


Note: Companies include industry, CTS, and freight transport in particular; net additional burden for "switching" companies shown here after offsetting €3 billion in freight transport savings
Source: BCG analysis

Additional burden on private households of up to 2.3%

EXHIBIT 10 | Additional financial burdens on “nonswitching” private households, 2030

% of net household income¹



1. Additional financial burdens for nonswitching private households (€20 billion at low carbon price, €30 billion at high carbon price) in each category (electricity/heat/mobility) distributed proportionally across all income groups according to current burden
 Note: Net household income classified as low (below €1,300/month), medium (€1,300–5,000/month), or high (over €5,000/month); annual additional burdens in real terms in 2019
 Source: Destatis (2020) *Wirtschaftsrechnungen*; BCG analysis

Public cofinancing of the expansion of the transmission grid is already laid down by law, analogous to § 24a section 2 of the Energy Industry Act (EnWG). This regulation would support the industrial sector and private households with around €1 billion each.

Eliminating the EEG levy—even beyond the exceptions for decarbonization technologies proposed in Climate Paths 2.0—would provide all income groups with a total of €6 billion in relief in 2030, depending on electricity consumption. There would also be broad relief for businesses and industrial companies in the amount of €14 billion. As well as alleviating financial burden, a blanket elimination for companies with exceptions would reduce the considerable regulatory risks and decrease bureaucracy by eliminating numerous reporting and notification obligations. Overall, it would foster widespread social acceptance of the energy transition. However, it risks reducing the incentive for efficiency investments.¹¹

Higher unemployment benefits, statutory social benefits, and pensions would provide targeted relief for the most burdened private households. In addition, people with low incomes outside the basic security system could be supported through hardship funds or a corre-

sponding increase in the statutory minimum wage. Supporting these groups with about €225 per year per capita would offer private households the same total amount of income relief as elimination of the EEG levy (€6 billion).

Higher carbon prices (e.g., €180 per ton in 2030 in the referenced study) will mean additional financial burdens for private households and companies that require a combination of the alleviation levers described above.¹²

If carbon prices remain low in contrast (e.g., €80 per ton in 2030 in the referenced study), targeted compensation for low-income populations appears to be sufficient. In addition to the measures mentioned in the previous section to maintain industrial competitiveness, the resulting burdens on companies in the event of low carbon prices could be addressed through government cofinancing of the transmission system and hardship funds.

In any case, social compensation should be carried out as gradually as possible, in line with the burdens actually arising from carbon pricing.

9

Government support for the transformation and balancing the shared burden for private households and companies will require additional annual public spending of €47 to €50 billion in 2030 and a total of €230 to €280 billion between 2021 and 2030. Spending will have to be financed through cuts to the federal budget, levies, taxes, or new debt.

The implementation of the outlined climate program will generate a financing requirement of around €47 to €50 billion for the public sector in 2030. The incentive scheme for the transport transition will account for approximately €20 billion; €15 to €17 billion are needed for support measures in buildings and €6 to €8 billion for industry. In addition, energy tax revenues will be reduced by around €9 billion. These burdens are offset by €16 to €34 billion in new revenue from carbon pricing, depending on the price level set. In turn, the need for relief will vary.¹³

The absolute level of fiscal burdens is comparatively independent of the carbon price. Although the public sector generates more revenue with higher carbon

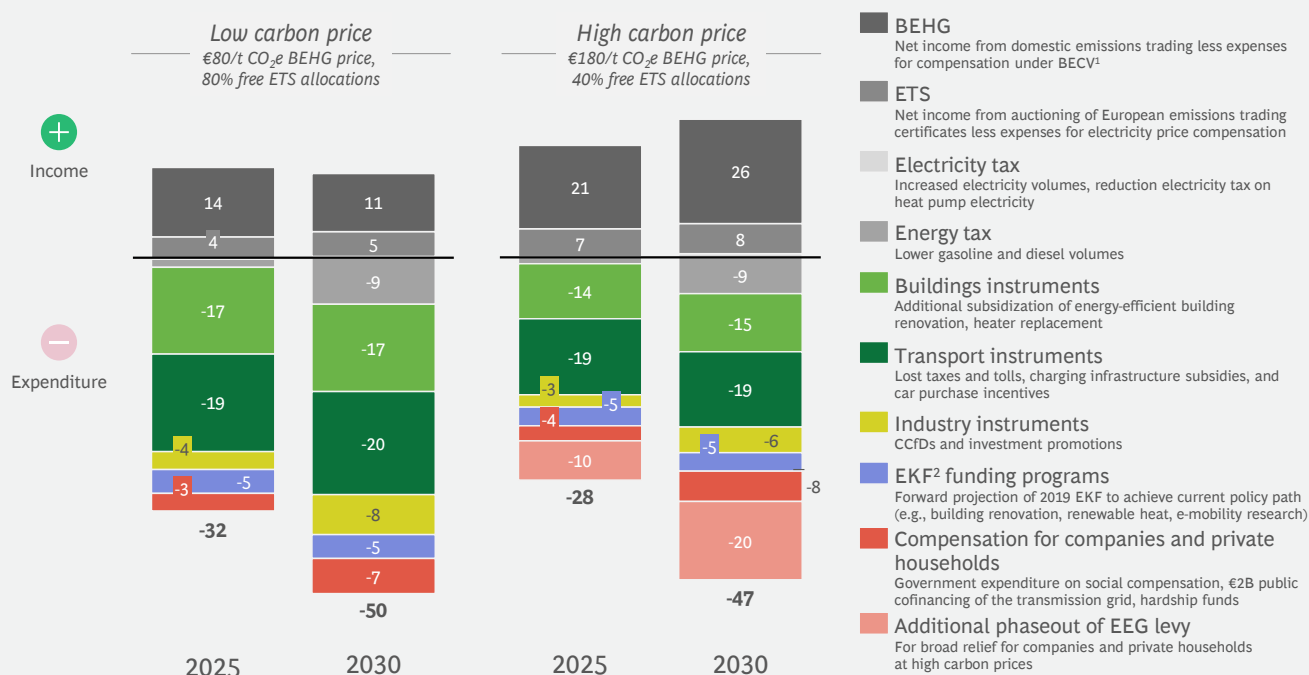
prices and pays fewer subsidies, it bears higher additional costs through alleviation measures. However, higher prices tend to relieve fiscal financing requirements.

Between 2021 and 2030, the cumulative net fiscal burden of the climate program is €230 to €280 billion, depending on the carbon price. This comprises cumulative expenditure of €330 to €370 billion to promote CO₂ measures and compensatory measures for private households and companies in the amount of €40 to €140 billion combined, offset by revenues of €130 to €240 billion from carbon pricing.

€47–50 billion fiscal burden in 2030

EXHIBIT 11 | Fiscal balance for climate protection in 2025 and 2030

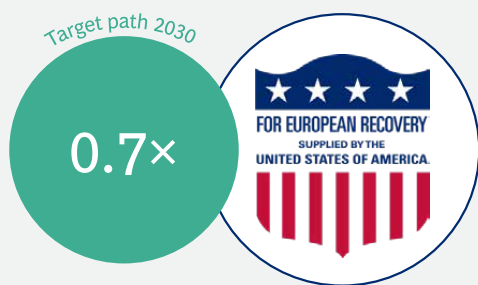
B€ in real terms 2019



1. BECV = BEHG Carbon Leakage Regulation 2. EKF = Energy and Climate Fund
Note: Carbon prices shown in nominal terms, calculated on a real basis, and VAT effects taken into account
Source: Federal Ministry of Finance (2020) *EKF-Bericht*; BCG analysis

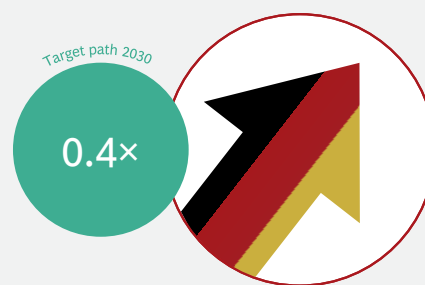
Spending on climate protection historic, but not without precedent

EXHIBIT 12 | Magnitude of annual government spending on climate protection



Marshall Plan 1948–1951

- For 2021–2030, the target path requires approx. €330B in cumulative government subsidies, **approx. 0.9% of GDP annually**
- The Marshall Plan provided cumulative investment aid of approx. €1.9B from 1948 to 1951, **approx. 1.3% of GDP annually at the time¹**



Reconstruction East 1990–2003

- Target path comprises approx. €470 billion in cumulative government subsidies and compensation for companies and private households² from 2021 to 2030, **approx. 1.3% of GDP annually**
- Reconstruction East comprised approx. €950B in cumulative net transfers 1990–2003, **approx. 3.6% of GDP annually at the time³**

1. The Marshall Plan paid the equivalent of €1.9 billion to Germany between 1948 and 1951, with an average German GDP of the equivalent of €50 billion at the time 2. Phaseout of the EEG levy by 2030 in line with a carbon price ramp-up to €180/t CO₂e 3. Reconstruction East = €250 billion reconstruction aid, €950 billion total net transfers between 1990 and 2003 with an average German GDP of €1.9 trillion at the time
Note: Target path 2030 shown at €180/t CO₂e (nominal) BEHG price (at €80/t CO₂e [nominal]: €370 billion government subsidies, €410 billion government subsidies and compensation), calculated on the real 2019 basis incl. the Energy and Climate Fund (EKF), avg. German GDP 2021–2030 €3.7 trillion
Source: Destatis (2021) *National accounts*; IWH (2004) *Press Release 27/2004*, KfW (2017) *70 Years Marshall Plan*; BCG analysis

A public spending program of this magnitude would be historic, but not without precedent. The public funding volume for climate protection amounting to about 0.9 percent of German GDP, for example, is in the order of magnitude of the Marshall Plan's reconstruction aid (€1.9 billion in annual investment aid between 1948 and 1951, approximately 1.3 percent of GDP at that time). The total expenditure on support and compensation amounting to about 1.3 percent of German GDP falls below that of the Reconstruction East program (€950 billion in net transfer payments between 1990 and 2003, annually about 3.6 percent of the GDP at that time).

These expenditures for climate protection must be counterfinanced in the budget. In principle, this can take the form reallocating the existing budget framework, new or higher taxation (e.g., VAT), new or higher levies (e.g., a consumption levy for steel- or plastic-intensive products), or new borrowing (e.g., a generational fund). Climate protection measures can only be counterfinanced within the individual sectors to a limited extent.

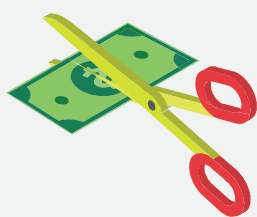
The possible emergence of a selection of different conceivable financing levers is shown in the figure on the next page as an example. Overall, there is no solution that is free of controversy. Therefore, a social debate on fair, sustainable, and acceptable burden sharing is necessary.



Four possible levers to finance the climate program

EXHIBIT 13 | Exemplary option space for financing fiscal burdens in 2030

Illustrative consideration of magnitude; examples do not constitute a recommendation



Savings

Example: Partial rededication of the federal budget in the amount of approx. 2% of the budget excluding Labor and Social Affairs¹ can free up approx. €5B in funding



Levies

Example: Climate levy on the final consumption of steel, cement, and plastic-intensive products of approx. 20% on 2019 commodity prices² can yield approx. €6B in funding



Taxes

Example: VAT increase by 1 percentage point to a 20% standard rate and 8% reduced tax rate with potential³ for approx. €12B in additional funding



Debt

Example: Intergenerational fund through annual new debt of approx. 0.5% of GDP⁴ can be used to finance approx. €20B

1. 2021 federal budget plan of €323B excl. Labor and Social Affairs and federal debt 2. For example, approx. €90/t steel on approx. 44 Mt steel in 2030, approx. €30/t cement on approx. 33 Mt cement in 2030, and approx. €180/t plastic packaging on approx. 5 Mt plastic packaging in 2030 3. Based on €183B in VAT revenue in 2019 4. Based on approx. €3.9T GDP in 2030. For comparison: Germany's new debt in 2020 amounted to €92B with the balanced-budget provisions, plus €184B in COVID-related new debt
Note: Figures in € in real terms 2019

Source: Federal Ministry of Finance (2020) 2021 Federal Budget Plan; Destatis (2021) Statistics Turnover Tax; IWD (2021) Corona-Verschuldung ist tragbar; BCG analysis

10

Germany's national endeavor can only have a major impact on global climate change if it brings international followers and partners on board. This is all the more reason for Germany to strongly endorse a European and internationally coordinated climate policy. In addition, Germany should work toward a significantly more open setup of EU state aid law, thus enabling government support for climate transformation.

Successful climate protection demands intensive effort on a global level. On the one hand, Germany can have a positive multiplier effect if it achieves an economically successful transformation into a climate-neutral industrial country. On the other, negative economic effects would not only endanger acceptance and feasibility in Germany but could also act as a deterrent for other countries.

The greater the international consensus and comparability of political climate protection instruments in other—especially G20—countries, the lower the risk to Germany of ambitious action having negative economic effects. A global climate protection consensus would also increase the export opportunities of German companies for efficient and climate-neutral technologies while reducing the need for fiscally burdensome compensatory measures.

To reduce the economic risks of an ambitious national climate policy, a German “climate foreign policy” should therefore focus on fostering globally coordinated efforts and supporting potential followers internationally. The concept of a “climate club” outlined by the federal government with high, voluntary minimum ambition levels and coordinated regulation should therefore be pursued consistently and as broadly as possible—with the medium-term goal of comparable ambitions and carbon price signals from at least the largest G20 emitters. This would also increase export opportunities for German companies in green technologies.

At the same time, European climate governance—the integration and coordination of all relevant actors—should be further strengthened. The new European climate target requires a significant increase in climate protection ambitions outside Germany as well.

On the one hand, targets in the European “effort-sharing” mechanism must tend toward alignment. On the other hand, an expansion of European coordination is required. To avoid long-term national governance and the associated risk of distortions within the EU internal market, instruments at the European level should be strengthened where possible. For example, the unilateral burden on non-ETS companies in the BEHG carries the risk of competitive distortions within Europe. To avoid this, either the New ETS should be extended to as yet non-ETS industries, or other sectors should be transferred to the ETS. Distortions caused by a national carbon price in other sectors should also be kept as low as possible. The carbon price path in the New ETS should therefore be designed as ambitiously as possible—ideally analogous to the envisaged German BEHG price path.

The prerequisite for many of the measures defined in the program is to ensure the compatibility of EU state aid law with key national climate protection instruments; for example, the immediate exemption of electricity-based applications for heat generation from the EEG levy, compensatory measures to maintain industrial competitiveness, or climate protection contracts for process industries. Germany should advocate at the European level for a design of EU state aid law that enables public support of investments and operation of climate protection technologies during the transformation, and secures necessary relief from related additional costs.

11

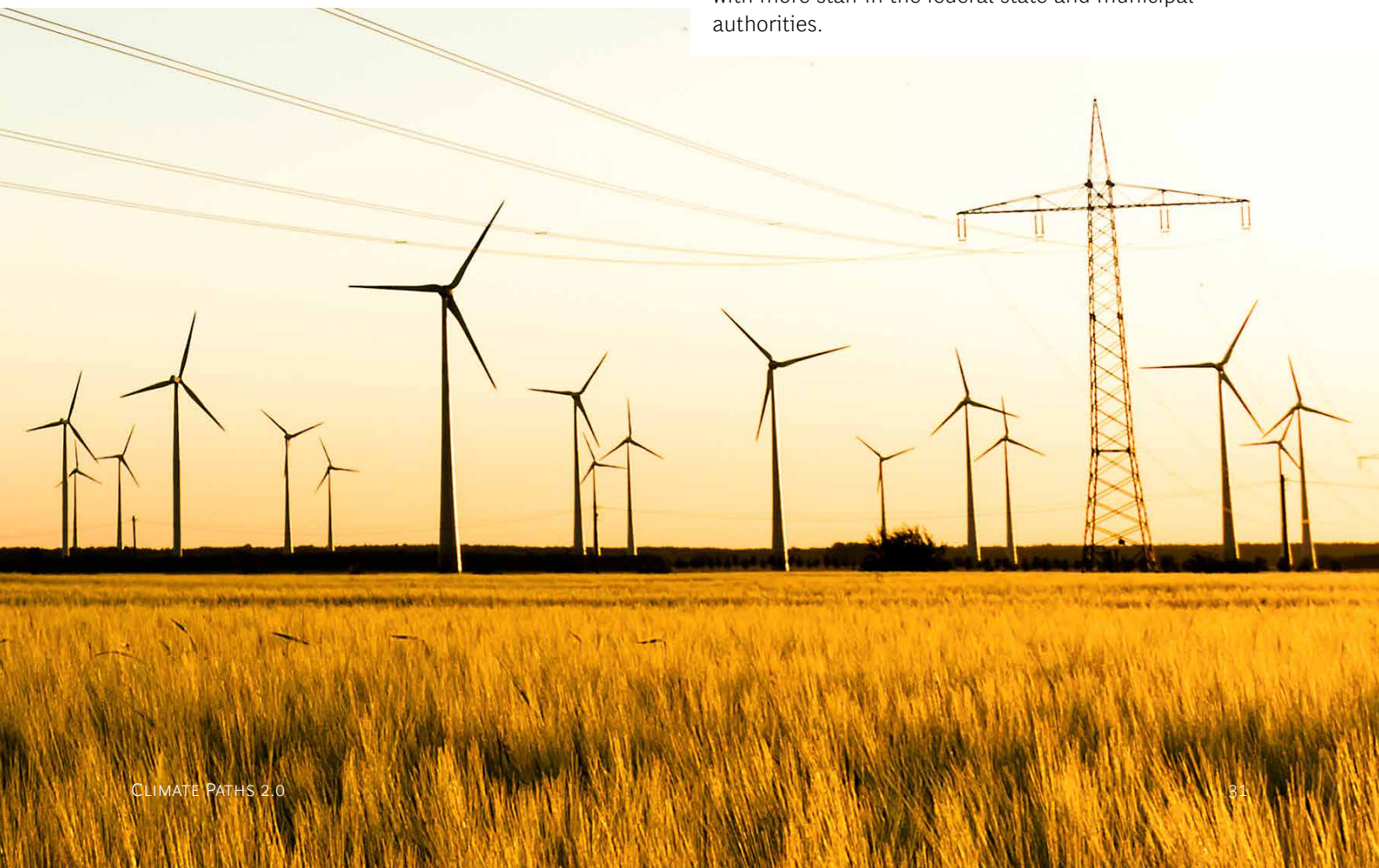
The next government must set the course on climate quickly. Germany needs both more effective and better coordinated political governance at the federal and state level and a substantial acceleration of planning and approval procedures.

As of now, achieving the legally set climate target requires numerous coordinated measures that will affect all areas of our society and economy. To this end, political and administrative structures at the federal and state level must be given more authority to act and become more efficiently interlinked with European processes and institutions.

Rapidly implementing of the large number of upcoming legislative projects requires efficient decision-making structures within the federal government. Coordination is currently being performed by the Climate Cabinet, which is fragmented with seven ministers involved. It will be essential to coordinate important responsibilities more strongly. Climate protection should become a top priority; for example, through binding requirements within the framework of the Federal Chancellery's central policy competence.

Permanent monitoring of leading indicators such as the renovation rate or the expansion of renewable energies would allow for significantly earlier countermeasures in the event of undesirable developments than the current ex post assessment of the previous year's emissions.

The implementation of many measures will have to accelerate dramatically. In this decade, significant investments must be made in energy infrastructures, renewable power generation, gas-fired power plants, rail networks, and industrial plants, for example. This requires far-reaching regulatory streamlining as well as the shortening and acceleration of the planning and approval procedures, including the legal protection procedures. At the administrative level, too, competences should be merged much more closely, and greater centralization of responsibilities should be sought. More standardized and digital processes are needed, along with more staff in the federal state and municipal authorities.



12

Achieving Germany's legal climate target is a massive undertaking for society at large, which requires an immediate course correction already in the first months of the new legislative period. At the same time, successful implementation of the comprehensive modernization program described here offers a historic opportunity for Germany to transform into a climate-neutral industrial country, and to make an ambitious contribution toward limiting the effects of climate change, thereby securing the prosperity of this and future generations.

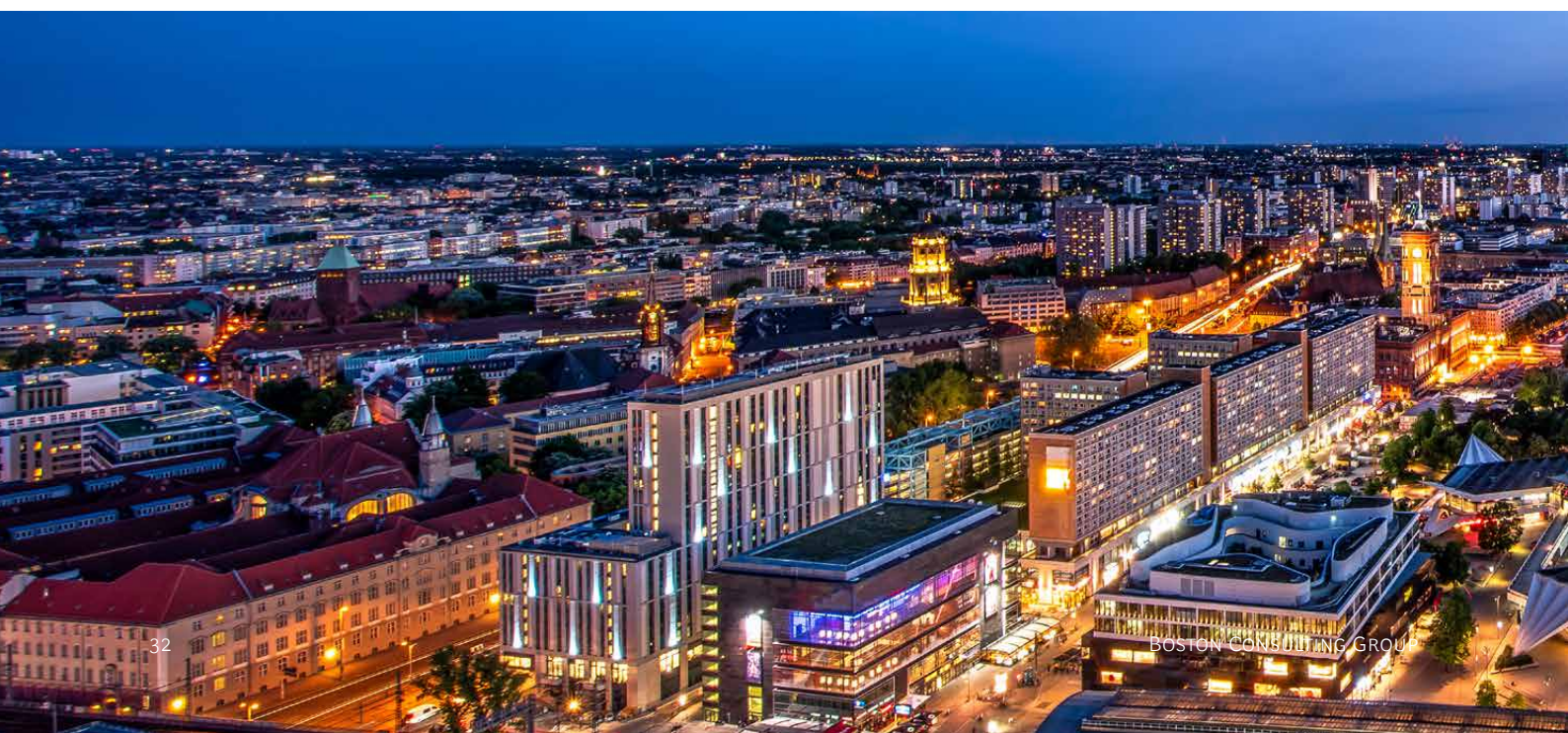
Germany is facing one of the greatest transformation projects in its post-war history. To this end, political decision-makers must set the decisive course over the next four years.

Fewer than nine years remain until 2030—many measures must therefore be developed and implemented extremely quickly. For this reason, the next federal government should launch a comprehensive climate program containing the most important regulatory measures within its first few months in office, significantly strengthening incentives for climate-neutral investments in all sectors.

The upcoming change process will span more than two decades. The scope, duration, and speed, as well as the fair distribution of the costs and burdens of this transformation require broad and lasting social legitimacy—this must be created across legislative periods and changing majorities in the Bundestag and Bundesrat. A broad consensus should be sought across legislative periods for central social trade-offs such as the distribution of burden between current social groups and future generations or the acceleration of necessary infrastructure development.

At the same time, Germany's transformation will generate new sources of future economic growth, which will require a historic modernization and infrastructure program. Dependence on energy imports is declining significantly, and German exporters can leverage demand for climate protection technologies in rapidly growing global markets.

More than anything else, Germany therefore needs a positive vision for the future. A successfully implemented climate turnaround represents a historic opportunity for Germany. It offers a chance to renew our economy, infrastructure, and industrial base—and thus the foundation for a successful, climate-neutral industrial country in the 21st century. By doing so, Germany will make an ambitious contribution to global climate protection, while at the same time laying the foundation for the future prosperity of the current and future generations.



Footnotes

1. The current policy path shows the development of GHG emissions, taking current conditions and existing efforts into consideration. Building on the current policy path, the target path demonstrates technical climate protection measures. Based on today's perspective, these measures would enable Germany to achieve the mandated climate targets in a cost-effective and technologically feasible manner.

2. The study "*Climate Paths 2.0: A Program for Climate and Germany's Future Development*" defines both additional financial burden and additional costs as annually recurring variables. Generally, these expenditures arise in every single year. Due to the focus of Climate Paths 2.0, the year 2030 is explicitly emphasized in this summary of findings. See "Classification of different cost perspectives" for additional information.

3. In addition to the technology path demonstrated, it is also possible to achieve the sector target with other technology combinations. With a green fuel quota of 30 percent, a stock of around 11 million battery-electric vehicles would suffice to achieve the target in 2030. A complete abandonment of additional green fuels would require either a premature, additional replacement of around 2 million combustion vehicles or restrictions amounting to more than five percent of traffic volume performed by the entirety Germany's combustion vehicles.

4. The current policy path does not include any effects of measures included in the "Fit for 55" package. At the time the study was prepared (October 2021), the package was still under negotiation by the European Commission, European Parliament, and Council of Europe.

5. Additional costs in the energy sector are passed on through electricity prices and are therefore included in the additional costs of the sectors discussed.

6. The free allocation system should be reformed so that companies retain their allowances when transforming processes to green solutions such as DRI steel or green hydrogen. This would provide higher incentives for technology change, especially in the basic materials industry, without simultaneously increasing economic risks.

7. In the building and industry sectors, electricity for heat pumps and power-to-heat applications as well as green fuels should be reduced to the EU minimum tax rates, while fossil fuels should be taxed according to existing regulations. In transport, fossil fuels should be harmonized with the current tax rate for gasoline, and electricity and green fuels with the current electricity tax rate.

8. Through higher energy taxes and carbon prices.

9. For example, with the concept of a "target grid 2045."

10. Through the BEHG Carbon Leakage Regulation (BECV).

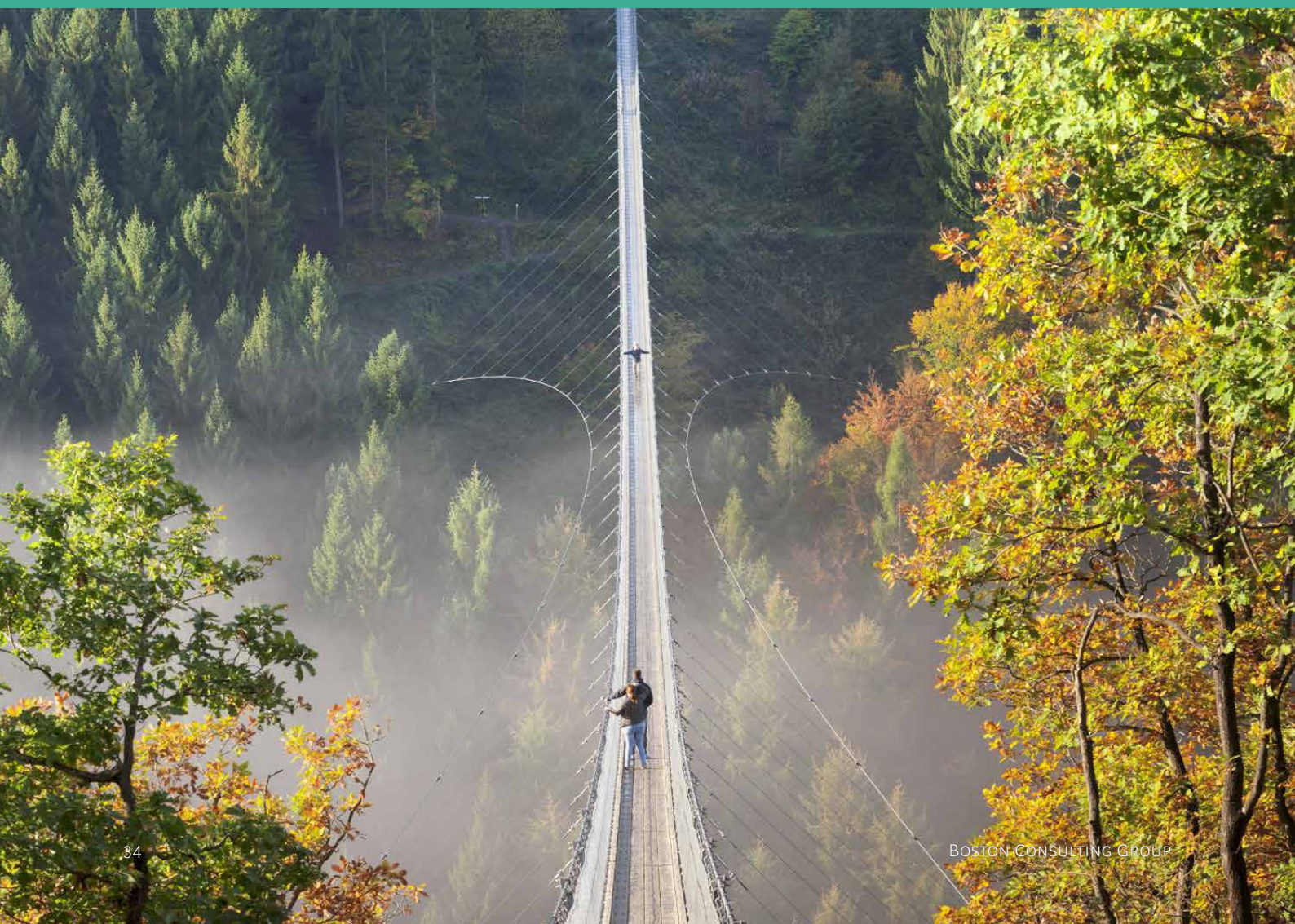
11. The remittance of an annual climate premium of €85 per capita would bring about very similar relief in private households as the full elimination of the EEG levy—without benefiting industrial and commercial companies at the same time. However, this would require the establishment of new administrative processes.

12. Relief could also be provided by introducing a mobility allowance, replacing the current commuting allowance. By doing so, commuters could be relieved of increased carbon costs for fuel. The mobility allowance would be deducted directly from the tax burden and thus provide equal relief for all recipients, regardless of their marginal tax rate. However, private households without employed people would not benefit.

13. Mainly due to subsidies for charging infrastructure and alternative powertrains, as well as revenue losses from tolls and taxes for vehicles.



Appendix: Overview of Key Levers and Policy Instruments





CLIMATE TARGETS

According to the Federal Climate Change Act of 2021, total emissions in Germany in 2030 must be 65 percent lower compared to 1990. This means a reduction to 438 Mt CO₂e, corresponding to a 46 percent reduction compared to 2019.

Achieving these targets requires a broad range of technical measures and policy instruments in the individual sectors. However, there are also central instruments that contribute across sectors. These overarching instruments are summarized here.

MAKE THE USE OF FOSSIL FUELS LESS ATTRACTIVE

Incentives in the EU ETS: The system of free allocations should be reformed to allow companies to retain their certificates if they convert their processes to green solutions such as DRI steel or green hydrogen. In parallel, the current system of free allocations should be maintained until an effective alternative protection against carbon leakage is available.

Carbon pricing in non-ETS sectors: Prioritizing carbon pricing over other instruments requires a political balancing of interests. This study therefore expects a range of €80 to €180 per ton of CO₂ (nominal) in non-ETS sectors for 2030. This pricing can be achieved through the existing BEHG, the energy tax or, partially, the proposed EU-wide New ETS.

Energy tax reform: In line with the latest European “Fit for 55” proposal of July 2021, the energy tax should be reformed, harmonizing tax rates by energy content and allowing a differentiation between sustainable energy carriers such as electricity, e-fuels, and biofuels on the one hand and fossil fuels on the other. In the building and industry sectors, electricity for heat pumps and power-to-heat applications, as well as green fuels, should be reduced to the EU minimum tax rates. Fossil fuels should be taxed in accordance with existing rules. In the transport sector, fossil fuels should be aligned with the current energy tax rate for gasoline. Electricity and green fuels should be aligned with the current electricity tax rate.

INCENTIVIZE SWITCH TO ELECTRICITY

Electricity price reform: Electricity prices should be lowered for renewable heat applications in the industry and building sectors, especially for heat pumps and power-to-heat. This includes, for example, a reduction of EEG and CHP levies as well as fees and grid charges.

NATIONAL INFRASTRUCTURE PROGRAM

Expansion of the existing energy infrastructure: Planning and approval procedures for electricity transmission grids need to be significantly accelerated to integrate the growing demand for electricity and high shares of renewable generation. The expansion of district heating also requires massive investments.

Development of new energy infrastructure: Integrated planning and rapid conversion/development of natural gas, hydrogen, and CO₂ networks are necessary to ensure a sufficient hydrogen supply by 2030, especially in the industry sector, along with options to remove captured CO₂. Based on the proposal by European gas network operators of a “European hydrogen backbone,” a largely optimized grid expansion plan should be implemented gradually but quickly in consultation with the industry sector and electricity grid operators.

Expansion and development of transport infrastructure: A rapid ramp-up of e-mobility will require the coordinated investment in a comprehensive national charging infrastructure (see also “charging and H2 infrastructure” as a core instrument in the transport sector). To support the growing rail transport usage, the rail network needs to be expanded accordingly (for example, new construction and expansion measures, expansion of neuralgic railway nodes, and expansion of access points to the rail network).

NATIONAL BIOMASS STRATEGY

To ensure a system-serving distribution of the limited resource of biomass, a strategy is needed leveraging the potential for cascaded use while also prioritizing the redistribution into large-scale industrial and district heat plants with potential future use of BECCUS to generate negative emissions. In order to achieve this, biomass from current applications in electricity generation, pellet heating, and biofuel production must be diverted primarily to the industry sector and district heating. This requires a phaseout of corresponding subsidies (e.g., EEG funding, and CAPEX support of biomass in new buildings.).



CLIMATE TARGETS

To achieve its target, the industry sector would have to realize a reduction to 118 Mt CO₂e in 2030, meaning a reduction by about 37 percent compared to 2019. Compared to the development since 2000, the industry sector must increase its annual GHG reduction sixfold by then. The industry sector can only achieve GHG neutrality in 2045 through negative emissions.

KEY LEVERS

Decarbonization of industrial heat

With every reinvestment in new plants, the entire industrial (process) heat production must be converted to renewable energies where possible. This includes electrification of high- and medium-temperature applications (+67 TWh in 2030), use of biomass mainly in medium temperature (+23 TWh in 2030), and green gases especially in high temperature (+40 TWh in 2030), as well as district heating and heat pumps at low temperature.

Process conversion in steel, basic chemicals, cement, and lime

To reduce process and energy emissions in the industry sector, massive process changes are required in the branches with the highest emissions: In steel production, one-third of the blast furnaces must be replaced by plants for direct reduced iron by as soon as 2030. In basic chemicals, ammonia and methanol production must be converted to green hydrogen, fossil steam crackers must be electrified, and, in perspective, all fossil raw materials must be replaced with synthetic or biogenic alternatives. In parallel, the cement and lime industry must build carbon capture, utilization, and storage (CCUS) facilities to capture carbon emissions from clinker burning and lime production.

Efficiency improvements in cross-sectional technologies

The efficiency potential in the industry sector must be further exploited by using the "best technologies available" in cross-sectional technologies such as drives, pumps, motors, and process automation technology wherever they can be used—if possible, at every reinvestment.

ADDITIONAL INVESTMENTS AND COSTS

Total investments of around €50 billion will be needed for climate protection measures in the industry sector until 2030. Investments are driven primarily by efficiency technologies, financing of hydrogen and PtX plants, and process changes; for example, to restructure the steel industry.

The additional cost gap to be closed through new policy regulation will amount to around €11 billion in 2030, largely due to high electricity prices as a result of the conversion to renewable industrial process heat (€5 billion).

OVERARCHING INSTRUMENTS

Carbon pricing of fossil fuels through ETS and BEHG or support of the New ETS price through the energy tax

Electricity price reform: Reduction of electricity prices for renewable heating technologies such as power-to-heat and heat pumps

Development of hydrogen and carbon transport infrastructures: Integrated planning approach to ensure supply for critical consumers

National biomass strategy: Development of a strategy for sustainable production and highly efficient use of biomass

CORE INSTRUMENTS

Carbon contracts for difference (CCfDs)

Carbon contracts for difference offset the additional costs of carbon-neutral alternatives compared to conventional fossil technologies, which are protected against carbon leakage. This study proposes selected product CCfDs during ramp-up, along with energy carrier CCfDs. In the case of the former, the cost difference in the end product, including specific investment costs, is considered and compensated for—these are introduced mainly in the steel, basic chemicals, cement, and lime industries to incentivize the ramp-up of the required process technologies. In the case of the latter, the cost difference between different energy carriers used is compensated—these are introduced for all renewable energy carriers across industries. This will require funding of approximately €6 billion in 2030. In the long term, these systems should be combined.

Investment support

Depending on the industry and process, existing fossil fuel plants for heat generation will have to be replaced with power-to-heat, biomass, and hydrogen technologies by 2045. In addition, investments will be needed in pilot plants for new production processes under development. To this end, subsidies for investments in plants powered by renewable energies amounting to 40 percent of the investment value should be granted.

Efficiency standards and subsidies

Standards for the efficient combination of cross-sectional technologies and steering should be based on the existing European Ecodesign Directive, considering the entire application. In addition, support for efficiencies should be adapted to incentivize highly efficient technologies with accelerated depreciation.

Green lead markets

In order to create secured markets for sustainably produced end products and thus for green raw materials (especially in cement and steel), final producers in selected sectors should be required to source raw materials from green production in order to be able to sell their products within the EU. Climate Paths 2.0 envisions the public sector as a pioneer in this regard.

ADDITIONAL INSTRUMENTS

- Definition of green raw materials
- Innovation and research funding
- Reform of building standards
- Higher rates of recycling and use of recycled materials for plastics
- Increase in recyclable material volume

COMPENSATORY INSTRUMENTS

- Continuation of the existing electricity price exemptions and electricity price compensation
- Government transmission grid subsidy
- Hardship fund (limitation of additional burdens to a, to be further defined, proportion of gross value added)
- (Partial) elimination of EEG levy depending on carbon prices
- Extension of the New ETS to BEHG industries to avoid distortions of competition within Europe—option: possibility of individual industries joining ETS



CLIMATE TARGETS

To reach its target, emissions from national transport may amount to a maximum of 85 Mt CO₂e in 2030. Compared to 2019 (164 Mt CO₂e), this represents a reduction by 48 percent—after an on average stagnating development since 1990. The transport sector must achieve greenhouse gas-neutrality by 2045.

KEY LEVERS

Modal shift

By 2030, the rail transport performance will have to increase by 30 percent in passenger and 40 percent in freight transport (compared to 2019). Overall, 4 percent of motorized private transport, 4 percent of road freight transport, and 20 percent of national air traffic must be shifted to rail, inland waterway, bus, and nonmotorized transport. Across all transport modes, passenger transport performance will stagnate; in freight transport, it will increase by 17 percent.

Drive change in road traffic

By 2030, alternative car powertrains will have to account for nearly all new registrations (in the target path: 90 percent battery-powered cars), leading to 14 million battery-powered cars in stock in 2030 in the target path. The share of electric and hydrogen-powered trucks in new registrations must be increased (in the target path: 75 percent in 2030).

Expansion of infrastructure for e-mobility and hydrogen

The transport sector needs a massive infrastructure expansion to 9 million private charging points, 5 million charging points at employers, and 1 million additional, publicly accessible charging points, as well as 0.2 million fast charging points, and 500 hydrogen filling stations.

Green fuels

In 2030, a green fuel quota of 22 percent must be achieved in the transport sector, including biofuels, synthetic fuels (PtL), and hydrogen. These include imports of 3 Mt of synthetic fuels in 2030 for nonelectrified national transport; in addition, 0.3 Mt are required for international air and sea transport.

ADDITIONAL INVESTMENTS AND COSTS

By 2030, a total of €220 billion will need to be invested in climate measures in the transport sector. The largest items are the charging and hydrogen infrastructure (approx. €75 billion), a widespread switch to cars and trucks with alternative powertrains (approx. €70 billion), and the construction of PtX plants abroad (approx. €40 billion).

The additional cost gap to be closed through new regulations will amount to around €13 billion in 2030, primarily to develop charging infrastructure, financing of PtL imports, and additional acquisition costs for vehicles with alternative powertrains.

OVERARCHING INSTRUMENTS

Carbon pricing of fossil fuels through ETS and BEHG or support of the New ETS price through the energy tax

Harmonization of energy tax: Taxation of green hydrogen and green synthetic fuels such as electricity, taxation of biofuels based on their sustainability level, and phaseout of the different tax treatment of gasoline and diesel fuel

CORE INSTRUMENTS

Charging and H₂ infrastructure

In order to expand the charging infrastructure as early and large-scale as possible to bridge noneconomic operating phases, appropriate investment support should be provided, amounting to around €4 billion funding requirement in 2025 and €2 billion in 2030.

Purchase incentives for battery and H₂ cars

Purchase incentives to partially remove the acquisition cost disadvantage of cars with alternative drive systems should be extended beyond 2025 but gradually reduced. The purchase premium amounts to about €12 billion in funding in 2025 and approx. €2–3 billion in 2030. The vehicle tax and company car tax reductions should be maintained.

Powertrain-oriented, carbon-based truck toll

The agreed-upon toll exemption for electric and fuel cell-powered trucks should be extended, while at the same time the toll should be expanded to all trucks over 3.5 tons. In anticipation of the revision of the Eurovignette Directive, the toll should generally be based on the carbon emissions of the powertrain type. In the longer term, the toll advantages should be gradually reduced in line with the market ramp-up and full-cost development of alternative trucks as compared to combustion trucks.

PtX quotas and auctions

From 2025 on, a mandatory progressive PtX quota should be introduced for fuel distributors with a target value of 10 percent in 2030 (nationally). The PtX market ramp-up should be supported by a double-auction mechanism that concludes offtake agreements with PtX manufacturers and resale agreements with customers through a public intermediary. The cost risk for the public sector could be avoided, such as through a levy on fuel customers.

ADDITIONAL INSTRUMENTS

- Information campaigns on subsidies and advantages of alternative powertrains
- Construction standards for e-mobility
- Digital register for charging stations
- Design of the vehicle tax for commercial vehicles as an incentive to switch to alternative drive systems in case of insufficient progress
- Definition of PtX sustainability standards
- Partnerships with PtL export countries
- Acceleration of rail infrastructure measures
- Expansion of overhead line infrastructure as part of the overall concept of “climate-friendly commercial vehicles”
- Aviation research funding



CLIMATE TARGETS

To reach its target, emissions from the building sector may amount to a maximum of 67 Mt CO₂e in 2030. Compared to 2019 (123 Mt CO₂e), this represents a reduction of 46 percent. Compared to its current development, the sector needs to double its annual GHG reductions.

In 2045, the building sector must achieve greenhouse-gas neutrality.

KEY LEVERS

Emission-free new buildings

Effective immediately, fossil fuels should no longer be used in new buildings.

More energy-efficient building renovation

The average annual renovation rate will increase significantly across all building classes, from 1.1 percent in 2019 to 1.9 percent by 2030, with simultaneous extension of the depth of renovation. In 2030, a residential building that has been energy-efficiently renovated across all trades will have an average energy consumption for space heating and hot water of approx. 70 kWh/(m² a).

Acceleration of the heat transition

By 2030, there will be a total of 6 million heat pumps (+5 million compared to 2019) and over 2 million district heating connections (+1 million compared to 2019). Wherever possible from 2023 on, any renovation investment in existing buildings must be made in locally completely carbon-neutral heating solutions.

Carbon-neutral devices and processes

Efficiency improvements and electrification should ideally be implemented already in this decade with every reinvestment for a wide range of uses in devices and processes in private households and in the commerce, trade, services segment (e.g., cooking, baking, drying, and commercial special transport).

ADDITIONAL INVESTMENTS AND COSTS

By 2030, total investments of around €175 billion will be needed in climate protection measures in the building sector. The largest item is accounted for by more extensive energy-efficient refurbishment (€80 billion). Renewable heat solutions account for €67 billion, decarbonization of equipment and processes for €27 billion.

The additional cost gap to be closed through new regulations will amount to around €9 billion in 2030, primarily for the transition to renewable heating solutions. In addition, an investment gap needs to be filled particularly in energy-efficient renovations.

OVERARCHING INSTRUMENTS

Carbon pricing for fossil fuels through BEHG, or support of a New ETS price through the energy tax

Electricity price reform: Reduction of levies on heat applications (such as the EEG levy)—resulting heat pump electricity price: approx. €170/MWh in 2030

National biomass strategy: Development of a strategy for the sustainable generation and highly efficient use of biomass, including in district heating

CORE INSTRUMENTS

Energy demand targets and duty to prepare renovation schedules

Building-specific primary energy demand targets should be introduced, and space heating and hot water demand targets identified, coupled with a tiered obligation to prepare renovation schedules between 2023 and 2028 (starting with the buildings most in need of renovation). In parallel, the CO₂e sector targets should be regularly reviewed under an innovation clause, and, if targets are not met, an announced, tiered obligation to meet the primary energy demand targets within 10 years should be enforced as a last resort, combined with additional support offers.

Infrastructure planning in municipalities

A systemic and economically efficient plan for heating and infrastructure networks should be introduced, based on a survey of demand in independent cities and districts with building-specific definition of energy carriers. The duty to prepare a plan can be tiered, prioritizing of urban areas. The CO₂e sector targets should be regularly reviewed under an innovation clause and, if targets are not met, potential event-related rules (e.g., when replacing a gas boiler) for heating in accordance with the heat plan should be set as a last resort.

Modular building subsidies

Existing subsidies should be connected and expanded to encourage faster, more comprehensive renovation and energy carrier changes, including a combined bonus for multiple renovation measures, an early-bird premium for an energy conversion before 2030, a bonus for complex measures, and access to financing through earmarked, quickly accessible KfW loans. The promotion of energy solutions (e.g., H₂ boilers) should be tied to availability as mapped in the municipal infrastructure plans or to demonstrably completely locally carbon-neutral operation from installation on. A total of around €15–17 billion in funding will be needed in 2030, around €13–15 billion more than in 2019.

Renewable energy requirement in new construction

At the latest starting in 2025, only completely locally carbon-neutral heating solutions should be permitted in new buildings (heat pumps and district heating; in oil and gas boilers or similar, proof that only carbon-neutral fuels were used from installation on).

ADDITIONAL INSTRUMENTS

- Promotion of skilled workers: appraisers, planners, craftsmen
- Innovation support: serial retrofitting (e.g., “Energiesprong”)
- Information campaigns for energy-efficient renovation
- Ability to pass BEHG levy on to the tenant depending on the energy-efficient condition of the building
- Standards to ensure the reusability and resource efficiency of building materials
- Formulation of standards and quality criteria for building automation (e.g., interoperability, and technical flexibility)
- Reform of the Heat Supply Regulation: consideration of rising carbon prices for fossil solutions in a cost comparison before switching to heat supply



CLIMATE TARGETS

To reach its climate target, emissions from the energy sector (primarily electricity, district heating, and refineries) may amount to a maximum of 108 Mt CO₂e in 2030. Compared to 2019 (at 258 Mt CO₂e), this represents a reduction by 58 percent. In 2045, the energy sector must also achieve at least greenhouse-gas neutrality.

At the same time, the energy sector is facing a historic development project: Due to decarbonization in other sectors, electricity demand will increase by a total of more than 40 percent by 2030.

KEY LEVERS

Expansion of renewable power generation

In order to meet the increasing demand for electricity while simultaneously transitioning to renewable electricity, the current renewable generation capacity will have to be doubled by 2030. The target path provides for 140 GW of solar PV, 98 GW of onshore wind, and 28 GW of offshore wind to serve an increase in net electricity demand to 722 TWh while meeting the emissions budget (2019: 507 TWh).

Grid expansion at all voltage levels

The integration of these renewable energies (especially offshore wind), the connection of large new consumers (e.g., electrolyzers, industrial power-to-heat, electromobility) and the electricity transmission with as little congestion as possible will require an enormous expansion of the grid.

In doing so, the ambitious scenario of the current grid development plan (NEP) must be slightly exceeded by 2035 and accelerated to as early as 2030. At the same time, the distribution grids must be significantly expanded and digitized, and demand-side response must be incentivized within technical and economic limits, so that electricity consumers, such as battery-powered vehicles or heat pumps, receive price signals for flexible operation that best support the electricity system.

Expansion of thermal capacity to ensure security of supply

To achieve the climate target with the assumed electricity demand, coal-fired power generation will be phased out by 2030 under the assumptions of Climate Paths 2.0. In order for these capacities to be taken off the grid, more than 40 GW of gas-fired power plants would have to be added by 2030 to ensure security of supply (especially in times of little wind and sun)—otherwise, coal-fired power plant capacity will continue to be needed. This represents the most ambitious expansion of thermal capacity to have ever taken place in Germany over such a period.

Development of hydrogen and CO₂ transport infrastructures

In order for hydrogen to be used as a new climate-friendly energy carrier in all sectors, a dedicated hydrogen infrastructure will have to be built up, linking centralized production on the northern coasts and later imports, especially from the south, with major consumers (especially steel, basic chemicals, and later energy). A CO₂ pipeline construction/repurposing will also be needed in Germany for the required use of carbon capture and storage (unavoidable process emissions, negative emissions).

ADDITIONAL INVESTMENTS

By 2030, total investments of around €415 billion will be needed for climate protection measures in the energy sector. The largest investments will be in the expansion of the electricity, hydrogen, and CO₂ grids at €155 billion, and in the expansion of renewable generation capacities (€67 billion for photovoltaics, €63 billion for onshore wind, and €40 billion for offshore wind). While maintaining the levy system from the base year 2019, this leads to retail prices for private households rising to 36 cents/kWh, an increase of 6 cents/kWh compared to 2019 (+4 cents/kWh compared to 2021).

OVERARCHING INSTRUMENTS

Carbon pricing of fossil fuels through ETS and BEHG or support of the New ETS price through the energy tax

Development of hydrogen and CO₂ transport infrastructures: An integrated planning approach to ensure supply for critical consumers and financing of the necessary ramp-up until 2030 through existing grid fees (H₂) or public prepayment (CO₂)

CORE INSTRUMENTS

Renewable energy expansion offensive

In order to stimulate a faster expansion of renewable electricity generation capacity, auction volumes and compensation for renewable energies should be adjusted accordingly. Mandatory nationwide land use-quotas and bilateral contracts for difference for wind and photovoltaics, along with significantly accelerated planning, approval, and objection processes, should ensure that the expansion targets are achieved.

Accelerated grid expansion

This includes focusing the depth of review, setting tighter deadlines, using fictitious approvals, and building up new official capacities; for example, through a special panel at the Federal Administrative Court. The expansion required in the long term should be envisaged in advance through the perspective of a “target grid” and can also be relieved by making better use of existing lines.

Flexibilization of electricity consumption

Electricity distribution networks, consumers, and feeders must invest significantly in digitalization and flexibility, for which appropriate incentive regulation should be created. The introduction of incentives for customers such as matching algorithms can also lead to consumption that better supports the system.

Central capacity market

The ambitious increase in gas-fired power plants to ensure security of supply will likely not be sufficiently incentivized by the energy-only market. A central capacity market should therefore be created that remunerates the provision of the necessary generation capacity.

ADDITIONAL INSTRUMENTS

- Social support of an earlier phaseout of coal
- Increased attractiveness of rooftop photovoltaics
- “Hydrogen-ready” standard for new gas-fired power plants
- Increased attractiveness of renewable electricity trading
- Coordinated construction of electrolyzers
- Introduction of a “target grid” in the network development plan
- Measures to increase acceptance of the energy transition
- Integration of decarbonization incentives in the KWKG
- Expansion/federal funding of efficient heat networks
- Municipal heat planning
- “Use, don’t throttle”

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Acknowledgments

Our special thanks goes to the Federation of German Industries (BDI) and its member associations, as well as to more than 150 stakeholders and experts from more than 80 companies and associations for their extensive contributions and support in validating the analyses—as members of the steering committee and as participants in working groups, around 30 workshops, and numerous, bilateral expert discussions during the course of this study.

We thank the study's scientific advisory board members for their methodological support and many supporting and constructive insights. Dr. Hubertus Bardt, Dr. Ralf Bartels, Prof. Veronika Grimm, Stefan Kapferer, Andreas Kuhlmann, Prof. Andreas Löschel, Franz Loogen and Prof. Karen Pittel.

Equally, we would like to thank Dr. Cassian Behlau, Nora Claußnitzer, Albina Kamberi, Artur Klingbeil, Verena Kornherr, Ulrich Kremer, Ina Leppert, Alexander Meyer zum Felde, Ching Teng Tam, and Nicola Wenz for their support in terms of content, graphics, editing, and organization.

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October 2021





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