First Biennial Transparency Report of the German Federal Government under the Paris Agreement

Für Mensch & Umwelt

Umwelt Bundesamt

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Summary

Climate action at national level

The European Union has committed to reducing its emissions by 55% between 1990 and 2030. As a Member State of the European Union, Germany forms part of this commitment. Germany is playing its part in fulfilling the European contribution to climate change mitigation via the various mechanisms of the European Union and via substantial national arrangements, laws and measures.

Policies and measures

In view of the very different challenges faced by the various sectors, the Federal Government is opting for a broad range of instruments drawing on regulation, carbon pricing, funding programmes, fiscal incentives, advice and a variety of support measures for the stakeholders involved.

Climate action programmes bring together the measures needed to implement Germany's medium-term and long-term climate targets. They generally contain measures for all sectors covered by the Federal Climate Action Act: energy, industry, buildings, transport, agriculture, waste, and others like land use and forestry. In addition, there are cross-sectoral measures. The Federal Government is constantly updating its national climate policy in the climate action programmes.

The latest 2023 Climate Action Programme was adopted on 4 October 2023. It contains some 160 measures. Of the approx. 160 measures and sub-measures in the 2023 Climate Action Programme, 43 measures have already been fully implemented, 92 are currently being rolled out, and 17 measures are undergoing detailed planning (as of August 2024).

Emissions and sinks

Germany produces and transmits greenhouse gas inventories each year. The greenhouse gas inventories cover all five IPCC sector categories: energy, industrial production and product use; agriculture; land use, land use change and forestry, and waste.

From 1990, the emissions dropped from 1251 Mt CO2 equivalents by 40%, or 501 Mt CO2 equivalents, to 750 Mt CO2 equivalents in 2022. Emissions fell by 10 Mt CO2 equivalents or 1.3% between 2021 and 2022.

638 Mt CO2 equivalents were emitted by the energy sector, 52 Mt CO2 equivalents from industrial production and product use, 53 Mt CO2 equivalents from agriculture; 4 Mt CO2 equivalents from land use, land use change and forestry, and 6 Mt CO2 equivalents from the waste sector.

In these figures, CO2 accounted for 90%, methane for 6%, nitrous oxide for 3% and fluorinated greenhouse gases for 1% of greenhouse gas emissions in 2022.

Projections

Germany produces annual projections (most recently in 2024) on the basis of section 5a of the Climate Action Act; these describe the projected development of greenhouse gas emissions in Germany in a "With Measures Scenario" (WEMS) and a "With Further Measures Scenario" (WAMS). The modelled timeframe stretches from the reference year to 2050. The report follows the requirements of Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action.

For total greenhouse gas emissions (excluding land use, land use change and forestry), there is a projected reduction of 64% from 1990 to 2030 in both scenarios, and a reduction of 87% by 2050 (WEMS) or 88% (WAMS).

There are several main drivers behind the projected development in emissions. Renewable energy is being sharply expanded. For example, the share of gross electricity consumption covered by renewable energy rises to more than 72% in both scenarios. Energy efficiency and energy conservation measures result in much lower final and primary energy consumption. Beyond this, there are measures to reduce those greenhouse gas emissions which are not related to energy consumption.

Vulnerability, climate impacts and adaptation measures

The impact of climate change can already be felt and measured in Germany today. Both in Germany and worldwide, 2023 was the hottest year since measurements began in 1881; the average air temperature in Germany has already increased since this time by 1.8 Celsius (linear trend). At the same time, Germany has experienced disastrous effects of heavy rain and flooding events, particularly in 2021 and also recently in the early summer of 2024. In future, all regions in Germany will be affected by a further temperature increase, by an increase in the numbers of hot and dry days, and by an increased risk of heavy rainfall events.

For this reason, in the 20th legislative term – alongside ambitious climate action – the Federal Government has taken up the adaptation to the impacts of climate change as a central challenge and has created a new, binding basis for this in the Federal Climate Adaptation Act, which entered into force on 1 July 2024. It obligates the Federation, Länder and municipalities nationwide to address the consequences of climate change and to identify adaptation measures. In the new, precautionary climate change adaption strategy, the Federal Government is therefore, in line with section 3 of the Federal Climate Change Adaptation Act, presenting for the first time a strategy with measurable targets for adaptation to the effects of climate change in its field of responsibility. The strategy is expected to be presented by the end of 2024. The coalition agreement also calls for provision of joint Federal/Länder financing, at adequate financial levels, for climate-action and climate-adaptation measures. Also, it calls for providing greater latitude for innovation, digitalisation and private-sector initiatives in the areas of climate adaptation. The Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection is currently reviewing the options for implementation of such efforts.

Financial support and technology cooperation

Financing climate change mitigation

The German Federal Government is one of the largest donors worldwide in the area of international climate finance. The doubling of German climate finance from budgetary funding announced by the Federal Government in 2015 up to 2020 from €2 to 4 billion was fulfilled as early as 2019, and was exceeded again in 2020. In 2021, the Federal Government announced that Germany wished to increase its climate finance from €4 to 6 billion each year by 2025 at the latest. The Federal Government increased its climate finance from the public budget to €5.22 billion/$6.14 billion in 2021 and €6.28 billion/$6.61 billion in 2022 [1] (cf. Chapter 4C)[2], and thus met the goal it set itself three years ahead of schedule. Since 2013, in addition to reporting on its climate finance from public-sector budgetary resources, Germany has also reported on publicly leveraged climate-relevant loan financing provided by KfW Development Bank and DEG (Deutsche Investitions- und Entwicklungsgesellschaft mbH),

[1] Conversion via the OECD reference exchange rates for 2021 and 2022; https://data.oecd.org/conversion/exchange-rates.htm

[2] In addition, funding of approx. €118 million/$139 million was provided in 2021 to Annex I countries receiving official development assistance (ODA) – Ukraine, Turkey and Belarus. In 2022, funding for Annex I countries amounted to about €103 million/$108 million. These amounts are not taken into account in the aggregated climate-financing figures given in the report.

including with the help of market resources. Since 2015, such reporting has extended to the individual project level. In 2021 – and in addition to the budgetary resources used in this area – KfW and DEG made €2.59 billion/$3.05 billion in loan commitments from capital-market funds. The figure for 2022 as €3.09 billion/$3.25 billion. The Federal Government aims to achieve a suitable balance between its international climate finance from budgetary funding for emissions-reduction projects and its financing for adaptation to climate change. It was successful in this regard in 2021, with 50% going towards reductions and 50% towards adaptation. In 2022, of the federal budgetary resources allocated in this area, 55% was used for reduction measures and 45% was allocated to adaptation measures.

Context

As a contracting party to the United Nations Framework Convention on Climate Change, Germany is subject to regular reporting requirements. In addition to the annual national inventory report, and the national report to be presented every four years (National Communications), a Biennal Transparency Report (BTR) must be presented from 2024, replacing the format of the previous Biennial Reports (BRs).[3] In this report, Germany provides information in line with the guidelines for greenhouse gas emission trends about the national reduction target, measures to attain the target and progress achieved, projections of future emission developments, the provision of financial and technological assistance, and capacity building in developing countries. In line with the common tabular format, comprehensive information in the form of tables[4] is provided in the annex.

[3] UNFCCC Decision 1/CP.16.

[4] Common tabular format for "UNFCCC biennial reporting guidelines for developed country Parties". UNFCCC Decision 19/CP.18.

1 Information about the GHG inventory

Germany has decided to submit the National Inventory Document (NID) on its GHG Inventories for 1990 to 2022 in line with 18/CMA.1 Annex para. 12 as a separate report. Chapter 2.E contains a summary of the emissions and sinks, providing an overview of the greenhouse gas emissions.

2 Information on the status of implementation of the Nationally Determined Contribution under Article 4 of the Paris Agreement

2.A National circumstances und institutional arrangements

2.A.1 National circumstances

2.A.1.1 Government structure

2.A.1.1.1 How Germany is structured

The Federal Republic of Germany is a federation of 16 states ("Länder"). The Basic Law governs the division of responsibilities between the Federation and the Länder. The administrations of the Länder are generally organised in three levels: State (Land) government, regional councils (Regierungspräsidien), and administrative districts (Landratsämter) or urban districts (Stadtkreise). As a rule, the Länder decide for themselves how their administrations are to be structured.

The Federal Government and the Länder cooperate on climate policy in specific working groups such as the Working Group on Climate and Sustainability (BLAG KliNa). Also, a Federation-Länder Cooperation Committee at state secretary level was anchored in the Renewable Energy Sources Act (RES Act) in order to implement the energy transition.

2.A.1.1.2 Environmental protection as a national goal

Since 1994, protection of vital natural resources has been enshrined as a national goal in Art. 20a of the Basic Law (the constitution) of the Federal Republic of Germany. In addition, a Climate Action Act was adopted in 2019, aimed at enabling Germany to achieve greenhouse gas neutrality.

2.A.1.1.3 Legislation and enforcement

Legislative authority is shared between the Federation and the Länder. The Federation has exclusive powers of legislation in certain areas allocated to it under the Basic Law.

The various areas of environmental law are assigned to the area of "concurrent legislation." This means that the Federation can both shape environmental legislation and transpose EU directives in the environmental sector. The Federation has the power of concurrent legislation when uniform regulation is necessary.

All federal laws are submitted to the Bundestag and the Bundesrat, with some laws requiring "acts of consent" and some requiring "acts of objection", depending on their content.

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The Länder have primary responsibility for the execution of laws. They implement Land laws and, pursuant to Article 83 of the Basic Law, most federal laws as well, under their own responsibility. Exceptions to this under which the federal administration enforces laws include those relating to the Foreign Service, the German Federal Tax Administration, the German Federal Border Police, and the German Federal Waterways Administration.

As a member of the European Union (EU), the Federal Republic of Germany transposes relevant agreements made by the union. Like the German Basic Law, the Treaty on European Union and the Treaty on the Functioning of the European Union frame sustainable development and improvement of the environment as overarching goals. In the areas of the environment, energy, transport and

agriculture, which are areas of key significance for climate action, the EU and its Member States share competencies. In these areas, the Member States have regulatory competence in cases in which the EU fails to exercise its competence.

A great many of the environmental laws in Germany are based on EU decisions, issued either as directives, which the Member States are required to transpose into their own national legislation, or as regulations, which have direct legal effect on the Member States.

2.A.1.1.4 Federal Climate Action Act

Since 2019, the Federal Climate Action Act has formed the legal framework for German climate policy. It stipulates the climate targets and the annual reduction path in law; the contributions of natural and technical sinks are also regulated. The Act prescribes the annual monitoring of the reduction targets and an annual climate action report to the German Bundestag. It regulates the approach to be taken when the targets are not met, and provides for climate action programmes to be drawn up in the first year of each new parliament. The establishment and tasks of an independent Council of Experts on Climate Change are also described.

The Federal Climate Action Act was last revised in July 2024. One of the main focuses of the revision was a redesign of the requirement to take additional policy measures, and a cross-sectoral approach to target attainment. The decisive factor for further climate action measures is no longer a missed target in the past, but a forward-looking, multi-annual, quantified and cross-sectoral overall calculation. The intention is to make climate policy more forward-looking and effective. The climate targets are not affected by the revision.

2.A.1.2 Population

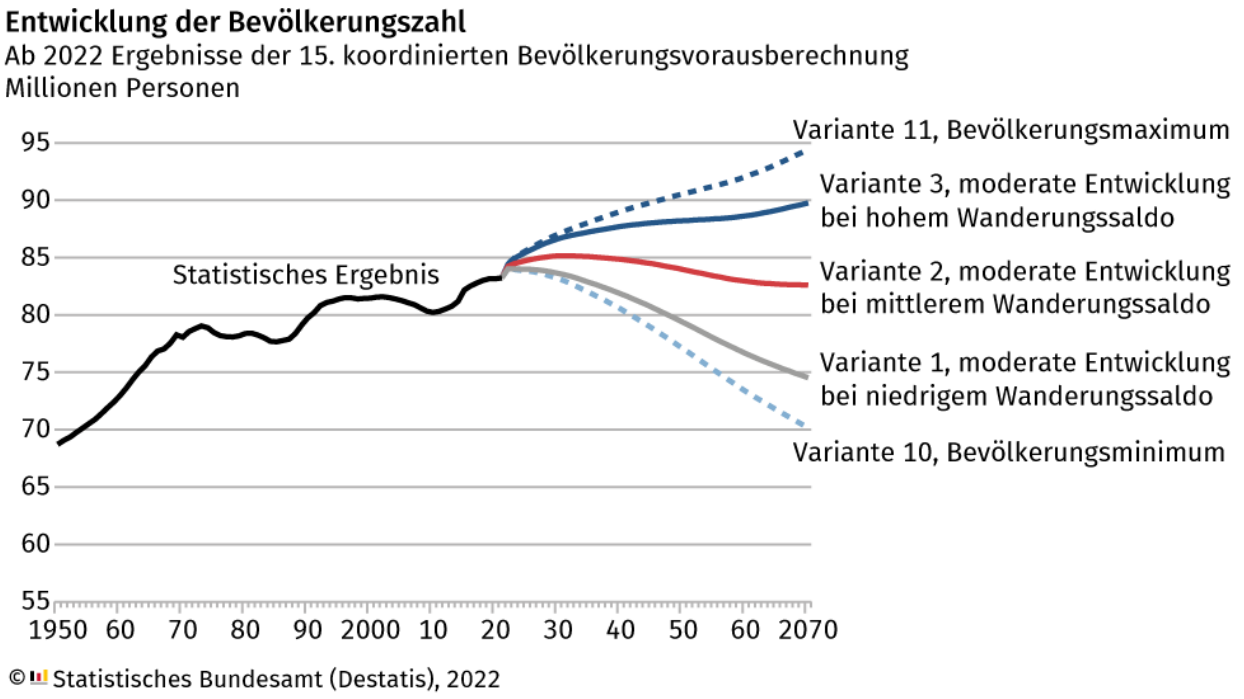
Since the end of 1990, the year of German reunification, the population in Germany has risen from 79.8 million to 83.4 million in 2023. That is an increase of around 5%.

As in all years since 1990, the balance of births and deaths was in 2023 again negative, as more people died than were born. Since 1990, net immigration (balance of immigration and emigration) has been the sole cause of population growth.

The population grew by around 300,000 people between 2022 and 2023. This growth corresponds to the average for the years from 2012 to 2021, and was well down on the growth in 2022, when the total population expanded by 1.1 million people, largely due to the high influx of people from Ukraine.

Various scenarios have been developed for the future population development in the 15th population projection by the Federal Statistical Office in 2022:

Figure 1: Development of the total population



According to the main variants of the 15th coordinated population projection, Germany's population can both grow or diminish from 2023. The decisive variable is the development of the balance of migration.[5]

Demographic change has long since arrived in Germany. The declining number of people of a younger age, and the simultaneous increase in older people, is resulting in an unprecedented shift in the demographic parameters. One person in two in Germany is now aged over 45, and one person in five is older than 66. On the other hand, the population has "rejuvenated" to some extent due to more immigration and births in the last decade. Since 2010, more people have come to Germany than have left the country. The surplus in migration was particularly obvious amongst younger and middle-aged people. The average number of births has risen over the last ten years: between 2014 and 2023, a total of 803,000 (+11.8%) more children were born than in the preceding decade. Despite this increase, there is still a birth deficit, and demographic change is only slightly mitigated by this development.

In 2023, there were approx. 41 million households in Germany. The largest shares were single (17 million) and two-person households (nearly 14 million). According to the latest projection of households by the Federal Statistical Office, the number of single-person households in particular will rise further up to 2040, to nearly 20 million.[6]

[7]Germany's demographic trends differ sharply by region. For one thing, population growth between 2015 and 2022 was concentrated in cities: in 2015, a total of 56.2 million people lived in communities with fewer than 100,000 inhabitants. By the end of 2022, the total population of such communities had

[5] Federal Statistical Office (2022): 15th coordinated population projection: https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Bevoelkerung/Bevoelkerungsvorausberechnung/begleitheft.html; accessed on 4 September 2024.

[6]Federal Statistical Office (2023): Vorausberechnete Privathaushalte: Deutschland, Jahre, Varianten der Haushaltsvorausberechnung, Haushaltsgröße (Advance calculation of households in Germany, years, variants of advance household calculations). .**Fehler! Linkreferenz ungültig.**, accessed on 23 September 2024

[7] The text presented in the next two sections has been taken, with minor changes, from the Datenreport 2021 (2021 Data report) of the Federal Statistical Office (**Fehler! Linkreferenz ungültig.**). As far as the data themselves are concerned, however, more recent data of the Federal Statistical Office have been used (https://www-genesis.destatis.de/genesis/online).

grown by 1.7 %, or by 0.95 million people. During the same period, the total population of cities with 100,000 or more inhabitants grew by 4.7 %, to 27.2 million (+ 1.2 million). In addition, the differing trends seen in the eastern and western parts of Germany continued after German reunification. For example, the population in the territory of former West Germany grew continuously (except in the years 2006 through 2009), by a total of 8.8% (5.4 million persons). The new Länder, in contrast, recorded a consistent decline in the population from 1990 – except for 2014 and 2015 – until 2021, by a total of 15.5% (2.3 million people); however, the population grew by 130,000 in 2022.

According to the current 2021/ 2023 mortality table, the life expectancy of male newborns was 78.2 years and that of female newborns was 83.0 years. In addition, the life expectancies for older people have increased sharply.

2.A.1.3 Geographical profile

The total area of Germany was 357,595 km^2 in 2022. Agricultural land accounted for about 50.4 % (180,200 km^2) of the total. The area under forest in 2022 accounted for a land share of nearly 29.9 % (106,795 km^2). Among the areas allocated to the four overarching use types – settlement, transport, vegetation and waters – the area taken up by waters is the smallest in Germany. With an area of 8,230 km^2, it accounts for a share of slightly more than 2.3 % of the country's total area.[8]

2.A.1.4 Economy

The German economy is characterised by a strong industrial base which is export-oriented and deeply integrated into global value chains. Nominal gross domestic product amounted to 4,122.21 billion Euro in 2023. Whilst nominal gross domestic product expanded by 6.3% in 2023, the Federal Statistical Office says that the price-adjusted gross domestic product was 0.2% down in year-on-year terms for the whole of 2023.

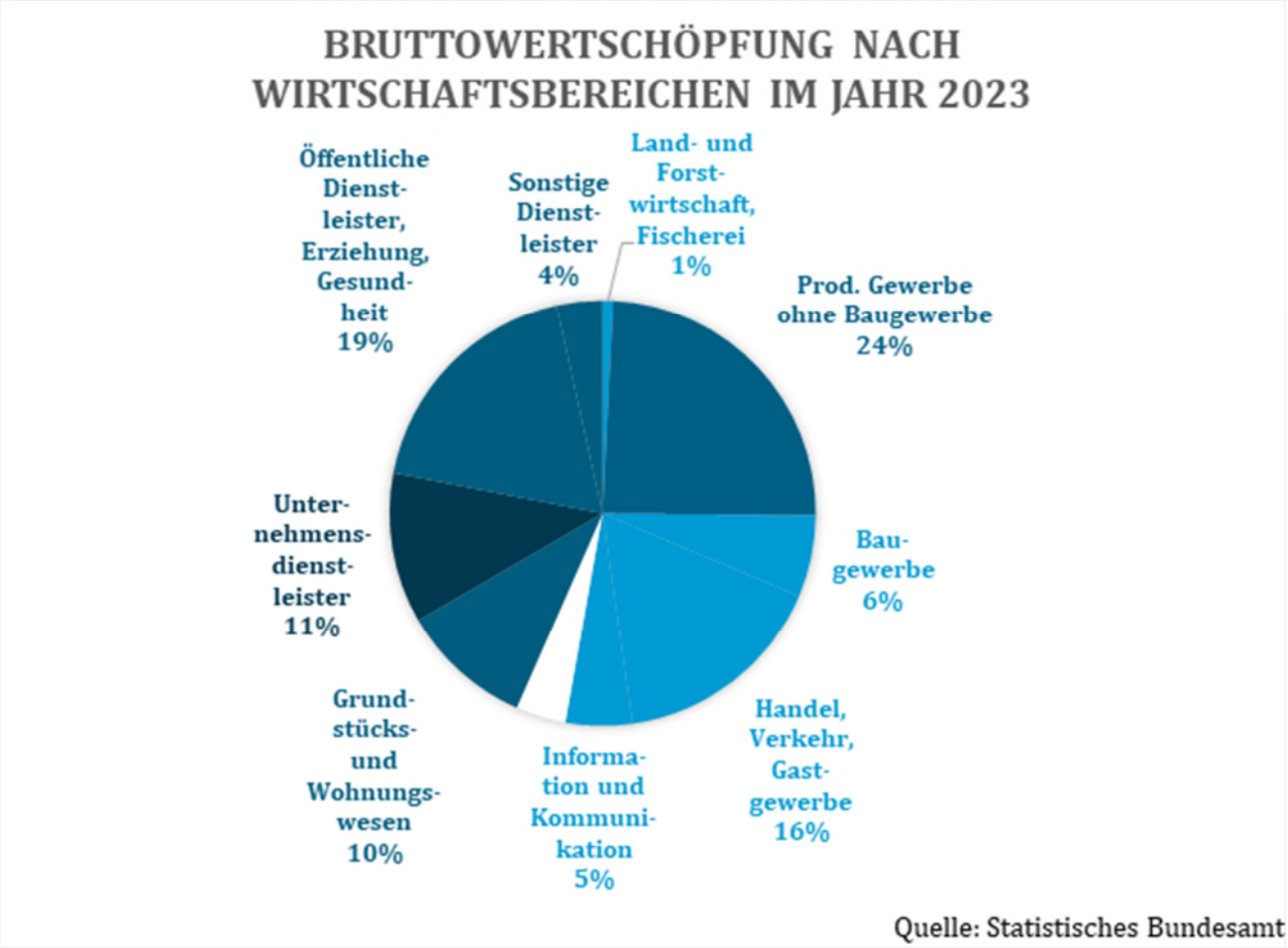
Gross output developed in differing ways in the various sectors in 2023. Overall economic output in the goods-producing sector (excluding construction) fell appreciably, by 1.5%. The main reason for this was much lower output in the field of energy supply. Manufacturing industry, which accounts for nearly 85% of the goods-producing sector (excluding construction), was also down in 2023 in price-adjusted terms (-0.1%). The main positive stimuli here came from the automotive industry and other vehicle manufacturing. In contrast, output and value creation in the energy-intensive sectors of industry like chemicals and metal-working recorded another fall, after output in these sectors had already responded to the rising energy prices with a particularly sharp decline in 2022.

In the construction industry, the deteriorating financing conditions were felt, alongside the persistently high construction costs and the skills shortage. The construction sector (excluding civil engineering and finishing trades) was particularly affected by this. In contrast, output in the civil engineering sector and the finishing trades rose. The overall construction sector registered a price-adjusted fall of 0.4% in 2023.

Most of the service sectors were able to continue the year-on-year expansion of their economic activity, and bolstered the economy in 2023. However, the overall rise was weaker than in the two preceding years.

[8] Federal Statistical Office (2024): Bodenfläche nach Nutzungsarten in Deutschland (Land area by type of use in Germany), as of 31 December 2022, https://www.destatis.de/DE/Themen/Branchen-Unternehmen/Landwirtschaft-Forstwirtschaft-Fischerei/Flaechennutzung/Tabellen/bodenflaeche-insgesamt.html, accessed on 19 July 2024

Figure 2: Gross output by economic sector in 2023



On the expenditure side, the largest component, consumer spending, fell by 0.7% (price-adjusted) in 2023 due to the lingering loss of purchasing power and to consumer restraint, and also as a result of the increased uncertainty among consumers caused by the geopolitical conflicts and crises. Public-sector consumption was also down 1.0 % on the previous year. This reflects the post-pandemic normalisation of government spending following the significant expansion during the coronavirus pandemic.

Gross fixed capital formation fell slightly by 0.7%, mainly because construction investment fell again by 2.7% on average in 2023 (price-adjusted) as a result of higher financing and material costs. In contrast, investments in machinery and equipment increased significantly by 2.8%. In addition to the well-filled order books and the good equity base of companies, increasing investments in the transformation are also likely to have contributed to this.

Exports fell by 0.7% as a result of the historically weak demand from abroad; due to the weak domestic demand, the drop in imports was much greater, at 2.4%. This means that, in arithmetical terms, foreign trade contributed +0.8 percentage points to the growth of the gross domestic product.

Despite the period of economic weakness, the labour market remained robust. Employment continued to increase during the year (+0.7%) and reached a historic high of some 46 million people on average in 2023. At the same time, the unemployment rate rose to 5.7% due to the weak economy and to the arrival of refugees on the labour market following completion of integration courses.

Disposable income of private households rose substantially, by 6.0%. Both wages and salaries (+6.7 %) and corporate and investment income (+6.3 %) were up significantly.

The inflation rate dropped from 6.9% in 2022 to 5.9% in 2023 as a result of the falling energy prices.

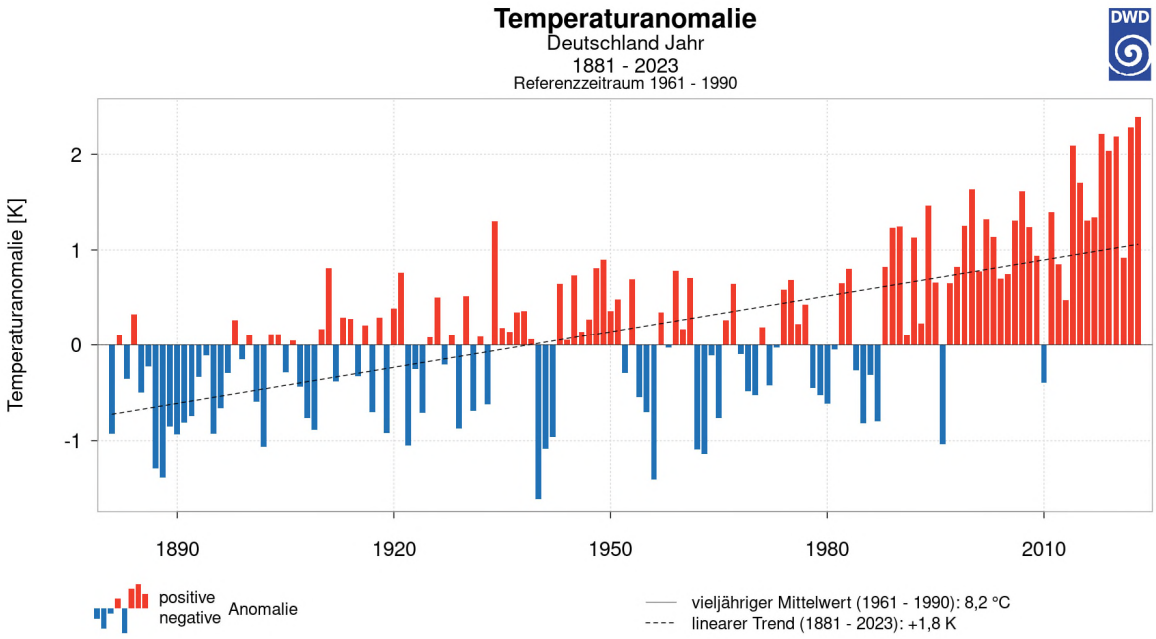
Following far-reaching economic stagnation in the wake of the energy price shock in the last two years, there are indications of an economic recovery in the course of 2024. According to its spring projection, the Federal Government expects the gross domestic product to grow by 0.3% in 2024. The reasons for this are lower inflation rates, rising wages and incomes, a stable labour market, increasing stimuli from the international economy, and expectations of looser monetary policy. In the remainder of this year, major growth stimuli are primarily likely to derive from an uptick in consumer spending.

2.A.1.5 Climatic profile

Overall, Germany's climate is a warm-temperate rainy climate typical for middle latitudes. The average annual temperature for the period 1961 – 1990, for the area between the isle of Sylt and the Zugspitze (Germany's highest peak), was 8.2 °C. In the period 1991 – 2020, it was 9.3°C. An average of 1544 hours of sunshine was recorded in the period 1961 – 1990, and an average of 1665 hours was recorded in the period 1991 – 2020. Throughout the entire year, predominantly westerly winds bring damp air masses from the Atlantic, and provide precipitation of 789 l/m2 per year (reference period 1961 – 1990). The oceanic influence on Germany's climate ensures that the country's winters are mild and its summers are not overly hot.[9]

Germany's National Meteorological Service, the Deutscher Wetterdienst (DWD), has been observing weather and climate for over 150 years. Since 2005, the DWD has been systematically digitalising historical weather records, in order to produce a database that can usefully complement its fund of daily, digital weather data – and thereby enhance the reliability of the information the service provides. The emergence of weather services led to the development of a unified (or at least partially unified) observation network that produces measurements that can be compared on an inter-site basis.

Figure 3: Temperature development in Germany until 2023



[9] Deutscher Wetterdienst (2022)

Source: Deutscher Wetterdienst (2024)[10]

From 1881to 2023, the annual mean of Germany's air temperature rose by 1.8°C (linear trend). This temperature trend has accelerated in recent decades. With an average temperature of 10.1 °C, the decade 2014-2023 was 2.3 °C warmer than the first 30 years of the observation period, 1881-1910.

The largest increase since 1881, 1.9 °C, has occurred in the low mountain ranges west of the Rhine River; the smallest increase, 1.3 °C, has occurred in the northeast German plain. The year of 2023 was recorded as the warmest year in Germany since 1881. Fifteen of the 20 warmest years have occurred in the 21st century.

On average, Germany receives 789 litres per square metre (l/m2) of precipitation per year. Precipitation varies widely over time and by area, however. The wettest-ever year since 1881, averaged over all of Germany, was 2002, with a precipitation of 1,018 l/m2. The driest year, with 551 l/m2, was 1959. Since 1881, Germany's annual average precipitation – with fluctuations, including strong fluctuations, from year to year, and from decade to decade – has increased by 65 l/m2. Since the 1961–1990 reference period, it has increased by around 8%.

Germany's warmest regions experience the lion's share of the country's heat waves. In the period 1961–1990, the average number of hot days in the Upper Rhine Graben, the Westphalian Lowland and the east German basin and hills, ranged from six to nine per year.

In the period 1991–2020, that figure has grown to an average of twelve, while in the upper Rhine lowlands it has grown to sixteen days per year. In the Alpine foreland and the Alps, nine and four hot days per year, respectively, are the norm. Those numbers are more than double (Alpine foreland) and more than five times (Alps) the corresponding figures during the reference period 1961–1990.

A detailed overview of projected future climate changes in Germany is provided in 3.B.4, as well as in the section on analysis of climate impacts and risks (2021)[11].

2.A.1.6 Energy sector

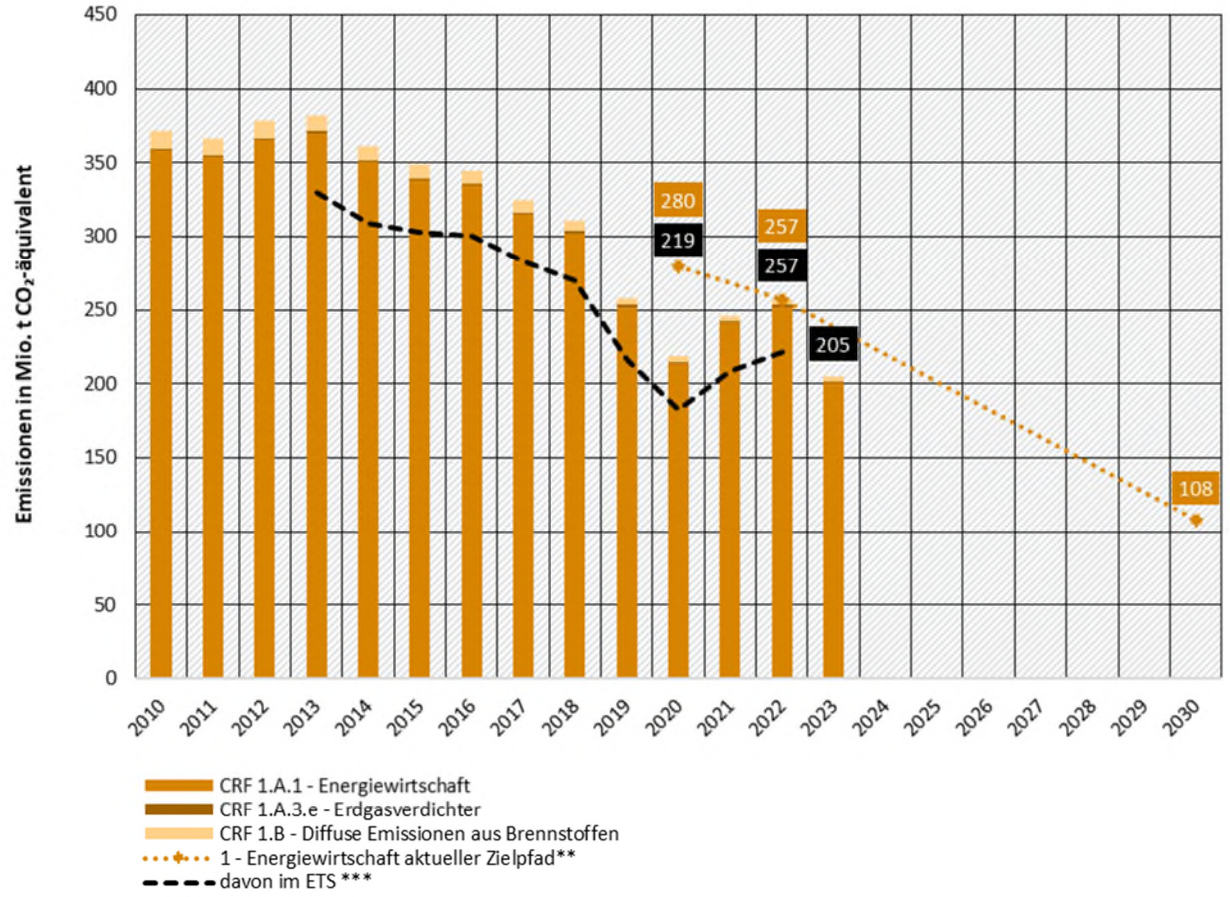
2.A.1.6.1 Current greenhouse gas emission trends

The bulk of the greenhouse gas emissions from the energy sector, approx. 98% in 2023, derive from the use of fossil fuels in power stations and district heating plants. The EU Emissions Trading System is making a significant contribution to achieve German climate targets. The greenhouse gas emissions also allocated to this sector, from the gas compressors in pipeline transport, and the fugitive emissions from the extraction, transport, storage and conversion of solid fuels and decommissioned coal mines are of no significance, in terms both of volume and trends.

[10] Deutscher Wetterdienst (DWD) (2022): Nationaler Klimareport (National Climate Report); 6th revised edition, Deutscher Wetterdienst, Germany, 53 pp. ISBN 978-3-88148-537-1. https://www.dwd.de/DE/leistungen/nationalerklimareport/report.html

[11] https://www.umweltbundesamt.de/publikationen/KWRA-Zusammenfassung

Figure 4: Development and attainment of the target for greenhouse gas emissions in Germany in the energy sector



* Die Aufteilung der Emissionen weicht von der UN-Berichterstattung ab, die Gesamtemissionen sind identisch
** entsprechend der Novelle des Bundes-KSG vom 12.05.2021, Jahre 2022-2030 angepasst an Über- & Unterschreitungen
*** EU-ETS-Anteile an CRF Kategorien basierend auf Auswertung für Bericht nach Art. 21 Emissionshandelsrichtlinie, jeweils jahresspezifisch angepasste Methodik

Quelle: Umweltbundesamt 07.03.2024

The volume of emissions of 205.4 million tonnes of CO2 equivalents in 2023 is the lowest volume of emissions in this sector in recent years. The figure is actually lower than that from the pandemic-hit year of 2020.

2023 was characterised by a significant drop in energy demand in all sectors in the wake of the energy crisis. Not least, the drop in electricity demand and a clear increase in gross electricity generation from renewables resulted in lower emissions. A crucial role here was played by the approx. 7% rise in electricity generation from renewable energy sources. The increase in electricity imports, the fall in electricity exports and the corresponding slight import surplus for electricity also had the effect of reducing emissions since, in line with the territorial principle, the emissions are assigned to the country of origin, i.e. the country in which the electricity is generated. The reduced volume of coal-fired electricity also had impact on emissions. The use of lignite in the energy industry as a whole dropped by approx. 23.6% in year-on-year terms, equating to approx. 254,000 terajoules less lignite being used. The use of hard coal also fell, by approx. 203,000 terajoules or 33.7%.

This sharp fall is due not only to the reduced energy demand, but also to the stabilisation on the energy markets following the successful tackling of the gas supply crisis: in 2022, much more coal was still

being used in the energy sector, in order to save gas from being used to generate electricity and to avoid a gas shortage situation due to the Russian war of aggression against Ukraine.

Despite the stabilisation of the availability of natural gas, which also finds expression in a strong drop in the price of this fuel since its record level in August 2022, the consumption of gas in the energy sector fell for the second year in succession, and stood at around 8% or approx. 51,200 terajoules below the preceding year's level.

The decline from the 2022 level is due not only to mild weather but also to significant energy conservation – not least as a consequence of lower household incomes caused by higher consumer prices. The sharp rise in energy prices in the wake of the Russian war of aggression against Ukraine also led to a drop in output from energy-intensive industry.

Even though the population growth in 2023 had a slight emission-increasing effect, in overall terms the fuel switching in the energy sector, the emission-reducing effect of renewable energy and the reduction of per-capita gross domestic product resulted in a sharp fall in combustion-related CO2 emissions.

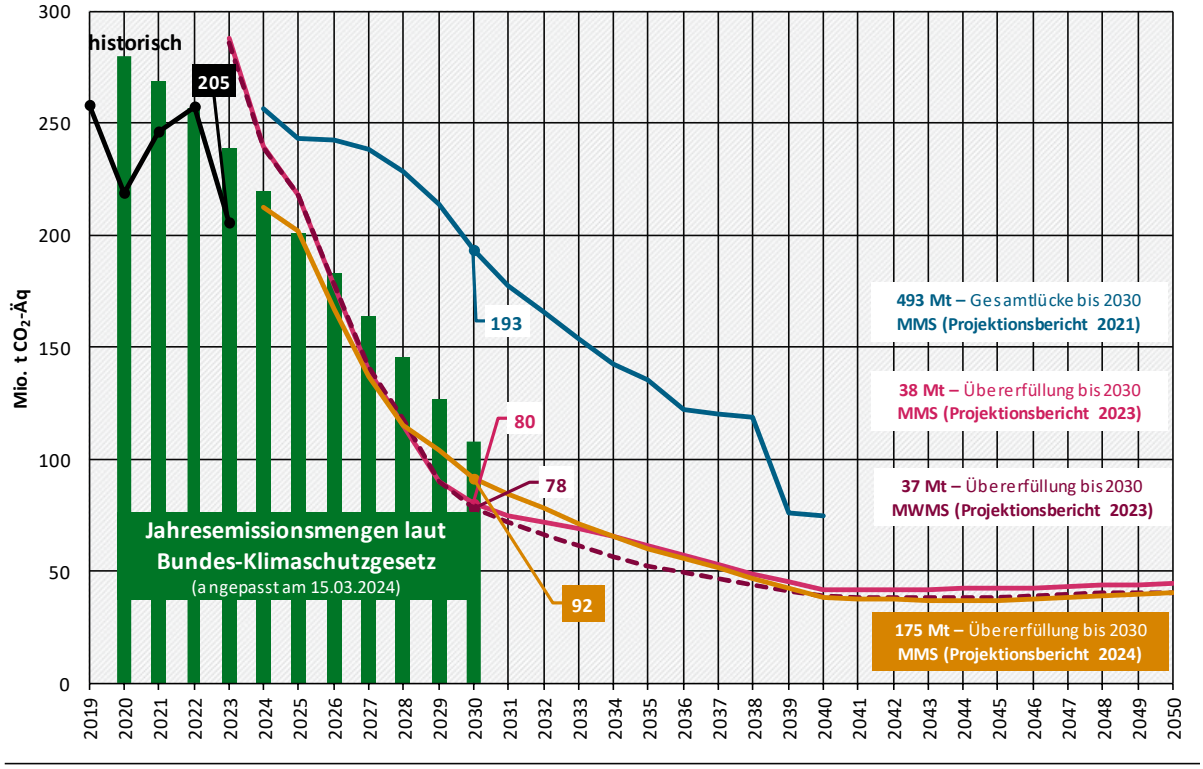
2.A.1.6.2 Outlook up to 2030

Since 1990, greenhouse gas emissions have been cut by an average of around 6.5 million tonnes of CO2 equivalents per year. This rate of transformation needs to triple to 18.5 million tonnes of CO2 equivalents per year in order to attain the target for the monitoring of the energy sector in accordance with the revised Climate Action Act. At the same time, it can be seen that the reduction rate has been much faster over the past five years than had been the case. This reflects the effect of ETS-1, alongside other measures and effects. The decision to phase out coal was ultimately also market-driven due to reduced electricity generation and the expansion of renewable energy.

In line with the greenhouse gas projections from 2024 by the German Environment Agency, the emissions from the energy industry will drop to approx. 92 million tonnes of CO2 equivalents by 2030 on the basis of the measures adopted up to autumn 2023. The cumulative emissions are well below the volumes envisaged in the Climate Action Act. For the period from 2021 to 2030, the intended path is overfulfilled by 175 million tonnes of CO2 equivalents in the 2021 – 2030 period in the WEMS. The set in the Climate Action Act for the monitoring for 2030 of 108.1 million tonnes of CO2 equivalents is thus over-fulfilled by a long way.

The following diagram illustrates the development of the greenhouse gas emissions in the energy sector from 2019 and shows that the measures adopted by the Federal Government are having an impact and making it possible for the energy sector to attain the climate targets. A key precondition for the reductions indicated by the projection data is that the expansion of renewable energy and the grid continues at an increased pace. Also, the expansion of flexibilities and storage is important in order to ensure that the peaks of the volatile renewables are smoothed out and not lost.

Figure 5: Development of the projected greenhouse gas emissions in the energy sector



Source: German Environment Agency (2024)12

2.A.1.7 Transport sector

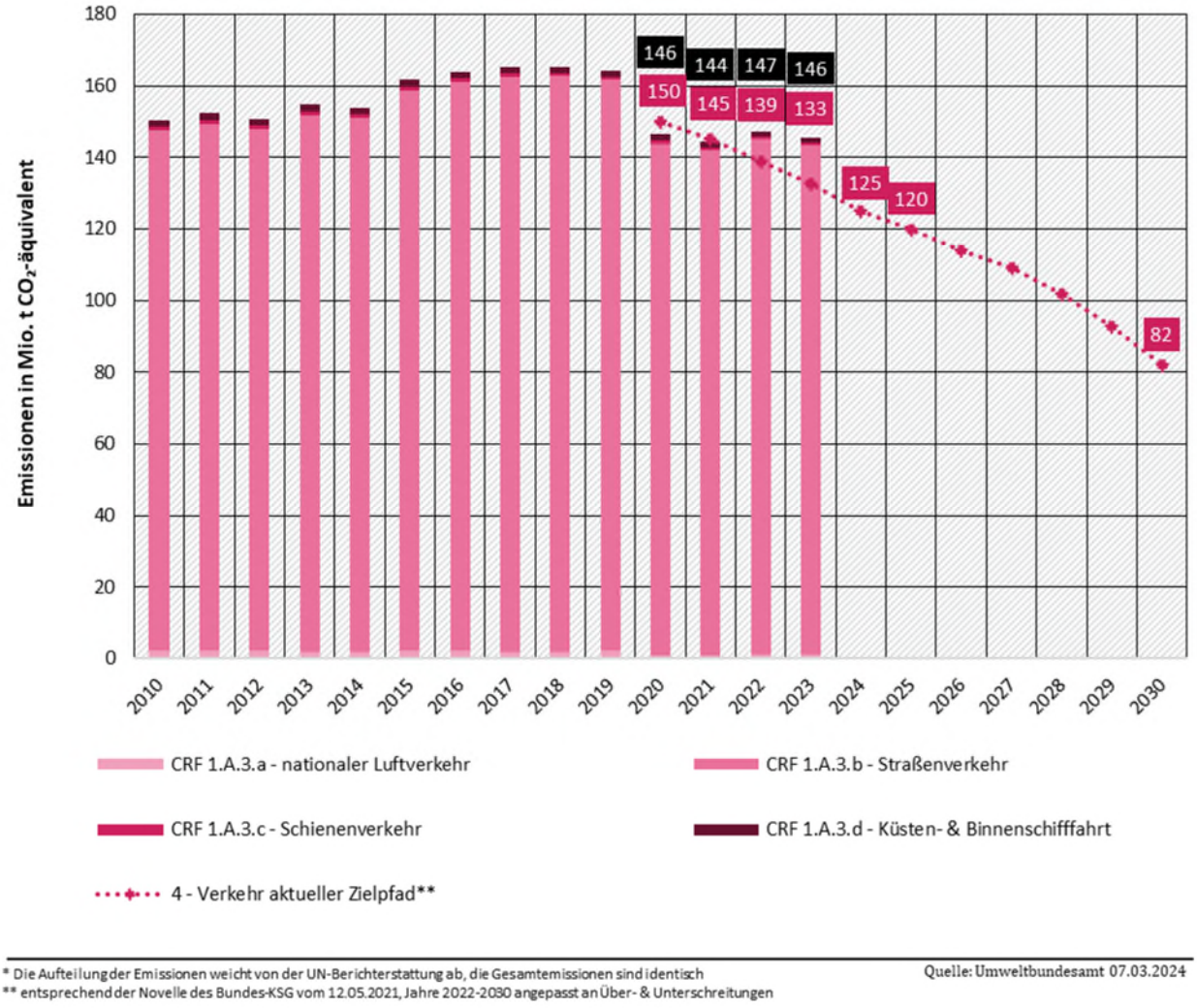
2.A.1.7.1 Current greenhouse gas emission trends

According to the Climate Action Act, the transport sector comprises the individual emitters “civil domestic aviation”, “road and railway transport”, “inland shipping” and “national maritime transport”.

The leading source of emissions by far is road transport, which accounts for over 98% of the sector’s total emissions. The development of the sector as a whole is therefore driven in particular by road transport.

[12] German Environment Agency (2024): Treibhausgasprojektionen 2024. Ergebnisse kompakt (Greenhouse gas projections 2024, compact results) https://www.umweltbundesamt.de/sites/default/files/medien/11850/publikationen/thg-projektionen_2024_ergebnisse_kompakt.pdf, accessed on 4 September 2024

Figure 6: Development and attainment of the target for greenhouse gas emissions in Germany in the transport sector of the Climate Action Act



Black boxes: actual emissions, pink boxes: requirements of the Climate Action Act

The emission trend is largely dominated by the development in carbon dioxide emissions, which account for more than 99% of the total greenhouse gas emissions. Since these emissions are calculated directly from the volumes of motor fuel sold each year in Germany, assuming full combustion (sales principle), there is a direct relationship here between the domestic sales statistics and the emitted CO2.

At around 146 million tonnes of CO2 equivalents, the transport sector is exceeding its target figure for annual emissions in 2023 by approx. 13 million tonnes of CO2 equivalents.

The further rise in the share of electric cars in the fleet has the effect of slightly reducing the emissions from car traffic.

National aviation traffic recorded an 8% increase in emissions in 2023. In view of much increased utilisation of the capacity of the aircraft, this rise is smaller than the rise in passenger transports.

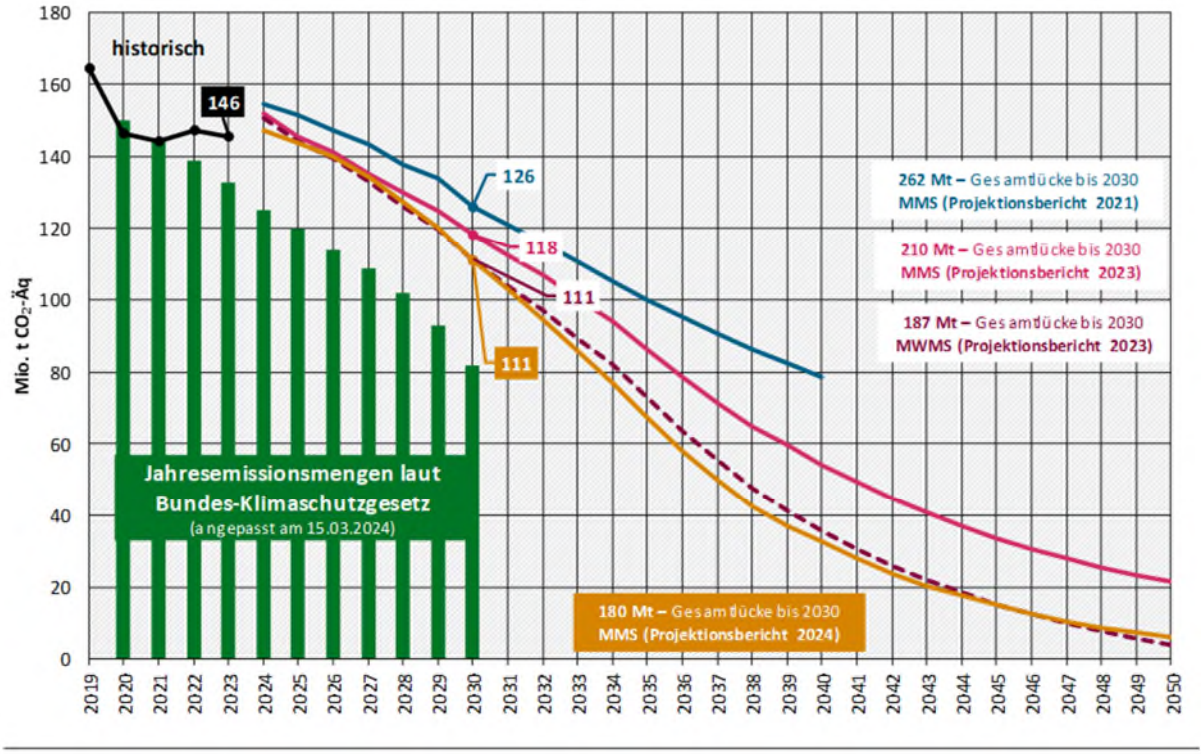
Railway transport and coastal and inland shipping all recorded slight falls in energy consumption and thus in emissions, but make only a very modest contribution to the development of the sector as a whole.

2.A.1.7.2 Outlook up to 2030

The annual emission volumes of the transport sector in Germany, according to the Climate Action Act, are 85 million tonnes of CO2 equivalents for 2030 (adjusted annual emission volume based on the 2023 pre-year emission figures: 81.9 million tonnes of CO2 equivalents). This figure is used in the monitoring process to check whether the sector is achieving or failing to achieve the annual emission volume up to 2030. The dotted line in Figure 7 shows the annual emission volumes up to 2030.

It shows that a fall of emissions of 64 million tonnes of CO2 equivalents (i.e. approx. 43%) is envisaged up to 2030. According to the Council of Experts on Climate Change, an annual reduction of approx. 0.49 million tonnes of CO2 equivalents was observed between 2011 and 2021 – whereby the emission trend in the transport sector was not linear over the past 30 years, and the sharp fall in emissions due to the COVID-19 pandemic in 2020 and 2021 dominated the trend for the last ten years.

Figure 7: Development of the projected greenhouse gas emissions in the transport sector



In the 2024 WEMS of greenhouse gas projections, it is assumed that the emissions in 2030 will amount to 111 million tonnes of CO2 equivalents in the transport sector, taking account of the measures adopted up to autumn 2023. The cumulative gap for the years from 2021 to 2030 is roughly 180 million tonnes of CO2 equivalents, taking account of the measures adopted up to autumn 2023. An annual reduction rate of 9 million tonnes of CO2 equivalents would be necessary to comply with the annual emission volumes set out in the Climate Action Act.

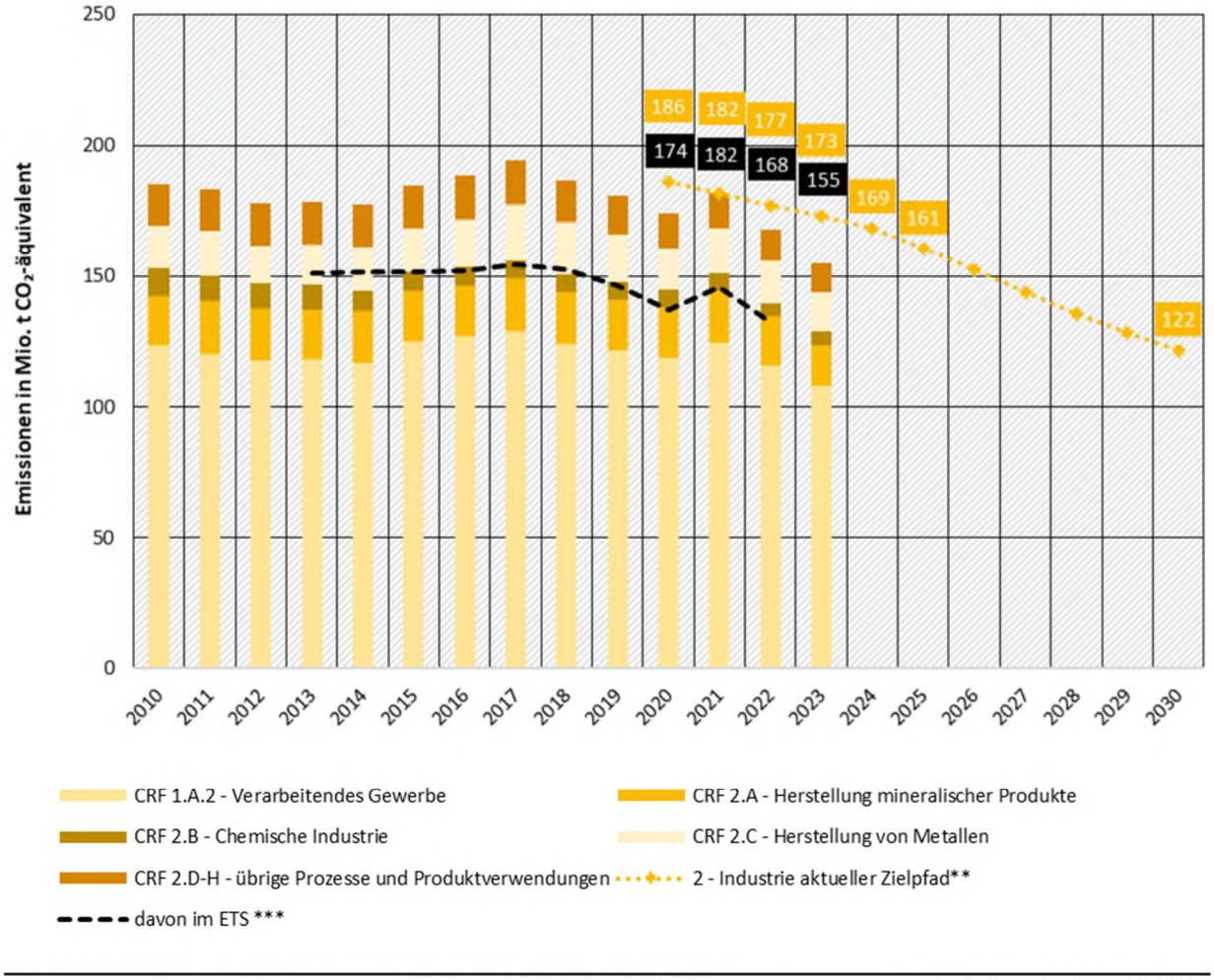
2.A.1.8 Industry sector

2.A.1.8.1 Current greenhouse gas emission trends

With 155 million tonnes of CO2 equivalents, the industry sector is responsible for around 23% of Germany's total CO2 emissions in 2023.

This sector cut its emissions between 2022 and 2023 further by approx. 13 million tonnes of CO2 equivalents, or 7.7%. A large proportion of these savings is however due to falls in output, particularly in the energy-intensive sectors like cement, steel and paper manufacturing. The sector emitted 18 million tonnes of CO2 equivalents less than the annual emission volume stipulated in the Climate Action Act for the monitoring of the development in emissions (2023 annual emission volume according to the Act: 173 million tonnes of CO2 equivalents).

Figure 8: Development and attainment of the target for greenhouse gas emissions in Germany in the industry sector of the Climate Action Act



* Die Aufteilung der Emissionen weicht von der UN-Berichterstattung ab, die Gesamtemissionen sind identisch
** entsprechend der Novelle des Bundes-KSG vom 12.05.2021, Jahre 2022-2030 angepasst an Über- & Unterschreitungen
*** EU-ETS-Anteile an CRF Kategorien basierend auf Auswertung für Bericht nach Art. 21 Emissionshandelsrichtlinie, jeweils jahresspezifisch angepasste Methodik

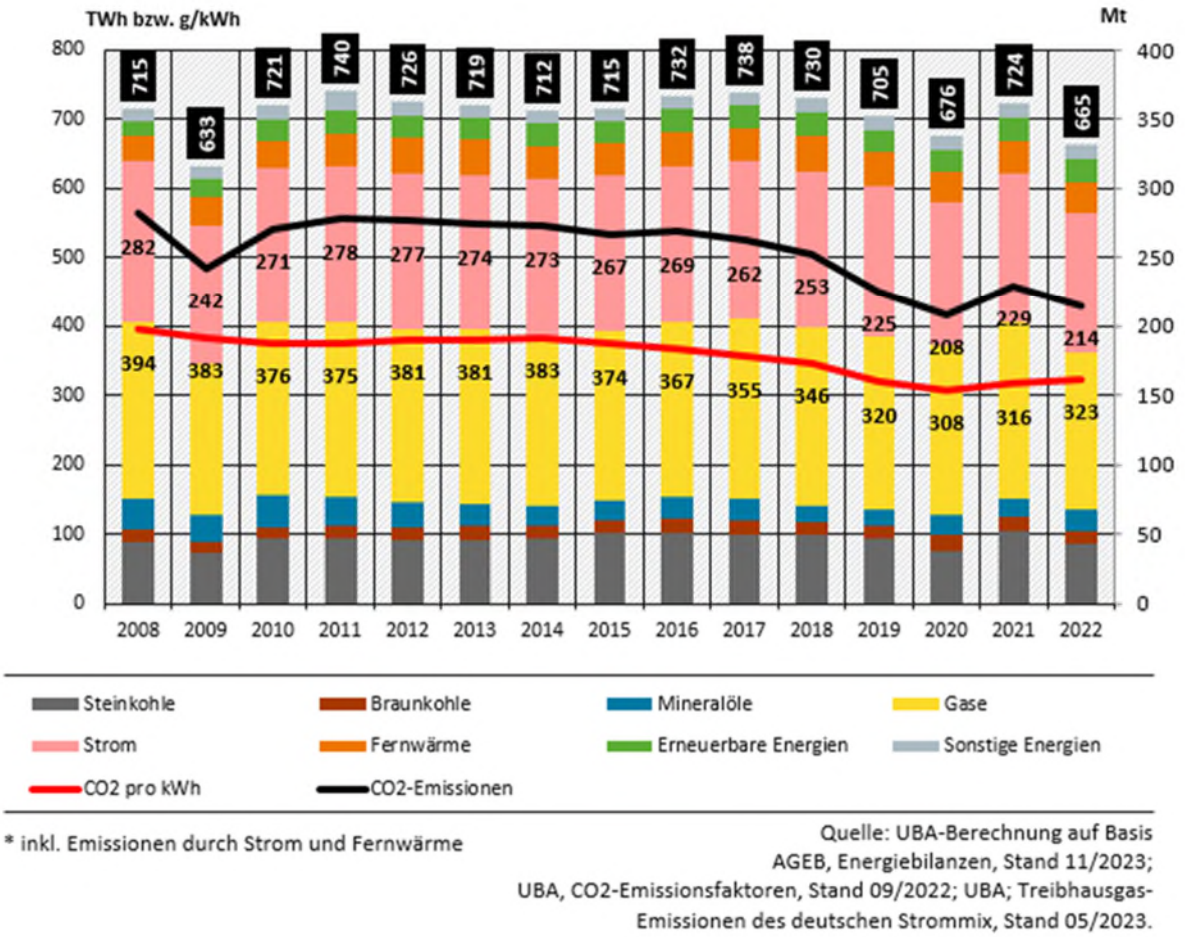
Quelle: Umweltbundesamt 07.03.2024

Caption: Black boxes: actual emissions, yellow boxes: requirements of the Climate Action Act

Even though the energy prices have fallen since 2022, the price level is still higher than in the pre-crisis years and there is still (price-related) uncertainty. Alongside the reduced demand due to the economic situation, the energy prices also contributed to declining energy demand.

The combustion-related emissions resulting from the use of fossil fuels in all branches of industry dominate the industrial emissions, accounting for two-thirds of the total. The next largest source of emissions, accounting for a tenth of the total, is process emissions from the minerals and metal-working industry.

Figure 9: Final energy mix and energy-related CO2 emissions* from industry



* inkl. Emissionen durch Strom und Fernwärme

Quelle: UBA-Berechnung auf Basis AGEB, Energiebilanzen, Stand 11/2023; UBA, CO2-Emissionsfaktoren, Stand 09/2022; UBA; Treibhausgas-Emissionen des deutschen Strommix, Stand 05/2023.

Figure 9 shows the development of final energy consumption in industry, broken down by energy source, between 2008 and 2022. It also illustrates the development of greenhouse gas emissions compared with energy consumption (kilowatt-hours). Consumption has fallen slightly in recent decades. In 2020 and 2022, consumption was well below trend, due to the crisis.

In the conversion from fossil to greenhouse-gas-neutral production processes in the industrial sector, certain technologies can entail a rise in final energy consumption. This means that progress on climate action can result in higher energy consumption.

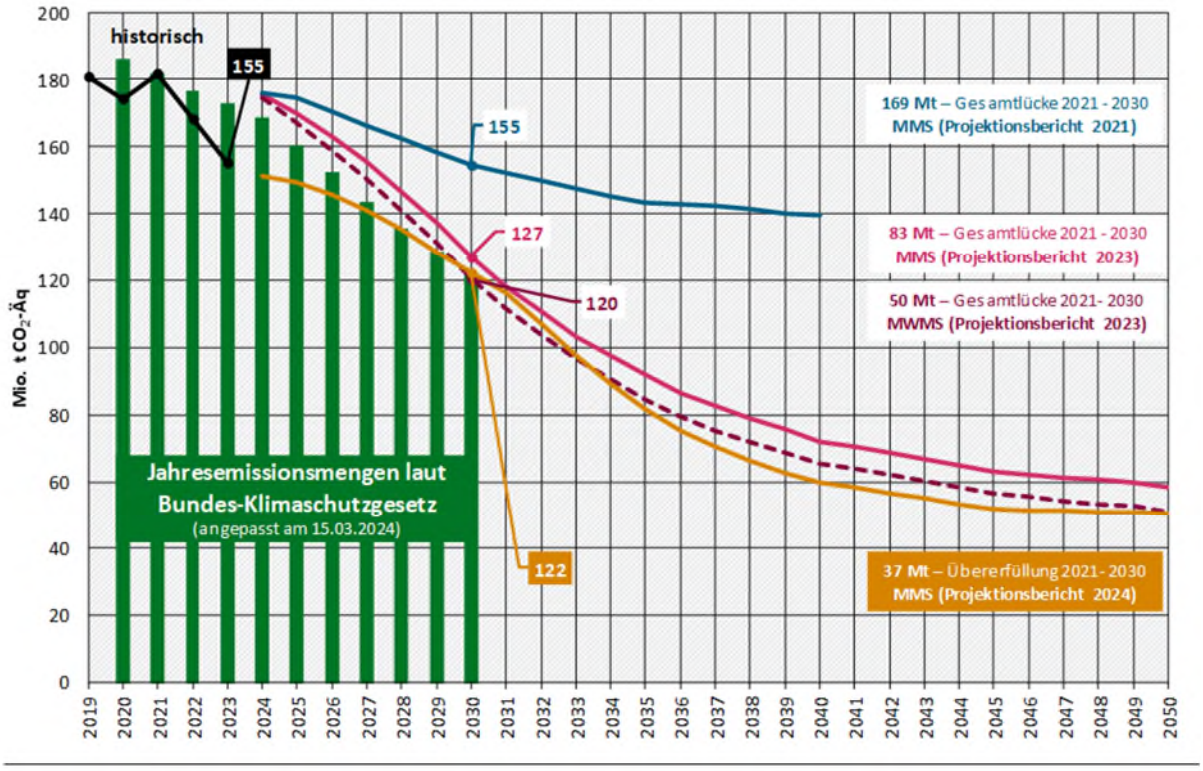
The CO2 emissions depicted in the diagram are broken down in line with the “polluter-pays principle”. As this principle assigns the emissions to the party causing them (e.g. from electricity or district heating), this accounting method is well-suited to depict comparative final energy consumption (the energy consumed by the end-user). However, this depiction is not consistent with the targets and annual emission volumes of the Climate Action Act (source principle), as found for example in the diagram entitled “Greenhouse gas emissions in industry”.

2.A.1.8.2 Outlook up to 2030

The Climate Action Act provides for an annual emission volume by the sector of approx. 118 million tonnes of CO2 equivalents (or, adjusted, of 121.6 million tonnes of CO2 equivalents; carry-over of deviations since 2021) in 2030.

That is a reduction of more than one-fifth compared with the reduction in 2023. Since 1990, emissions have been cut by an average of around 3.6 million tonnes of CO2 equivalents per year. The pace of transformation needs to nearly double if the targets are to be achieved by 2030.

Figure 10: Projected development of greenhouse gas emission in the industry sector



In accordance with the Federal Government's 2024 Projection Report, the industry sector will exceed its cumulative target up to 2030 by 37 million tonnes of CO2 equivalents on the basis of the measures adopted by autumn 2023 (WEMS). If further measures are included (WAMS), the projected greenhouse gas emissions (approx. 117 million tonnes of CO2 equivalents) are 5 million tonnes of CO2 equivalents lower than in the WEMS (approx. 122 million tonnes of CO2 equivalents) in 2030.

The projection up to 2030 assumes that the volumes of production in industry will recover from the current crisis by 2028 and continue to rise, and the emissions will nevertheless continue to fall. Carbon pricing is a central element to attain the emission targets in the industry sector. The measures to promote the climate-neutral conversion of production – such as the new instrument of carbon contracts for difference but also the Decarbonisation of Industry funding programme – will continue to make a decisive contribution and are key elements for the sector to attain greenhouse gas reductions on the basis of the projection data.

2.A.1.9 Waste sector

The sector of "waste and other" covers the emissions from landfill waste, biological waste treatment (composting and digestion), waste water treatment and mechanical biological waste treatment.

The two equally most significant sources in the sector are the emissions from landfill (CH4) and municipal waste water treatment (CH4 and N2O).

The emissions from landfill are determined via a calculation model based on official waste statistics. The calculations for the other subsectors are mainly based on an extrapolation of data from official statistics; in rare cases, the existing data are reused.

2.A.1.9.1 Current greenhouse gas emission trends

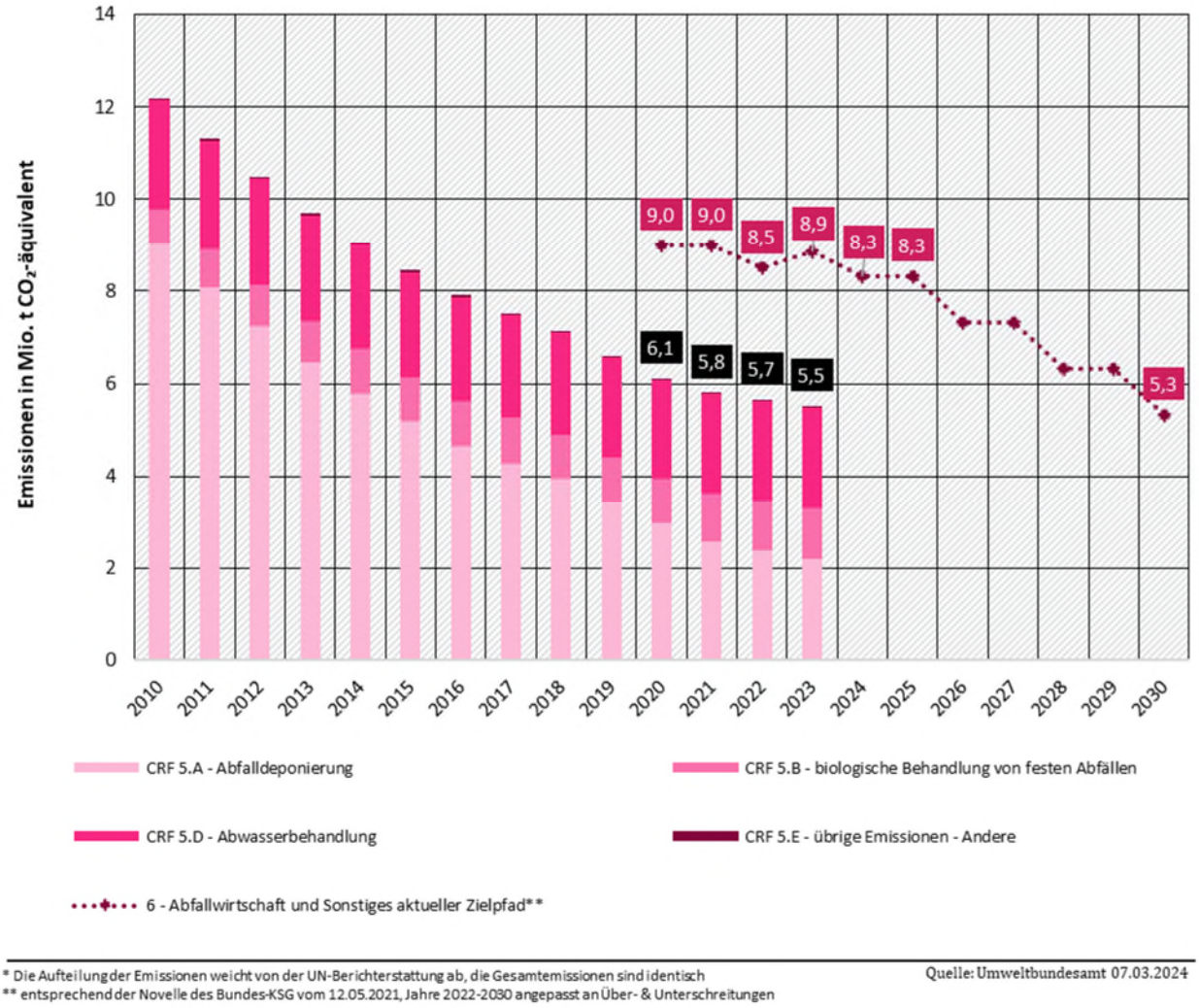
The emissions from the waste sector dropped by 2.5% in 2023, amounting to around 5.5 million tonnes of CO2 equivalents. In the landfill subsector, there are no special features in the current year of estimation.

For biological waste treatment, a rise in waste volumes is extrapolated, largely due to an increase in the volume of waste undergoing digestion. Experts believe that the reasons for this are that a) the quantities of separately collected biowaste have been increasing, as a result of political measures, and b) the additional biowaste quantities are mostly being treated in digestion plants, and not in composting facilities. As a result of political measures for improvement of separate collection, a further, slight increase in the pertinent biowaste quantities can be expected. At the same time, however, much of the organic waste is garden and park waste, so that there are also weather-related annual fluctuations in the quantity. For example, there is much less organic waste in dry years than in rainy years.

In the case of mechanical biological waste treatment, there are no special features in the current year of estimation.

In the case of municipal waste water treatment, the emission factors for CH4 and N2O emissions from sewage plants were revised in the emission reporting.

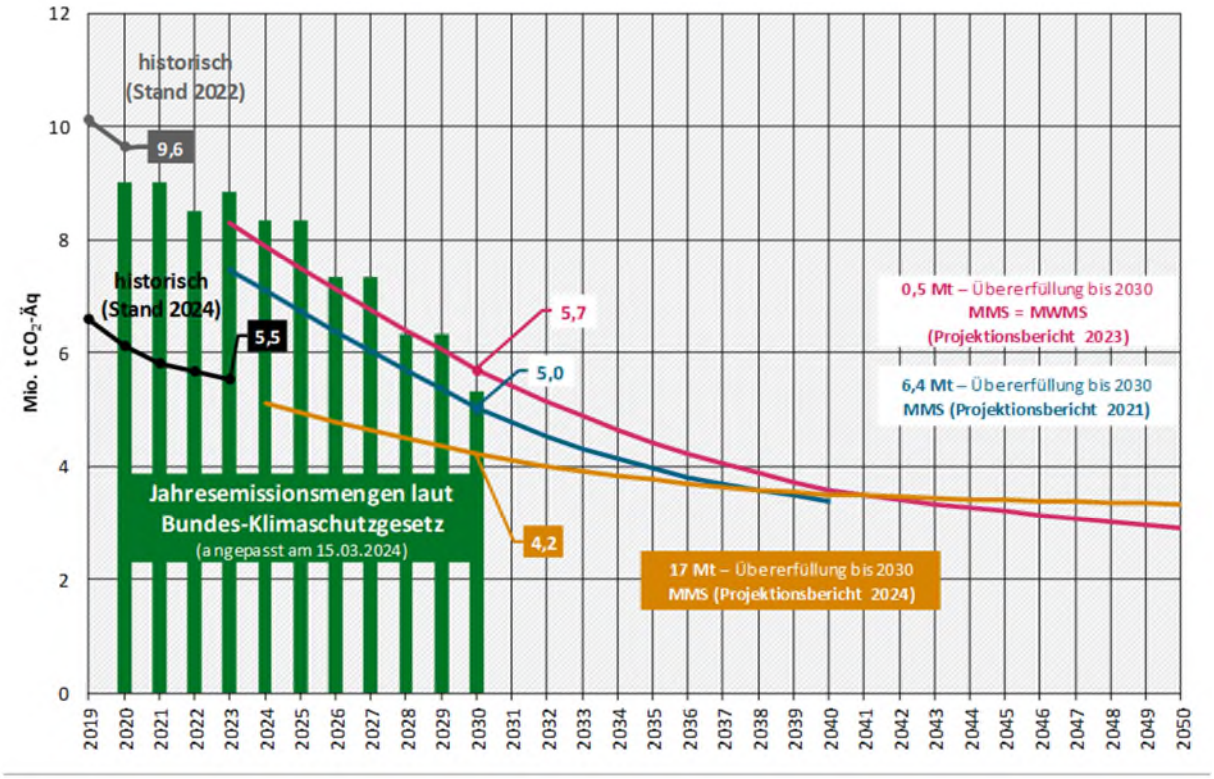
Figure 11: Development and attainment of the target for greenhouse gas emissions in Germany in the waste management and other sector of the Climate Action Act



Black boxes: actual emissions, pink boxes: requirements of the Climate Action Act

2.A.1.9.2 Outlook up to 2030

Figure 12: Development of the projected greenhouse gas emissions in the waste management and other sector



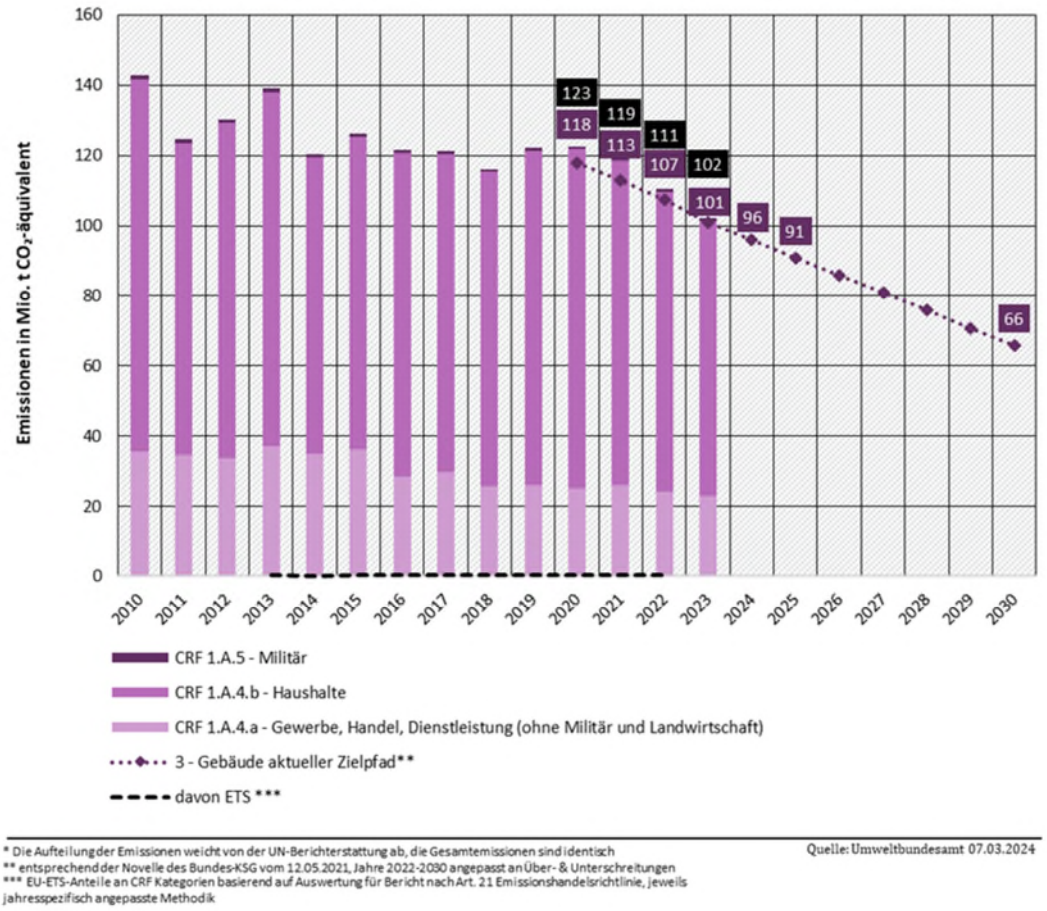
According to the 2024 projection data, the measures adopted so far result in a further drop in greenhouse gas emissions in the waste sector, to less than 4 million tonnes of CO2 equivalents.

2.A.1.10 Buildings sector

2.A.1.10.1 Current greenhouse gas emission trends

The development of emissions in the buildings sector is clearly pointing downward. The sector cut its emissions between 2022 and 2023 by approx. 8.3 million tonnes of CO2 equivalents, or 7.5%, to approx. 102 million tonnes of CO2 equivalents. On the basis of the estimates of the preceding year's emission data, it will exceed the annual emission volume set out in the Climate Action Act by approx. 1.2 million tonnes of CO2 equivalents. In view of large uncertainties affecting the estimates in the buildings sector, the Council of Experts on Climate Change consider that it is equally likely and unlikely that the sector will exceed its target.

Figure 13: Development and attainment of the target for greenhouse gas emissions in Germany in the buildings sector of the Climate Action Act



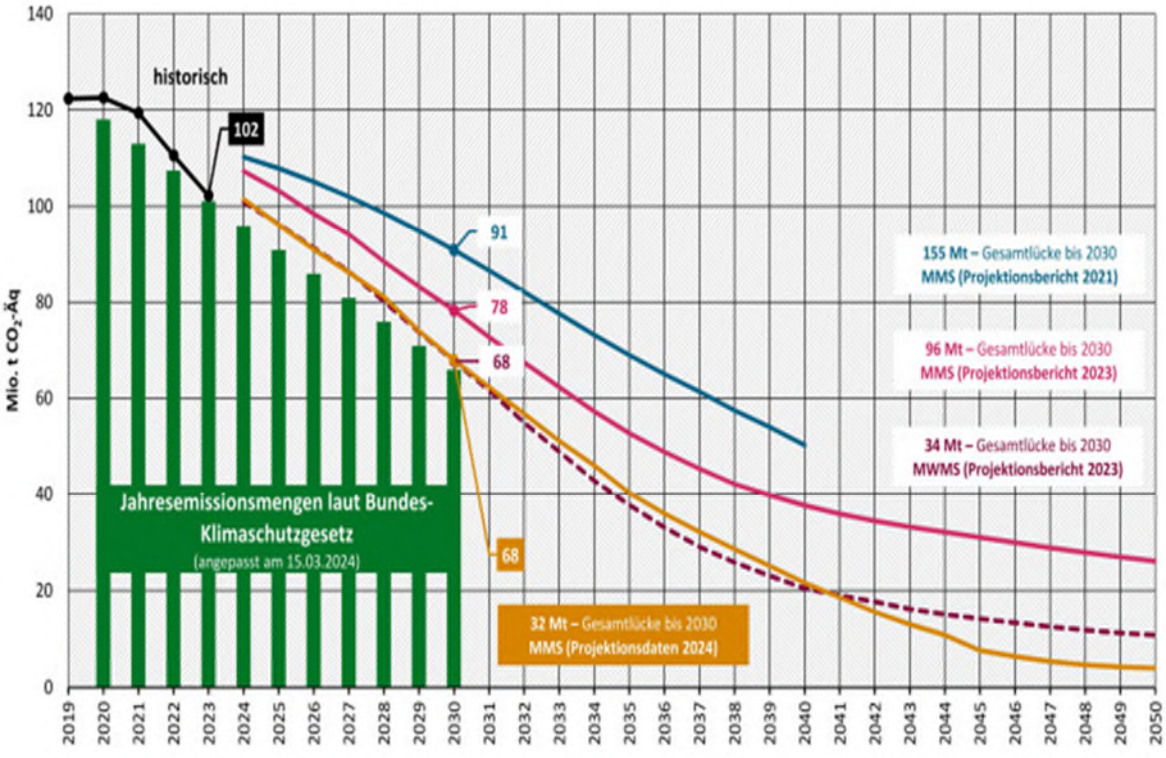
Black boxes: actual emissions, violet boxes: requirements of the Climate Action Act

The blend of instruments adopted by the Federal Government and the Bundestag for the buildings sector, consisting of regulations, funding, carbon pricing and information and advice, made a decisive contribution to the declining emission trend in 2023. Major driving forces include the mild weather in 2023 and the high energy prices. The inflation is resulting in consumption-reducing cost and energy savings, particularly by households, and these can be observed for all (fossil) energy sources.

2.A.1.10.2 Outlook up to 2030

The Climate Action Act sets an annual emission volume of approx. 67 million tonnes of CO2 equivalents (adjusted annual emission volume of 66 million tonnes of CO2 equivalents) for 2030. The purpose of this figure is in particular to permit monitoring to verify whether the sector is making an appropriate contribution to the overall target up to 2030.

Figure 14: Projected development of greenhouse gas emissions in the buildings sector



The Federal Government's projection data of 2024 show that there will be a cumulative gap of 32 million tonnes of CO2 equivalents up to 2030 on the basis of the measures adopted by autumn 2023 (WEMS). In the WAMS, this can be reduced to around 26 million tonnes of CO2 equivalents. The guideline figure set out in Annex 2a to the Climate Action Act of around 67 million tonnes of CO2 equivalents is nearly reached (adjusted annual emission volume 66 million tonnes of CO2 equivalents), and is fully reached if additionally planned instruments and measures are deployed (WAMS).

The assumption that there will be a strong expansion of heat pumps (the heat pump roll-out) plays an important role on this ambitious target path. The increased electrification of the heat supply is intended to ensure that a large proportion of the heat demand can be met from the environment (air, soil, water, etc.) and that typically only one-third of the final energy consumption will be needed compared with the previous volume (usually of gas and oil). An increase in efficiency measures in the building envelope (e.g. new windows, insulation) and building services (e.g. ventilation) can ensure that energy consumption is permanently reduced. Also, a tripling of the number of connections to heat networks can help not only to decarbonise the heat supply, but in the long term also to reduce primary energy consumption.

This triad of targets in the buildings sector – of technology-neutral decarbonisation of the heat supply, the expansion and conversion of the heat network infrastructure, and efficiency gains – is confirmed not only by the long-term strategies but also by further studies which also show that the targets in the buildings sector are achievable. At the same time, buildings can make a substantial contribution to reducing emissions in the energy and industry sectors via the new-build of rooftop -photovoltaic system (PV), landlord-to-tenant electricity, and incentives for the resource-efficient use of construction materials. At the same time, care is being taken to ensure that vulnerable groups are not overburdened when measures are implemented.

Since 1990, an average reduction of approx. 6.6 million tonnes of CO2 equivalents has been achieved per year; in the decade from 2010 to 2020, however, the average annual reduction was less than half of

this figure. If the indicative annual emission volumes laid down in the Climate Action Act are to be attained, the pace of reductions observed in recent years would have to be maintained. The comparatively high reductions in recent years do however include special factors, such as the higher gas prices in the wake of the Russian war of aggression. This is particularly true of the roll-out of heat pumps, the decarbonisation of the heat networks and the increase in the renovation rate to accelerate energy efficiency measures in buildings. In the case of all the measures, it is important to pay attention both to socially just implementation and to the economic feasibility of the measures.

According to data from the heating industry, around 356,000 heat pumps were sold in 2023 (51% more than in 2022). In the first quarter of 2024, however, there was a drop in sales figures of 52% (46,000 compared with 96,500 units in the same period of 2023). Under the Federal funding for energy-efficient buildings (BEG) programme, applications were made for funding for around 350,000 heat pumps, five times more than those in 2021. Applications for some 180,000 heat pumps were made in 2023. The new funding scheme for heating under the Federal funding for energy-efficient buildings (BEG) programme launched at the end of February 2024. Since the end of August, all categories of applicants have been able to apply for the funding. By the end of August, approx. 85,000 applications have been received for funding for heating systems.

Gas and oil heating systems continued to be the most popular heating solutions in residential and non-residential buildings in 2023 (approx. 900,000 heating units sold). Alongside the heat pump campaign (see below), the energy crisis resulting from Russia's war of aggression against Ukraine was a major trigger for the increased demand for renewable heat producers. This effect diminished from the second half of 2023 as the price level of oil and gas fell.

2.A.1.11 Agriculture sector

2.A.1.11.1 Current greenhouse gas emission trends

In agriculture, greenhouse gas emissions fell by more than 1 million tonnes of CO2 equivalents (minus 1.8%) between 2022 and 2023. This is in line with the trend of the previous years. The main driver of this development is the reduction in cattle stocks and of mineral synthetic nitrogen fertilisation. These trends influence the greenhouse gas emissions from digestion, farmyard manure management and soils. The sectoral reduction target of 67.4 million tonnes of CO2 equivalents for 2023 was, according to the emission data for the preceding year published by the German Environment Agency on 15 March 2024, overachieved by 7.1 million tonnes of CO2 equivalents (10.5%). This development is not due entirely to climate action measures, but also results from the economic situation and methodological changes to the calculation of emissions since the target was set.

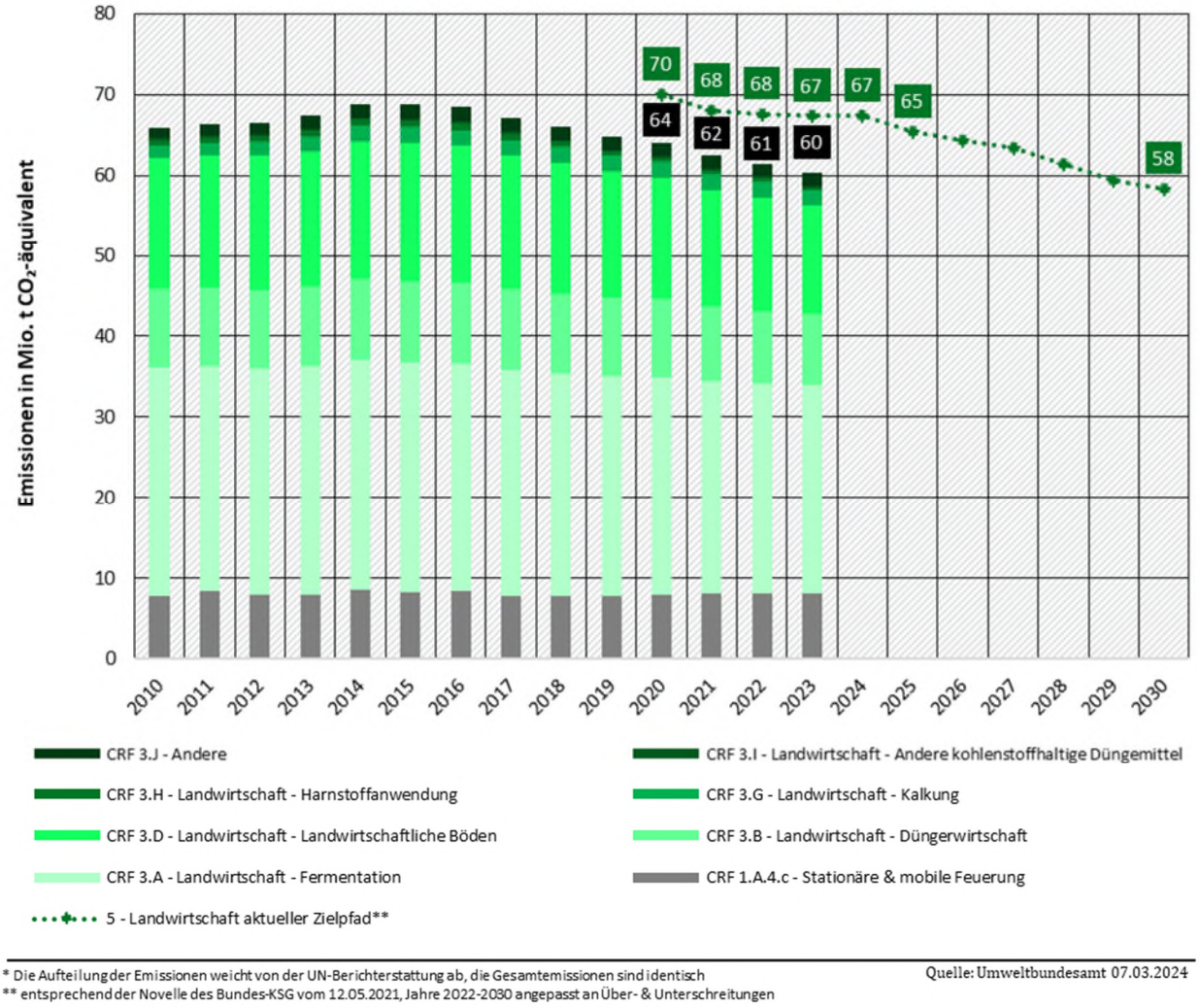
The agricultural sector accounts for around 9% of total emissions. This share will rise further in the coming years, in parallel to the decarbonisation of the energy supply.

According to the Federal Climate Action Act, the agriculture sector includes emissions from animal husbandry, the use of agricultural soils, the digestion of energy crops and the consumption of fuel in agriculture. Emissions from the upstream sector and land use changes are not allocated to agriculture.

The leading sources of emissions of greenhouse gases in the agriculture sector are, alongside fuel consumption, enteric fermentation (methane - CH4) and the use of agricultural soils (nitrous oxide - N2O). The management of farm manure is another major item (CH4 and N2O). Greenhouse gas emissions from agricultural soils – according to data available so far, more than 13 million tonnes of CO2 equivalents in 2023 – are mainly caused by nitrogen fertilisation which, alongside animal husbandry and farm manure management, is one of the largest sources of emissions from agriculture. On drained wetlands used for agriculture, the mineralisation of peat generates a particularly high

emission of greenhouse gases (alongside nitrous oxide, which is reported in the agriculture source group, these are also CO2, which is assigned to the LULUCF source group). The remaining sources are emissions from the liming of agricultural and silvicultural areas (CO2), urea spreading (CO2) and emissions which arise in the digestion of energy crops and the storage of the digestate.

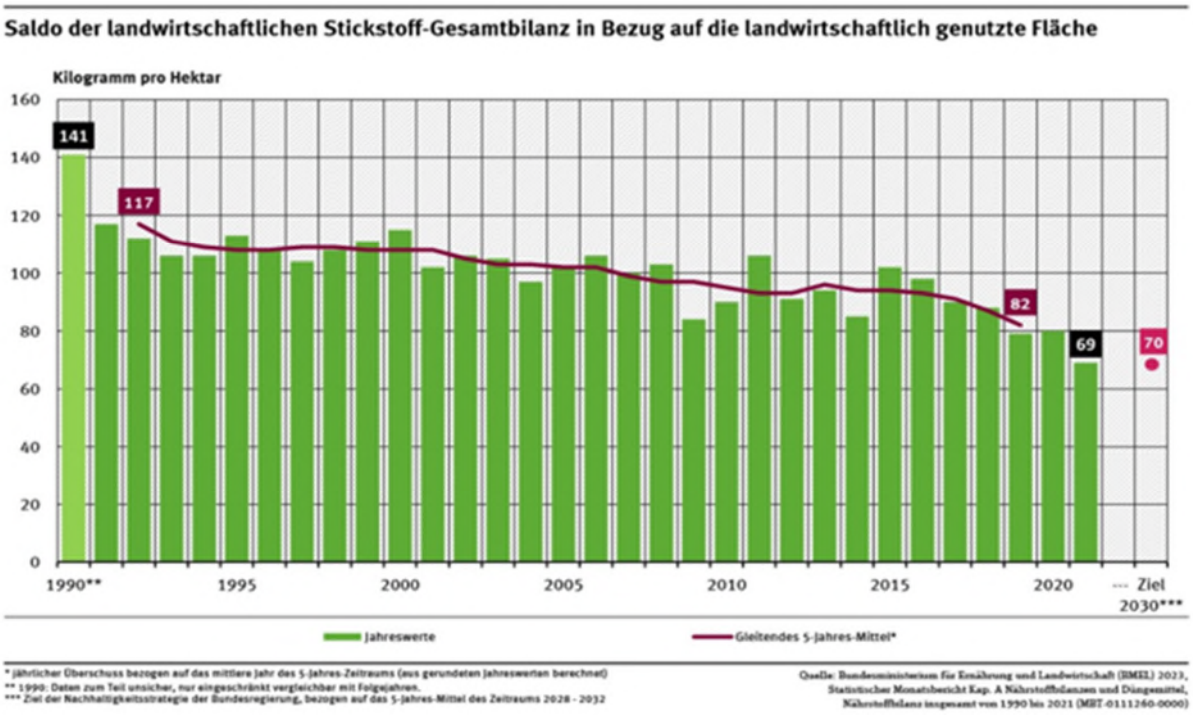
Figure 15: Development and attainment of the target for greenhouse gas emissions in Germany in the agriculture sector of the Climate Action Act



Black boxes: actual emissions, green boxes: requirements of the Climate Action Act

Figure 16 shows how the overall nitrogen footprint has developed in terms of the area used for agriculture between 1990 and 2021.

Figure 16: Overall nitrogen footprint of areas used for agriculture

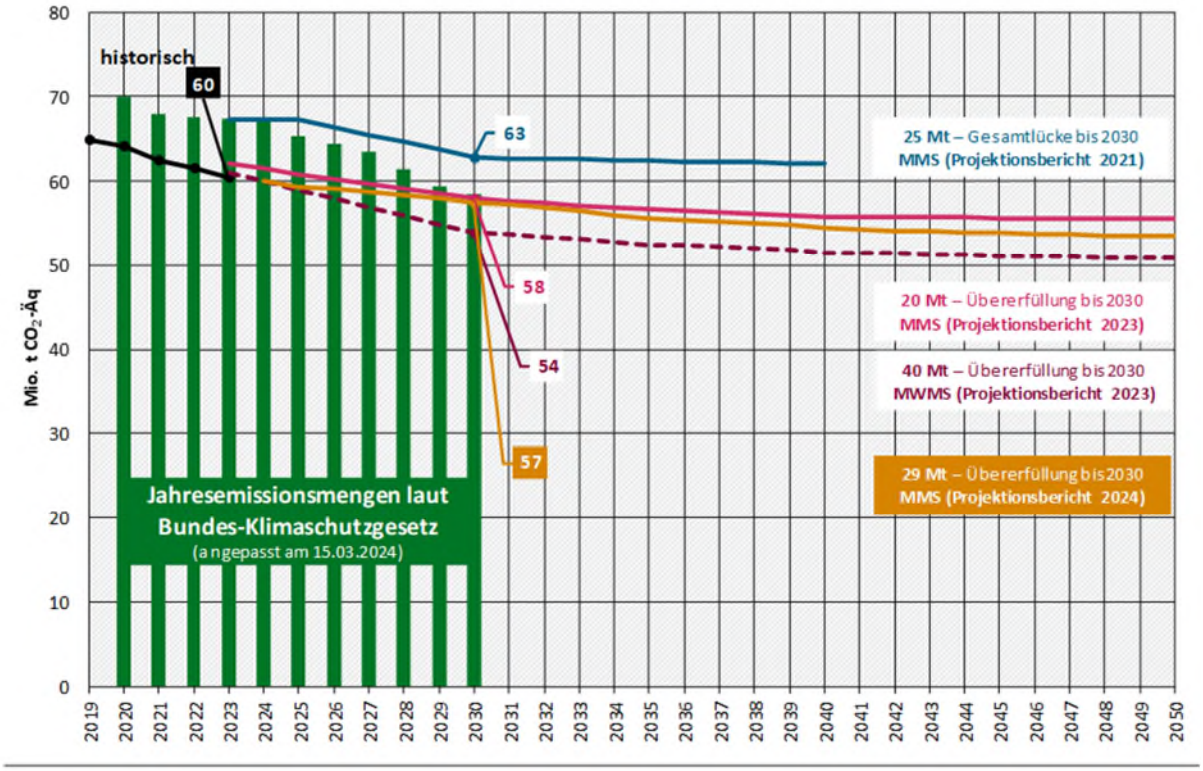


Measures for more efficient fertilisation and the reduction of nutrient surpluses in agriculture play a particularly important role in the reduction of greenhouse gas emissions.

2.A.1.11.2 Outlook up to 2030

The annual emission volumes of the agriculture sector in Germany, according to the Climate Action Act, are 56 million tonnes of CO2 equivalents for 2030 (adjusted annual emission volume: 57.3 million tonnes of CO2 equivalents). According to the 2024 Projection Report, the outcome is greenhouse gas emissions of 57 million tonnes of CO2 equivalents in 2030 on the basis of the WEMS. This means that the annual emission volume for 2030 is complied with. The cumulated annual emission volumes for 2021 – 2030 are undershot by a total of 20 million tonnes of CO2 equivalents in the WEMS of the 2024 Projection Report, and by 29 million tonnes of CO2 equivalents in the WAMS.

Figure 17: Development of the projected greenhouse gas emissions in the agriculture sector



Important basic assumptions for the development of emissions in the WEMS are continuing declines in the stocks of cattle and pigs – here, the current trend is continued in a slightly milder form up to 2030. The assumptions show a slight future rise in the current very low figure for the spreading of nitrogen fertilisers. Another driving force is the expected sharp decline in the use of energy crops in biogas production, resulting in a reduction of the volumes of nitrogen spreading and the methane emissions from biogas production and digestate storage.

2.A.1.12 Forests and forestry sector

2.A.1.12.1 Current greenhouse gas emission trends

According to the current pre-year estimate, the LULUCF sector was a net source of greenhouse gases in 2023. This amounted to 3,614 kilotonnes of CO2 equivalents.

The LULUCF sector covers anthropogenic emissions of carbon dioxide, methane and nitrous oxide (positive: source; negative: sink) resulting from land use and land use change. For the land use categories of forest, arable land, grassland, wetlands, settlements and other land, positive (release) and negative (sequestration) emissions from the pools of organic and mineral soils, above-ground and below-ground biomass, deadwood, litter and artificial waterbodies are inventarised. Also, changes to the carbon stocks in timber products are recorded.

Figure 18: Development of forest area in Germany

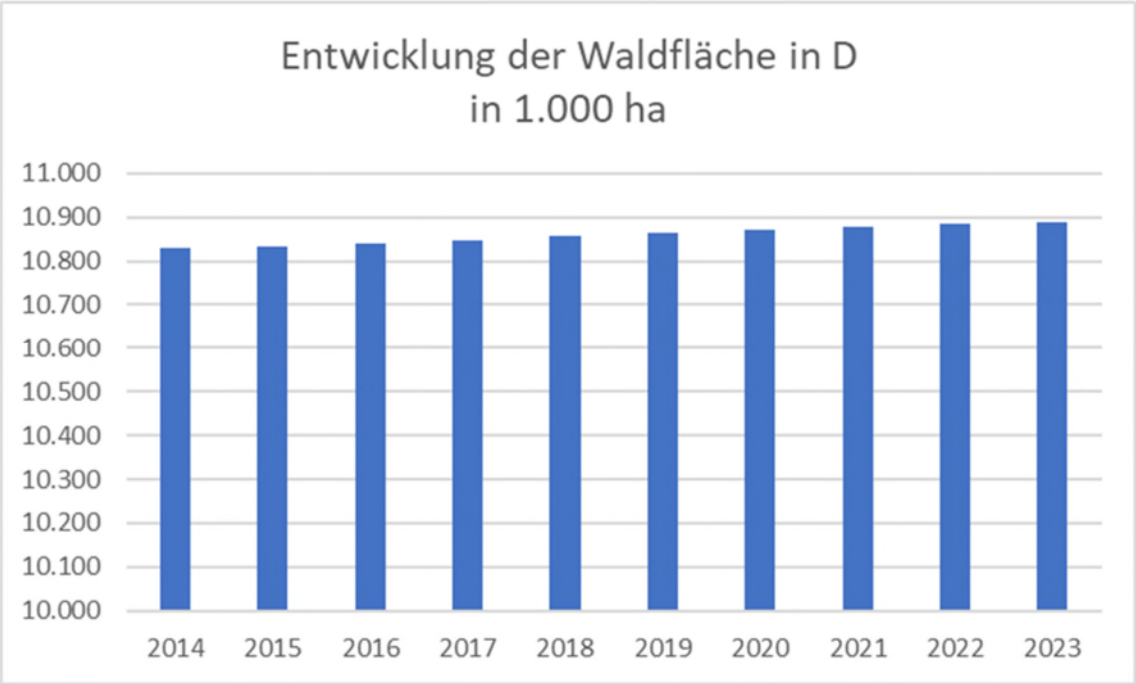


Figure 18 shows that the area covered by forest in Germany has increased slightly over the last ten years.

Figure 19: Net CO2 sequestration in forest land

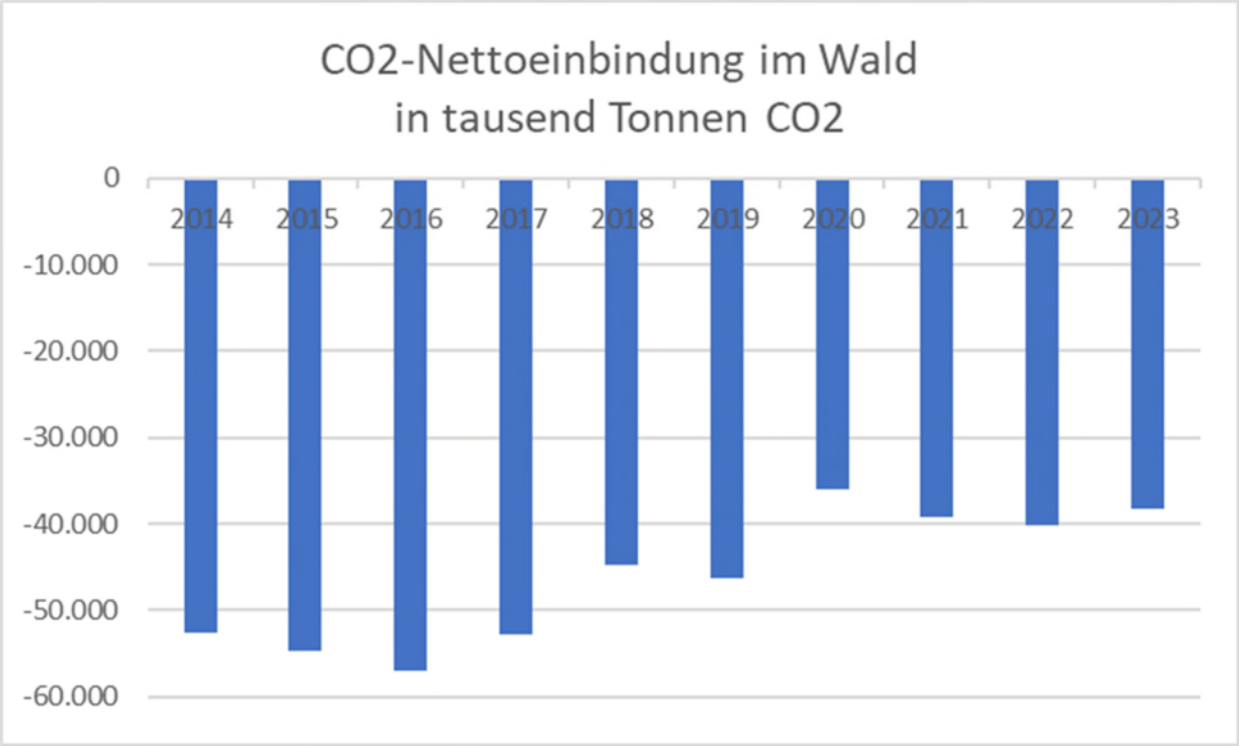


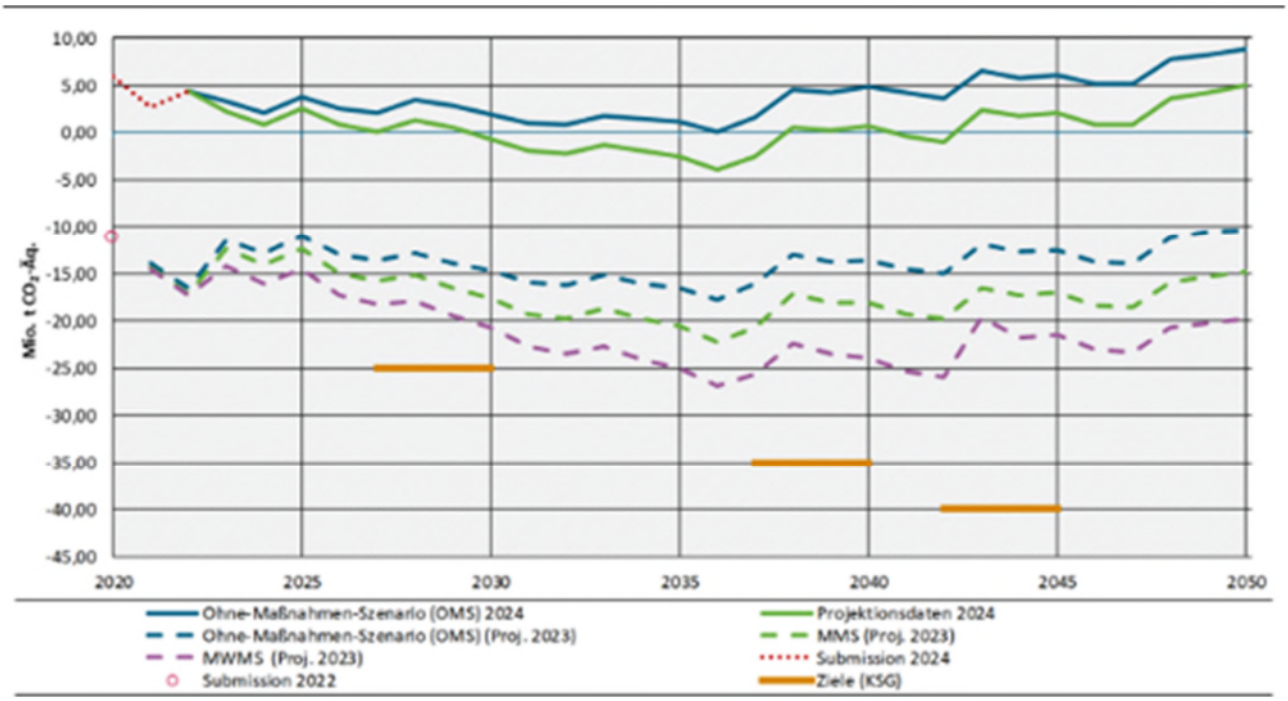
Figure 19 shows the annual CO2 sequestration by the forest over the last ten years. The volume of bound CO2 fluctuates from year to year; it is trending downward. The bark beetle disaster of the years from 2018 – 2022 and some high wind events have resulted in a loss of particularly high-growth forest stocks that cannot be replaced in the short term, therefore these events will reduce the absolute level of

annual CO2 sequestration by forests over the coming decades. Furthermore, forest growth, and thus the annual CO2 sequestration by forests, requires sufficient precipitation. Should precipitation fail across a large area, as was the case in the years from 2018 to 2022, the overall annual CO2 sequestration performance of the forests could decline.

2.A.1.12.2 Outlook up to 2030

According to the results of the greenhouse gas projections, the targets for the LULUCF sector will not be attained in 2030, 2040 or 2045.

Figure 20: Development of the projected greenhouse gas emissions in the LULUCF sector



In the Climate Action Act, it is defined that the mean emission footprint of the LULUCF sector is to amount to at least minus 25 million tonnes of CO2 equivalents in the years from 2027 to 2030. For the period from 2037 to 2040, the sink is to be expanded further to an average of minus 35 million tonnes of CO2 equivalents, and to an average of minus 40 million tonnes of CO2 equivalents in the period from 2042to 2045.

The LULUCF sector is thus of particular importance for the attainment of the national climate targets, particularly in terms of achieving net greenhouse gas neutrality by 2045. In the WMS, the 2024 projection data show that these targets will be missed by 23.7 million tonnes of CO2 equivalents in 2030, by 34.8 million tonnes of CO2 equivalents in 2040, and by 41.6 million tonnes of CO2 equivalents in 2045. Rather than building up necessary the sink performance to attain greenhouse gas neutrality in 2045, and net negative emissions thereafter, the sector is serving as a sink only between the projected years from 2027 to 2042. In the other years, it is a source.

2.A.2 Institutional arrangements

2.A.2.1 Institutional arrangements for tracking progress in the European Union

The EU's Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action ('Governance Regulation')[13] establishes a governance mechanism and specific arrangements to track the progress of the Union and its Member States towards the implementation and achievement of the EU's climate and energy targets and commitments under the UNFCCC and the Paris Agreement. These arrangements include the monitoring of GHG emissions and removals, the reporting of policies and measures, projections of GHG emissions and removals and progress on adaptation to climate change.

Under the Governance Regulation, the EU has established a Union Inventory System to ensure the timeliness, transparency, accuracy, consistency, comparability and completeness of the data reported by the EU and its Member States. This inventory system includes a quality assurance and quality control programme, procedures for setting emission estimates, and comprehensive reviews of national inventory data to enable the assessment of compliance towards climate goals.

Each EU Member State compiles its GHG inventory in accordance with the requirements of the Paris Agreement[14] and the relevant Intergovernmental Panel on Climate Change (IPCC) guidelines[15]. Inventory data on GHG emissions and removals, including information on methods, are submitted electronically using a reporting system managed by the European Environment Agency (EEA). The submitted data are subject to quality control procedures and feed into the compilation of the GHG inventory of the EU. Net GHG emissions, calculated from emissions and removals reported in the GHG inventory of the EU, are the key information used for tracking progress towards the EU NDC target of at least -55% net emission reduction by 2030 compared to 1990.

Given the scope of the EU NDC related to international aviation and navigation, a specific share of international aviation and navigation emissions as reported in the GHG inventory data is calculated based on the Joint Research Centre's Integrated Database of the European Energy System (JRC-IDEES)[16]. Details on the methodology applied to identify GHG emissions from international aviation and navigation in the scope of the EU NDC, which are added to the national totals from the EU GHG inventory, are given in Annex 2 to this BTR.

Under the Governance Regulation each Member State must report to the Commission biennially on the status of implementation of its integrated national energy and climate plans (NECPs). This process allows the Commission to ensure that the EU and the Member States remain on track to achieve the climate-neutrality objective and progress on adaptation. Under the Governance Regulation, Member States further operate national systems for policies and measures and projections and submit and report standardised information, which is subject to quality and completeness checks. Based on the submitted data, the EEA compiles projections of GHG emissions and removals for the EU. The EU-wide information is summarised annually in the Climate Action Progress Report[17] by the European

13 Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action, http://data.europa.eu/eli/reg/2018/1999/oj.

14 Chapter II of the annex to decision 18/CMA.1, https://unfccc.int/documents/193408; and decision 5/CMA.3, https://unfccc.int/documents/460951.

15 2006 IPCC Guidelines for National Greenhouse Gas Inventories, https://www.ipcc-nggip.iges.or.jp/public/2006gl/; and on a voluntary basis: 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, https://www.ipcc.ch/report/2019-refinement-to-the-2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/.

16 European Commission, Joint Research Centre, Rózsai, M., Jaxa-Rozen, M., Salvucci, R., Sikora, P., Tattini, J. and Neuwahl, F., JRC-IDEES-2021: the Integrated Database of the European Energy System – Data update and technical documentation, Publications Office of the European Union, Luxembourg, 2024, https://publications.jrc.ec.europa.eu/repository/handle/JRC137809.

17 Climate Action Progress Report 2024, https://climate.ec.europa.eu/document/download/d0671350-37f2-4bc4-88e8-088d0508fb03_en?filename=COM_2024_498_F1_REPORT_FROM_COMMISSION_EN_V4_P1_3729454.PDF

Commission and in the 'Trends and projections' report by the EEA.[18] Both the Union and the national systems are subject to continuous improvements.

The national energy and climate plans (NECPs) were introduced by the Governance Regulation.

For Member States, the NECP for 2021-2030 play a key role to enabling the tracking of progress towards the 2030 climate and energy targets. The update of the NECPs provides an opportunity for Member States to assess their progress, identify gaps and revise existing measures or plan new ones where needed.

Member States were due to submit their final updated NECPs, taking account of the Commission's assessment and recommendations, by 30 June 2024.

2.A.2.2 Institutional arrangements for tracking progress in Germany

The Federal Climate Action Act provides a framework for a regular review of the progress on climate policy in Germany.

The German Environment Agency publishes and transmits the emission data of the preceding year to the Council of Experts on Climate Change by 15 March of each year. This comprises the greenhouse gas emissions in overall terms and broken down by the sectors in Annex 1 of the Climate Action Act. The data show whether the emission data of the individual sectors of energy, industry, buildings. transport, agriculture and waste/other are higher or lower than the total annual emission volume according to Annex 2. Sources and sinks of greenhouse gases are reported for the land use, land-use change and forestry sector. In order to review the progress on implementing the European Effort Sharing Regulation, the emission data for the preceding years from reference year 2020 transmitted to the European Commission are added to the report, and a breakdown is provided of the emission shares of the sectors which are subject to the European Effort Sharing Regulation.

Furthermore, the German Environment Agency compiles projection data annually on the basis of currently available emissions data and in line with the requirements of the European Governance Regulation on the future development in overall emissions and in emissions in the sectors under section 5(1) for all subsequent years until and including 2030 and at least for 2035, 2040 and 2045. The German Environment Agency transmits the projection data by the end of 15 March of each year at the same time as the publication of the emission data under section 5 to the Council of Experts on Climate Change and forwards them to the Bundestag.

The Council of Experts on Climate Change examines the emissions data and the projection data, and presents the Federal Government and the Bundestag with an assessment of the transmitted data by 15 May. In this process, it determines the extent to which the total greenhouse gas emissions are higher or lower than the total annual emission volumes prescribed by the Federal Climate Action Act on the basis of the projection data in the period 2021 – 2030. If the Council finds that the total annual emission volumes are higher than those prescribed for the 2021 – 2030 period in two successive years, there is a requirement for new policy measures.

It is also to be found whether, according to the emission and projection data, the stipulated allocations under the European Effort Sharing Regulation are complied with in the years from 2021 to 2030 or not. If the Council finds that the ESR targets are not being met, the Federal Government must inform the

[18] Trends and Projections in Europe 2024, https://www.eea.europa.eu/en/analysis/publications/trends-and-projections-in-europe-2024 https://www.eea.europa.eu/en/newsroom/news/eea-trends-and-projections

Bundestag of this within one month and comment on potential effects under Article 8 of the European Effort Sharing Regulation.

2.A.2.3 Institutional arrangements for implementation of the NDC

2.A.2.3.1 Institutional arrangements for implementation of the NDC in the European Union

The EU and its Member States have set up a comprehensive system for the implementation of the EU climate change mitigation targets. The European Climate Law46 sets the goal of climate neutrality by 2050 and the intermediate target of reducing net greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels. These targets cover emissions and removals that are regulated in the Union law.

To ensure that the EU and its Member States achieve their target, the 2030 Climate and Energy Framework was put in place. The main policies of this framework are the EU Emissions Trading System (EU ETS)[19], which caps GHG emissions in energy, industry, aviation and maritime transport; the LULUCF Regulation which includes national net removal targets for the LULUCF sector; and the Effort Sharing Regulation (ESR) which establishes national reduction targets for GHG emissions not covered by the EU ETS or the LULUCF Regulation i.e. domestic transport (excluding aviation), buildings, agriculture, small industry and waste. The implementation of the ESR is supported by additional sectoral policies and measures (details can be found in this BTR in the chapter on mitigation policies and measures). The legislative acts under the 2030 Climate and Energy Framework require the European Commission and the EU Member States to set up the institutional arrangements for implementing the specific policies and measures.

The revised EU ETS Directive increases the level of ambition in the existing system from 43% to 62% emissions reductions by 2030, compared to 2005 levels and extend the system to also apply to international maritime transport. A separate carbon pricing system will apply to fuel combustion in road transport and buildings and small-emitting sectors (ETS2) with a 42% emission reduction target compared to 2005 across the sectors covered. The amended Effort Sharing Regulation (ESR) increased, for the sectors that it covers, the EU-level GHG emission reduction target from 29% to 40% by 2030, compared to 2005, which translates in updated 2030 targets for each Member State. The new LULUCF Regulation sets an overall EU-level objective of 310 Mt CO_2 equivalent of net removals in the LULUCF sector in 2030.

The ESR sets national targets for the reduction of GHG emissions in the Member States by 2030. Member States are also subject to gradually decreasing annual emission limits for each year from 2021 to 2030. The annual progress towards the national targets under the Effort Sharing Legislation is assessed by comparing GHG emission levels from the sectors covered by the ESR with the relevant annual emission allocations under the legislation (AEAs). To achieve compliance under the ESR, Member States are permitted to use flexibility options to a certain extent.

Progress in the implementation of these policies and measures is monitored under the Governance Regulation. Relevant information which is reported regularly and archived at the EEA include GHG inventories, approximated GHG inventories for the previous year, information on policies and measures, projections, and progress towards the implementation of integrated National Energy and Climate Plans (NECP). This information helps the EU and its Member States to correct their course if progress towards the targets of the 2030 Climate and Energy Framework is behind schedule. As an example, the European Commission assesses the drafts of new or updated NECPs and provides

[19] This refers to the ETS1, i.e. the Emission Trading System for stationary sources (Chapter III of the ETS Directive) and for aviation and maritime transport (chapter II of the ETS Directive). Note that the 'Emissions trading system for buildings, road transport and additional sectors' (ETS2), added in 2023 as Chapter IVa of the ETS Directive, forms an instrument under the Effort Sharing Regulation (ESR).

recommendations for improved planning and implementation. In addition, the reported information is subject to quality checks, and the GHG inventories reported by EU Member States are subject to comprehensive reviews in 2025, 2027 and 2032.

All EU legislation, including the legislation under the 2030 Climate and Energy Framework, is subject to a stakeholder engagement process. So-called 'better regulation tools' ensure that policy is based on evidence and the best available practice. During the preparation of legislative proposals, the European Commission invites citizens, businesses and stakeholder organisations to provide their views on the subject of the new legislation. These comments are documented in a dedicated portal, and the European Commission reports on how it takes these comments into account in the development of the legislative proposals. Furthermore, the Governance Regulation sets requirements for Member States to ensure that the public is given early and effective opportunities to participate in the preparation of the NECPs.

2.A.2.3.2 Institutional arrangements for implementation of the NDC in Germany

The rules governing the implementation of the targets are also anchored in the Federal Climate Action Act.

Section 9 of the Act states that the Federal Government must adopt a climate action programme within the first year of each legislative term. After each update of the climate action plan, the Federal Government examines whether a new climate action programme is to be adopted. The climate action programmes contain proposals of which measures are taken in the respective sectors and on a cross-sector basis to attain the national climate targets in the Federal Climate Action Act. The basis for this is always the latest projection report. Where further measures are necessary to comply with the total annual emission volumes, all the relevant federal ministries, within six months following the commencement of the legislative term, propose measures that are suitable for compliance with the total annual emission volumes. Besides scientific estimates of the probable greenhouse gas reduction effects, the proposals for measures also contain scientific estimates of potential economic, social and other environmental impacts. These estimates also include as far as possible effects on employment trends, the economic structure, the equivalence of standards of living, also in rural areas, and the efficiency of the use of natural resources. The lead ministry responsible for climate action, in coordination with the relevant federal ministries, determines the probable greenhouse gas reduction effect of the proposed measures. A public consultation procedure involving the Länder, municipalities, business associations, civil society organisations and scientific advisory bodies of the Federal Government is envisaged for each climate action programme. Before the climate action programmes are adopted, the Federal Government is obliged to obtain comments from the Council of Experts on Climate Change regarding the assumed greenhouse gas reductions.

An update of the climate action programme is required if the Federal Government is obliged to take new measures in response to a finding in two successive years by the Council of Experts on Climate Change that the target will be missed due to an overshoot of the annual total emission volumes from 2021 – 2030.

The Federal Government submits the Climate Action Report to the Bundestag each year on 30 June. It presents the development of greenhouse gas emissions in overall terms and in the respective sectors, as well as the status of implementation of the climate action programmes. Furthermore, it contains a forecast of the expected future greenhouse gas reduction effects and the status of implementation and a forecast of the attainment of the sink targets.

2.B Description of the Nationally Determined Contribution under Article 4 of the Paris Agreement

Under their updated NDC[20] the EU and its Member States, acting jointly, are committed to a legally binding target of a domestic reduction of net greenhouse gas emissions by at least 55% compared to 1990 by 2030. The term 'domestic' means without the use of international credits.

The NDC consists of a single-year target, and the target type is 'economy-wide absolute emission reduction'. The scope of the NDC covers the 27 Member States of the EU.

The 17 October 2023 updated NDC scope is supplemented by additional information to clarify the precise amount of international aviation and maritime emissions which are covered under the EU NDC. Details on the EU NDC can be found in Table 1 and in the 202 below.

Table 1: Description of the NDC of the EU

Information	Description
Target and description	Economy-wide net domestic reduction of at least 55% in greenhouse gas emissions by 2030 compared to 1990. The term 'domestic' means without the use of international credits.
Target type	Economy-wide absolute emission reduction.
Target year	2030 (single-year target)
Base year	1990
Base year value	Net greenhouse gas emissions level in 1990: 4 699 405 kt CO_2eq.
Implementation period	2021-2030
Geographical scope	EU Member States (Belgium, Bulgaria, Czechia, Denmark, Germany, Estonia, Ireland, Greece, Spain, France, Croatia, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Malta, the Netherlands, Austria, Poland, Portugal, Romania, Slovenia, Slovakia, Finland, Sweden) including EU outermost regions (Guadeloupe, French Guiana, Martinique, Mayotte, Reunion, Saint Martin (France), Canary Islands (Spain), Azores and Madeira (Portugal)).
Sectors	Sectors as contained in Annex I to decision 5/CMA.3: Energy, Industrial processes and product use, Agriculture, Land Use, Land Use Change and Forestry (LULUCF), Waste. ***International Aviation:*** Emissions from civil aviation activities as set out for 2030 in Annex I to the EU ETS Directive are included only in respect of CO_2 emissions from flights subject to effective carbon pricing through the EU ETS. With respect to the geographical scope of the NDC these comprise emissions in 2024-26 from flights between the EU Member States and departing flights to Norway, Iceland, Switzerland and the United Kingdom. ***International maritime Navigation:*** waterborne maritime navigation is included in respect of CO_2, methane (CH_4) and nitrous oxide (N_2O) emissions from maritime transport voyages between the EU Member States.
Gases	Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6), nitrogen trifluoride (NF_3)
LULUCF categories and pools	The included LULUCF categories and pools are as defined in decision 5/CMA.3.

[20] The update of the nationally determined contribution of the European Union and its Member States, https://unfccc.int/sites/default/files/NDC/2023-10/ES-2023-10-17%20EU%20submission%20NDC%20update.pdf.

Information	Description
Intention to use cooperative approaches	The EU's at least 55% net reduction target by 2030 is to be achieved through domestic measures only, without contribution from international credits. The EU will account and report for cooperation with other Parties in a manner consistent with the guidance adopted by CMA1 and any further guidance agreed by the CMA.
Any updates or clarifications of previously reported information, as applicable	The information on the NDC scope contains clarifications/further details compared to the information provided in the updated NDC of the EU.

Note: This table is identical to table 'Description of a Party's nationally determined contribution under Article 4 of the Paris Agreement, including updates,' which has been submitted electronically together with this BTR. This table is also annexed to this BTR.

Source: Updated NDC of the EU[21]

2.B.1 National climate targets

The Federal Climate Action Act anchors in law a GHG reduction path for Germany which is consistent with the EU's climate targets. Germany is to cut its GHG emissions by at least 65% by 2030 (from 1990; EU target is 55%). Germany is to achieve net greenhouse gas neutrality by 2045. A corresponding reduction path – with annual reduction targets up to and including 2040 – is stipulated in the Federal Climate Action Act. The reduction targets cover the CRF categories of energy, industrial processes and product use, agriculture and waste.

The Federal Climate Action Act offers in principle the possibility to attain part of the reduction targets via international mechanisms.

For the LULUCF sector, the Federal Climate Action Act does not set any annual emission volume, but targets for the period up to 2050 are provided. In the period from 2027 – 2030, the capacity of natural sinks is to be raised by an average of -25 million tonnes of CO2 equivalents a year. The Act envisages the setting of targets for technical sinks for 2035, 2040 and 2045.

[21] The update of the nationally determined contribution of the European Union and its Member States, https://unfccc.int/sites/default/files/NDC/2023-10/ES-2023-10-17%20EU%20submission%20NDC%20update.pdf.

2.C Necessary information relating to the progress on implementation and realisation of the Nationally Determined Contributions stipulated in Article 4 of the Paris Agreement.

2.C.1 Indicator, including definitions

For the tracking of progress towards implementing and achieving the NDC of the EU, an indicator is used which has the same unit and metric as the NDC base year and target values. The chosen indicator is 'annual total net GHG emissions consistent with the scope of the NDC in CO2eq' Table 2 provides more information on this indicator.

Table 2: Indicator for tracking progress

Information	Description
Selected indicator	Annual total net GHG emissions consistent with the scope of the NDC in CO_2eq.
Reference level and base year	The reference level is total net GHG emissions of the EU in the base year (1990). The reference level value for the EU is 4 699 405 kt CO_2eq.
Updates	This is the first time the reference level is reported, hence there are no updates. The value of the reference level may be updated in the future due to methodological improvements to the EU GHG inventory and to the determination of international aviation and navigation emissions in the NDC scope.
Relation to the NDC	The indicator is defined in the same unit and metric as the target of the NDC. Hence it can be used directly for tracking progress in implementing and achieving the NDC target.
Definitions	Definition of the indicator 'annual total net GHG emissions in CO_2eq': Total net GHG emissions correspond to the annual total of emissions and removals reported in CO2 equivalents in the latest GHG inventory of the EU. The totals comprise all sectors and gases listed in the table entitled 'Reporting format for the description of a Party's nationally determined contribution under Article 4 of the Paris Agreement, including updates.' Indirect CO2 emissions are included from those Member States that report these emissions.

Note: The information in this table is identical to the information in Common Tabular Format (CTF) tables 1 ('Description of selected indicators') and 2 ('Definitions needed to understand the NDC'), which were submitted electronically together with this BTR.

Source: The reference level is based on the Annual European Union GHG inventory 1990-2022.

2.C.2 Methodologies and accounting approach

The EU use the following accounting approach for tracking progress towards the joint EU NDC: annual GHG data from the national GHG inventory of the EU, complemented for international aviation and navigation with estimations from the Joint Research Centre's Integrated Database of the European Energy System[22]. The total net GHG emissions are provided in the scope of the EU NDC and are compared to the economy-wide absolute emission reduction target as defined in the NDC. The EU will account for its cooperation with other Parties in a manner consistent with guidance adopted by the CMA.

As far as emissions and removals from the LULUCF sector are concerned, net emissions are used for tracking progress towards the 2030 target of the NDC based on all reported emissions and removals.

[22] European Commission, Joint Research Centre, Rózsai, M., Jaxa-Rozen, M., Salvucci, R., Sikora, P., Tattini, J. and Neuwahl, F., JRC-IDEES-2021: the Integrated Database of the European Energy System – Data update and technical documentation, Publications Office of the European Union, Luxembourg, 2024, https://publications.jrc.ec.europa.eu/repository/handle/JRC137809.

Details on methodologies and accounting approaches consistent with the accounting guidance[23] under the Paris Agreement can be found in CTF table 3 ('Methodologies and accounting approaches'), which was submitted electronically together with this BTR.

2.C.3 Structured summary – status of progress

An important purpose of the BTR is to demonstrate where the EU and its Member States stand in implementing their NDC, and which progress they have made towards achieving it. The most recent information on GHG emissions and removals in the scope of the NDC constitutes the key information for tracking this progress. Table 3 summarises the current status of progress.

Table 3: Summary of progress towards implementing and achieving the NDC

	Unit	Base year value	Values in the implementation period			Target level	Target year	Progress made towards the NDC
			2021	2022	2030			
Indicator: Total net GHG emissions consistent with the scope of the EU NDC	kt CO_2eq	4 699 405	3 272 650	3 205 223	NA	(at least 55% below base year level)	2030	The most recent level of the indicator is 31.8 % below the base year level.

NA: Not Applicable.

Note that an annual emissions balance consistent with chapter III.B (Application of corresponding adjustment) will be provided in a subsequent BTR upon finalisation of relevant further guidance by the CMA, based on the annual information reported under Article 6.2.

Note: More detailed information can be found in CTF table 4 ('Structured summary: Tracking progress made in implementing and achieving the NDC under Article 4 of the Paris Agreement'), which has been submitted electronically together with this BTR.

Source: The indicator values are based on the Annual European Union GHG inventory 1990-2022.

Based on the GHG inventory data and data on international aviation and navigation for 2022, the EU and its Member States reduced net GHG emissions by 31.8 % compared to 1990. The EU and its Member States made progress towards implementing and achieving their NDC. The legal and institutional framework is in place to make further progress in the years ahead and to achieve the NDC target by 2030.

[23] Decision 4/CMA.1, Further guidance in relation to the mitigation section of decision 1/CP21, https://unfccc.int/documents/193407.

2.D Policies and measures

In view of the very different challenges faced by the various sectors, the Federal Government is opting for a broad range of instruments drawing on regulation, carbon pricing, funding programmes, fiscal incentives, advice and a variety of support measures for the stakeholders involved. The following section presents a few selected pertinent measures that have already entered into force and that are contributing to Germany's compliance with its climate goals.

The estimated GHG reductions from the measures are presented in five-year intervals up to 2045 as part of the assessment of the instruments in the Federal Government's annual projection report. The data for the preceding year's emissions from the German Environment Agency, which are published on 15 March each year, provide information about the development of emissions both in general and in the individual sectors.

2.D.1 Climate Action Programme 2023

The Federal Government is constantly updating its national climate policy in the climate action programmes. The climate action programmes bring together the measures needed to the implementation of Germany's medium-term and long-term climate targets in all sectors. This sets the course for the decarbonisation of all major sectors of the economy.

The latest 2023 Climate Action Programme was adopted by the federal cabinet on 4 October 2023. Before that, the draft programme was commented on by a number of stakeholders during a public consultation. Some of the key measures for the future transformation programme include the Act on the Need for Wind Energy Sites, the reduction of bureaucratic barriers to the future expansion of PV in Solar Package I, the revised Buildings Energy Act with the requirement that new heating systems should in future use at least 65% renewable energy, and a corresponding change to the funding for the replacement of heating systems in the Federal funding for energy-efficient buildings (BEG). These measures are described in greater detail in the following section and in CTF Table 5.

The assessment of the impact of the measures of the 2023 Climate Action Programme[24] shows a very clear contribution towards reductions. At the outset of this legislative term, the Federal Government still assumed that there would be a cumulative overall gap of more than 1,100 million tonnes of CO2 equivalents during the 2022 – 2030 period (2021 Projection Report[25] and Climate Action Status Review of the Federal Minister for Economic Affairs and Climate Action[26]), but the 2024 projection data show that, if the climate change mitigation measures are rigorously implemented, including the 2023 Climate Action Programme, the gap can be expected to close by around 900 to around 200 million tonnes by 2030.

The Council of Experts on Climate Change confirmed in its independent audit of the 2024 projection data that the greenhouse gas emissions will drop substantially up to 2030. The Council of Experts believes that GHG emissions will however likely see a smaller decline than that shown by the 2024 projection data. Compliance with the goals of the Federal Climate Action Act – on the basis of the total volume of greenhouse gases emitted in the 2021 – 2030 period – is estimated by the Council of Experts

[24] Federal Government (2023): 2023 Climate Action Programme. https://www.bmwk.de/Redaktion/DE/Downloads/klimaschutz/20231004-klimaschutzprogramm-der-bundesregierung.pdf?__blob=publicationFile&v=10, accessed on 4 September 2024

[25] German Environment Agency: 2021 Projection Report. https://www.umweltbundesamt.de/sites/default/files/medien/372/dokumente/projektionsbericht_2021_uba_website.pdf, accessed on 4 September 2024

[26] Federal Ministry for Economic Affairs and Climate Action (2022): Climate Action Status Review. https://www.bmwk.de/Redaktion/DE/Downloads/Energie/220111_eroeffnungsbilanz_klimaschutz.pdf?__blob=publicationFile&v=1, accessed on 4 September 2024

to be uncertain / unlikely on the basis of an assessment of the assumptions in the 2024 projection data and current developments.

Of the approx. 160 measures and sub-measures in the 2023 Climate Action Programme, 43 measures have already been fully implemented, 92 are currently being rolled out, and 17 measures are undergoing detailed planning.

The climate change mitigation measures with the greatest reduction effect, including those from the 2023 Climate Action Programme, are described in greater detail in the following part of the chapter.

2.D.2 Cross-cutting policies and measures

2.D.2.1 National Climate Initiative, Municipal Guideline (CS1)

In view of the large scope to shape local policy and the high potential for greenhouse gas reductions, the municipalities play a significant role in the attainment of the Federal Government's climate targets. According to current research, the municipalities can reduce emissions by more than 100 million tonnes of CO2 equivalents from the 2019 level via municipal climate change mitigation measures. This reduction potential was identified on the basis of a selection of municipal climate change mitigation measures. The funding portfolio of the National Climate Initiative offers actors at municipal level a comprehensive range of support services to implement strategic and investment measures at the local level.

The Municipal Guideline boosts incentives to develop greenhouse gas reduction potential in the municipal sphere, accelerates the reduction of greenhouse gas emissions, and achieves measurable greenhouse gas reductions with a view to the goal of greenhouse gas neutrality.

From 2008 until the end of 2023, the Municipal Guideline provided approximately €1.3 billion in funding to some 26,300 projects in more than 5,060 municipalities (completed projects). This has triggered investment amounting to around €3.2 billion. A total of 4,816 applications for funding were received in the 2023 reference period.

The quantification of the GHG reduction effect of the individual measures funded via the National Climate Initiative is undertaken in the respective sector models (industry, waste management) in the 2024 projection data.

2.D.2.2 EU Emission Trading System (CS2)

The revised EU Emissions Trading Directive, which took effect on 10 May 2023, thoroughly reformed European emissions trading and aligned it with the EU's climate target of cutting net greenhouse gas emissions in the EU by at least 55% between 1990 and 2030. The amended Directive contains important innovations designed to strengthen the EU-ETS and its price signal. Core elements of the reform include:

- the increase in the level of ambition in the existing emissions trading system (EU ETS 1), which covers major energy and industrial facilities and intra-European aviation, via an increase in the linear reduction factor compared with the previous version;
- the inclusion of European and international (at a 50% rate) maritime transport in EU ETS 1 and
- the introduction of a new, separate fuel emissions trading system (EU ETS 2) for emissions from the buildings sector, road traffic and small industrial facilities.

Also, the free allocation was fundamentally reformed, and supplemented with the element of the EU's Carbon Border Adjustment Mechanism.

In order to determine the GHG reduction effect in the 2024 projection data, it was assumed that the tightening of the EU ETS will result in a higher price path than was assumed in the 2023 Projection Report. The CO2 price of the EU ETS is prescribed as an exogenic framework parameter in the sector modelling. The adjustment of the benchmarks changes the volumes of allowances allocated free of charge. The EU ETS is complemented by the Carbon Border Adjustment Mechanism. It replaces successive free-of-charge allocations to domestic installations with obligations to pay duty on imports. The quantification of the effect is undertaken in the sector models for the relevant sectors (mainly energy sector, industry).

2.D.2.3 Fuel Emission Allowance Trading Act (CS3)

Carbon pricing in the form of the national fuel emission trading system was successfully launched on 1 January 2021. In the introductory phase, the national carbon price for heating and transport rises steadily and predictably; for 2026 free price formation is envisaged with a minimum price (€55) and a maximum price (€65). The price per tonne of CO2 was €30 in 2022. The increase in the CO2 pricing was suspended for 2023 in view of the sharp rise in energy prices in 2022. Article 7 of the 2024 Budget Financing Act introduced the return to the originally agreed price path, so that the price in 2024 stands at €45 per tonne of CO2. From 2027, price formation will be entirely free, unless a different proposal is made on the basis of the evaluations up to 2025.

From 2023, further fuels (e.g. coal) were included in the pricing, and waste combustion joined the system in 2024.

Companies which are particularly severely affected by the CO2 pricing of the Fuel Emission Allowance Trading Act and at risk of carbon leakage are granted a partial offsetting of the carbon price. This is contingent on environmental measures made in return, such as the introduction of an energy management system and the implementation of efficiency and decarbonisation measures. The compensation and the measures made in return are stipulated in the Carbon Leakage Ordinance under the Fuel Emission Allowance Trading Act.

In order to restrict the possibility for landlords to pass on the carbon price to tenants, the Bundestag adopted an Act on the Sharing of the Carbon Price on 10 November 2022, followed by the Bundesrat on 25 November 2022. Since 1 January 2023, it has only been possible to pass on to the tenants some of the carbon costs that accrue on top of the heating costs.

The modelling of the measure and its greenhouse gas reduction effect in the 2024 projection data took place via assumptions on the CO2 price path defined on a cross-sector basis for the relevant sectors (transport, buildings, industry), and is prescribed as an exogenic framework parameter for the sector modelling. The modelling of the environmental measures undertaken in return for CO2 price compensation in line with the Carbon Leakage Ordinance under the Fuel Emission Allowance Trading Act is being implemented in the industry model via expedited progress on efficiency and swifter market dissemination of energy management systems. The scope of the Fuel Emission Allowance Trading Act largely overlaps with the EU ETS 2 being introduced at European level from 2027. The question of how the two systems can be combined in Germany, or how the Fuel Emission Allowance Trading Act will be reformed when the EU ETS 2 is introduced, was unclear at the outset of the modelling. It is therefore assumed in the modelling that the scope and estimated price level of the Fuel Emission Allowance Trading Act remain in place.

For the national emission trading system under the Fuel Emission Allowance Trading Act, the first progress report presented to the Bundestag by the Federal Government in 2022 also considered distributive effects. It shows that the underlying burden of the national emissions trading system would

in principle be regressive across the income groups. Furthermore, more recent studies show that the range of burdens within the income groups plays an important role, e.g. via differences between urban and rural areas, or between owner-occupiers and tenants. The Federal Government therefore attaches key priority to ensuring that the transformation is designed in a socially just manner. In order to be able to estimate the distributive effects of climate change mitigation measures whilst they are still being formulated, social climate action monitoring is being developed. In this way, future measures are to be designed to be as socially just as possible at the drafting stage.

In order to help the incentive deriving from the cost imposed by the carbon price to encourage energy conservation in and energy-related renovations of rented accommodation, the carbon price on heat no longer has to be borne solely by the tenants since 2023. The Carbon Dioxide Distribution Act now divides the burden between the landlords and the tenants in a staggered model depending on the energy efficiency of the building. The worse a building's energy performance, the higher the share to be borne by the landlords; landlords have an incentive to improve their buildings' energy performance. The distribution of the costs in line with the staggered model also aims to provide incentives to save energy. The distribution in line with the staggered model also provides relief for tenants. In view of the very different energy requirements of non-residential buildings, their carbon costs are shared equally until the staggered model is introduced.

2.D.2.4 Climate-neutral federal administration (CS4)

The Federal Climate Action Act assigns a special role model function to the federal administration on the path to a greenhouse gas neutral Germany. According to section 15(1) Federal Climate Action Act, it is a stated aim of the Federation to organise the federal administration on a climate-neutral basis by 2030.

The measures already implemented include the introduction of environmental management systems in authorities (cf. section 6(4) Energy Efficiency Act), compliance with a high standard in new buildings and renovations (energy efficiency stipulations for federal buildings from 2021) and the conversion of the vehicle fleet to official cars with alternative drivelines and the use of low-emission and zero-emission vehicles (Act on the Procurement of Clean Vehicles in conjunction with the general administrative provision on clean vehicles). The "Roadmap towards a climate and greenhouse gas neutral federal administration" offers an overview of the main measures contained in the various pieces of legislation.

The Climate-neutral Federal Administration Coordination Office (KKB) in the Federal Ministry for Economic Affairs and Climate Action coordinates and supports the activities of the federal administration. Not least, the Office is working with the authorities to develop further greenhouse gas reduction measures in the federal administration. Also, the Office is collecting data to identify the greenhouse gas emissions of the direct federal administration, and is compiling a footprint from these. The data was first collected for the consumption in 2021. Based on this experience and follow-up improvement procedures, the Office is producing a climate footprint for 2022. The footprint will be updated each year.

The determination of the reduction effect in the 2024 projection data takes place via the modelling of the individual measures for the federal administration in the various sectors. The assessment of the impact takes place in the sector model to which the individual measure is assigned.

2.D.2.5 Energy Efficiency Act (CS5)

The Energy Efficiency Act entered into force at the end of 2023 and supports the implementation of the revised Energy Efficiency Directive adopted in the summer of 2023. The Energy Efficiency Act establishes the first cross-sectoral framework to boost energy efficiency. If the climate targets are to be attained, there must be a substantial improvement in energy efficiency; for this reason, the 2023

Conference of the Parties (COP 28) in Dubai agreed on the goal of doubling energy efficiency by 2030. The act stipulates targets for the reduction in primary and final energy consumption in Germany for 2030. For final energy consumption, this means a cut of around 500 terawatt-hours by 2030 from the 2022 level of consumption. Further to this, a target for the reduction of final energy consumption by 2045 is sketched out. It also obliges the Federation and the Länder to take energy conservation measures from 2024 to reduce their final energy consumption by an annual 45 terawatt-hours for the Federation and by at least 3 terawatt-hours for the Länder up to 2030. Further rules address the role model function of the public sector, the obligatory introduction of energy and environmental management systems for companies with a high level of energy consumption, energy efficiency standards for computer centres, and rules on the avoidance and use of unavoidable waste heat.

2.D.2.6 Climate and Transition Fund (CS6)

In 2010, the "Energy and Climate Fund" was set up, a special fund which is a major funding instrument for the energy transition and for climate action. The second Act Amending the Act on the Establishment of the "Energy and Climate Fund" Special Fund, which entered into force on 22 July 2022, implemented the mandate in the coalition agreement to develop the Energy and Climate Fund into a Climate and Transformation Fund (CTF). The designation and purpose of the special fund have been adjusted in order to permit a better and more flexible orientation to the climate targets in the Federal Climate Action Act and to focus on measures suited to driving Germany's transition to greenhouse gas neutrality.

The revenues received through the Fuel Emission Allowance Trading Act and the revenues from European emissions trading feed into the Climate and Transformation Fund – except where needed to finance the German Emissions Trading Office. The CTF is used in particular to fund measures relating to the improved energy performance of buildings and to the decarbonisation of industry, as well as to the establishment of a hydrogen economy, charging infrastructure for electric mobility, the expansion of renewable energy and measures to improve energy efficiency.

Around €49 billion was available in the CTF in 2024. For 2025, the draft CTF economic plan provides for programme-related spending of a total of approx. €25.47 billion. One reason for the sharp drop in programme-related spending is that the payment of the funding from the Renewable Energy Sources Act has been removed from the CTF and transferred to the core budget.

The reduction effect of the CTF is modelled as follows in the 2024 projection data: the CTF serves as an overarching financial instrument that provides the financial framework for implementation of numerous measures in the various individual sectors. For this reason, the assessment of the effects of these CTF-funded measures has been carried out for the various relevant sectors.

2.D.3 Policies and measures in the energy sector

2.D.3.1 2022 Amendment of the Renewable Energy Sources Act (E1)

The Renewable Energy Sources Act (2023 RES Act) envisages a massive acceleration in the expansion of renewable energy in order to increase the proportion of gross electricity consumption which is covered by electricity generated from renewable energy to at least 80% in 2030. Given gross electricity consumption of 750 terawatt-hours, which is implicitly assumed in the RES Act, this corresponds to around 600 terawatt-hours of electricity from renewable energy in 2030. The 2023 RES Act and the Offshore Wind Energy Act formulate expansion paths for the main energy sources and stipulate volumes to be auctioned in the coming years. The conditions for the auction and the funding rates for wind and solar energy are made more attractive in general, not least in response to higher raw

materials prices and interest rates. The principle that the expansion of renewables is in the overriding public interest and serves public security is anchored in law via the revised version of the RES Act.

For the long term, the parametrisation of the expansion path for renewables in the 2024 Projection Report is based on the expansion paths envisaged in the 2023 RES Act. The latest figures used are as follows: for installations covered by the auction regime, the volumes awarded in the auctions are evaluated as implemented by the Bundesnetzagentur (Federal Network Agency) until the time the modelling begins. They represent a ceiling for the potential new-build in the respective installation categories in the following one or two years. For installations not covered by the auction regime, the current new-build figures from the Core Energy Market Data Register are used for the parametrisation. The new-build path for renewable energy in the modelling therefore starts with the latest figures deriving from the evaluation of the available data and runs on a linear basis across several years to the target figures for the volumes of expansion set out in the 2023 RES Act and the Offshore Wind Energy Act.

In order to ascertain the GHG reduction effect of the more ambitious roll-out of renewable energy in the 2023 RES Act compared with the 2021 RES Act, the expansion path set out in the 2021 RES Act is taken as a reference development. Also, the expansion of battery storage, which is coupled in the modelling to the expansion of renewables, is reduced correspondingly.

2.D.3.2 Act to Develop and Promote Offshore Wind Energy (Offshore Wind Energy Act) (E2)

The Offshore Wind Energy Act regulates the use of offshore wind energy, taking account of nature conservation, shipping and offshore connection lines. The Act states that the installed capacity of offshore wind energy is to be raised from 8.5 GW (2023) to a total of at least 30 GW by 2030, at least 40 GW by 2035, and at least 70 GW by 2045. Planning and approval procedures are being accelerated, and auctions are being extended to include areas which have not previously been the subject of a centralised investigation.

The reduction effect of this measure is modelled and cited together with measure E1.

2.D.3.3 Act on the Need for Wind Energy Sites (E3)

The Act on the Need for Wind Energy Sites stipulates binding area targets for the Länder. By the end of 2027, a share of 1.4%, and by the end of 2032 a share of 2.0% of German territory must be designated for onshore wind energy. The integration of this area target in planning law simplifies and accelerates planning procedures to designate wind energy areas.

The reduction effect of this measure is modelled and cited together with measure E1.

2.D.3.4 Revisions of the Energy Industry Act (E4)

The 2022 revision of the Energy Industry Act anchored in law the aim of greenhouse gas neutrality and oriented electricity grid planning to climate neutrality in 2045. Changes, for example in the fields of grid planning, grid expansion and grid operation, facilitate planning, approval, realisation and the operation of electricity grids. In order to be able to ensure a swift ramp-up of the use of hydrogen, it is necessary to establish densely meshed hydrogen grid infrastructure. The planned roll-out of the hydrogen grid is taking place in two stages. For the first stage, the planning of a hydrogen core network, the rules of section 28r Energy Industry Act (now section 28q Energy Industry Act) entered into force on 29 December 2023. Working from this core network, a second act amending the Energy Industry Act introduced in particular sections 15a to 15e Energy Industry Act on 17 May 2024. These contain ongoing and integrated grid development planning for hydrogen and gas from 2025, and provide the necessary regulatory framework for the future hydrogen rollout. The rules on the financing of the hydrogen core network (sections 28r, 28s Energy Industry Act) are also part of the second revision of the Energy Industry Act. The core idea of the financing concept is to realise the hydrogen core network

on a private-sector basis, and to finance it entirely via grid charges. Should the hydrogen rollout fail or take place much more slowly than expected for reasons that cannot be foreseen today, a subsidiary state guarantee is envisaged.

The effect of these statutory regulations is not quantified separately in the 2024 projection data; rather, the Energy Industry Act is supporting a number of other measures in the energy sector.

2.D.3.5 Federal Requirements Plan Act (E5)

The expansion of the electricity grids is needed at all levels, from major electricity highways from north to south Germany through to the distribution grids which bring electricity to the local consumer. In the 2023 Network Development Plan, the Bundesnetzagentur has confirmed approx. 7,300 km of expansion measures for the transmission system which are needed for Germany up to 2037/2045 to attain climate neutrality. On this basis, the Federal Ministry for Economic Affairs and Climate Action is preparing a revision of the Federal Requirements Plan Act in order to anchor the need for the powerlines in law.

This measure supports the expansion of renewable energy (cf. Measure E1); the 2024 projection data do not include a separate reduction effect for it.

2.D.3.6 Amendment to the Grid Expansion Acceleration Act for the Transmission System (E6)

The Grid Expansion Acceleration Act for the Transmission System regulates the planning, construction, alteration and operation of ultra-high voltage grids which cross Länder and national borders.

This measure supports the expansion of renewable energy (cf. Measure E1); the 2024 projection data do not include a separate reduction effect for it.

2.D.3.7 Funding programme for community energy organisations (E7)

The funding programme for community energy organisations enables the state to cover up to 70% of the costs of planning and approval of onshore wind turbines up to a maximum amount of 25 MW per applicant (max. €300,000) erected by community energy organisations.

The reduction effect of this measure is modelled and cited together with measure E1.

2.D.3.8 Solar package I (E8)

The Act amending the Renewable Energy Sources Act and other provisions governing the energy industry to increase the expansion of energy generation from photovoltaics (“Solar Package I”) sets the course for an acceleration of the roll-out of PV and reduces red tape. It covers the entire range of PV, from the small installation on a balcony to roof-top installations on single-family and multi-family houses and on factory sheds, and to large-scale ground-mounted installations. It also contains important new rules for the energy transition regarding other renewable energy, electricity storage and electricity grids. The decision to introduce Solar Package I implements major parts of the Federal Ministry for Economic Affairs and Climate Action’s PV Strategy.

The reduction effect of this measure is modelled and cited together with measure E1.

2.D.3.9 Heat Planning and Decarbonisation of Heating Networks Act (Heat Planning Act) (E9)

The Heat Planning Act entered into force on 1 January 2024 and creates the legal basis for a nation-wide introduction of systematic heat planning. The statutory obligation is addressed to the Länder, which themselves can determine bodies responsible for planning, e.g. municipalities, and entrust them with implementation. Heat planning is a decisive key for strategic planning and control of decarbonisation of the heat supply at local level, taking account of the relevant local stakeholders. At the same time, the survey of needs which is undertaken as part of the heat planning offers the opportunity to identify groups of buildings or neighbourhoods with particularly a high potential for savings and to

address them specifically. The Heat Planning Act also imposes requirements on the decarbonisation of heat networks. In principle, each existing heat network must use at least 30% heat from renewable energy or unavoidable waste heat or a combination of these from 2030 (at least 80% from 2040). On average nation-wide, the proportion of renewable energy, unavoidable waste heat or a combination of these should amount to 50% from 2030. Each new heat network must use at least 65% heat from renewable energy or unavoidable waste heat or a combination of these from 1 March 2025. By the end of 2044, each heat network in Germany must be entirely supplied with heat from renewable energy or unavoidable waste heat or a combination of these.

Two separate reduction effects are connected to the transformation of district heating. GHG savings result from the decarbonisation of the existing production of district heating. This effect is ascribed to the energy sector in the 2024 Projection Report. Further savings derive from the expansion of the district heating infrastructure and the related rise in the number of connected consumers. This replaces distributed heat generation in the demand sectors (in particular buildings, industry). The related savings are ascribed to the relevant demand sectors in the 2024 Projection Report. In the buildings sector, the relevant savings are ascribed in particular to the Buildings Energy Act (specifically, the 65% requirement).

2.D.3.10 Combined Heat and Power Act (CHP Act 2023) (E10)

The 2023 Combined Heat and Power Act promotes the generation of electricity from CHP installations. New gas-fired CHP installations with more than 10 MWel which have been approved since 30 June 2023 under the Federal Immission Control Act must be H2-ready from 1 January 2028.

The surcharges for the CHP electricity, which has to be accepted by the grid, are paid by the consumers via the CHP levy, with the total payments being restricted to €1.8 billion. The CHP surcharge is determined in line with the Energy Financing Act, and is added to the grid charges by the grid operators. The surcharge is set afresh for each year in line with the need for funding and the extent of the privileged treatment.

The reduction effect of the CHP Act is quantified in the 2024 Projection Report, taking account of interactions with the phase-out of coal, the decarbonisation of the heat networks and the roll-out of hydrogen-fired power plants. In the modelling of the effect of the CHP Act, the installed electrical output of combined heat and power plants is taken from the Power Plant List, as are the efficiency ratings, the power-to-heat ratio and the extraction of heat. The output of the electrical heat generators incentivised by the CHP Act also feeds into the modelling.

2.D.3.11 Federal funding for efficient heating networks (BEW) (E11)

The Federal funding for efficient heating networks (BEW) has been available since 15 September 2022. The funding programme sets incentives for heat network operators to invest in the building of new heat networks with high proportions of renewable energy and waste heat, and to decarbonise and expand existing networks. The funding takes a systemic approach, viewing the heat network as a whole, and aims to provide reliable support for the time-consuming conversion of existing networks to renewable energy and waste heat, and for the building of new networks which are predominantly supplied with renewable energy. For example, municipalities, companies and cooperatives can obtain grants when they build a heat network using high proportions of renewable energy and waste heat, or gradually convert existing heat networks to the use of renewable energy and waste heat. Funding towards operating costs is possible for the generation of volumes of renewable heat from solar thermal installations and heat pumps which are fed into heat networks. On top of this, funding is available for individual measures which can be implemented quickly or are not yet foreseeable at the time the heat network is planned.

As expected, there is a high level of demand for the Federal funding for efficient heat networks: as things stand, more than 2300 applications for funding have been submitted, and 1800 of them have already been approved. In this context, approvals have been issued for funding exceeding €1.6 billion (status: 2 September 2024). In order to determine the reduction effect in the 2024 Projection Report, the data basis for non-fossil heat generators was updated, particularly for large-scale electric heat pumps, electrode boilers, geothermal energy, solar thermal energy and waste heat. Solar thermal energy, heat pumps, geothermal energy, biomass and waste heat are assumed to be sources of heat which are eligible for funding. For the modelling in the energy sector, the impact of the Federal funding for efficient heat networks on the technology mix in the supply of district heating is of relevance. The annual new-build of thermal output is mapped with a breakdown of the various eligible technologies in district heating networks on the basis of initial estimates of the effect of the Federal funding for efficient heat networks. In the mapping of the Heat Planning Act in the WEMS, the Federal funding for efficient heat networks and the Heat Planning Act are quantified together, by assuming a higher level of new-build of the relevant technologies in district heating networks.

2.D.3.12 Act on the Phase-Out of Coal Plants, “mining districts contract” for the accelerated phase-out in the Rhineland mining district up to 2030 (E12)

In line with the Act to Reduce and End Coal-Fired Power Generation, the use of lignite and hard coal for electricity generation is to be steadily reduced, so that the output of the power plants in 2022 is approx. 15 GW lignite and 15 GW hard coal, dropping to a maximum of 9 GW lignite and 8 GW hard coal in 2030, and falling to zero by the end of 2038 at the latest. The revision of the Act in December 2022 brought forward the phase-out of lignite in the Rhineland mining district to 2030.

The determination of the reduction effect in the 2024 Projection Report took place in a first step in line with Annex 2 of the Act for the large lignite-fired power plants, taking account of the results of the decommissioning auctions for small lignite-fired and hard coal-fired power plants. Also, account was taken of the statutory reduction for 2024 – 2026 and known CHP replacement projects. Finally, the installed capacities of lignite-fired and hard-coal-fired power plants available in every year between 2024 and 2038 is estimated, on a by-plant basis. Since the modelling starts with 2024, it was no longer necessary to take account of the effects of the Act on the Maintenance of Substitute Power Stations, because the relevant provisions expired in April 2024. The decommissioning then takes place from the 2027 target year on the basis of the statutory reduction. The statutory reduction takes place in the order of the plants’ ages, with recent modernisations being considered in the determination of that order. Small plants with capacities below 150 MW will be decommissioned, via regulatory law, no earlier than 2030. In a second step, the economic viability of the identified power plants is reviewed. It may be the case that coal-fired power plants already leave the market for commercial reasons before the end of their calculated lifetime.

2.D.4 Policies and measures in the industry sector

2.D.4.1 EU Innovation Fund (I1)

The EU Innovation Fund is a European funding programme which promotes:

- innovative low-carbon technologies and processes in energy-intensive industries including products which replace carbon-intensive industries,
- carbon capture and use (CCU),
- construction and operation of carbon capture and storage (CCS),

- innovative renewable energy generation and
- energy storage.

The Innovation Fund focuses on highly innovative technologies and flagship projects within Europe that can bring about significant emission reductions.

The Fund aims to finance a varied project pipeline, achieving an optimum balance between a wide range of innovative technologies in all eligible sectors (energy-intensive industries, renewable energy, energy storage, CCS and CCU) and Member States.

The Fund is generated from the revenues from auctions of ETS allowances. It was expanded in the course of the negotiations on the Fit for 55 Package in terms both of finance and of the eligible sectors. By 2030, 534 million allowances are to be auctioned for the Innovation Fund.

In the 2024 projection data, the following parameters are assumed for the modelling of this measure:

The available budget for the Innovation Fund is calculated via the carbon price assumed in the framework data and using a total volume of 530 million allowances up to 2030. It is assumed that Germany has a share of 16% of the total Innovation Fund, with 50% of this being used for industry. At most, ~60% of the costs are funded, including operating costs (OPEX funding). Finally, it is assumed that the funding is deployed effectively and the funded projects are successful.

2.D.4.2 Decarbonisation in Industry funding programme / further development into Federal Funding for Industry and Climate Action (BIK) (I2)

Under the funding guideline for the Decarbonisation in Industry funding programme, funding goes towards – in each case in the field of energy-intensive industry with process-related emissions – research and development, trialling in test/pilot facilities and investment in facilities to use and implement measures on an industrial scale which are suited to reducing GHG emissions as far and as permanently as possible and thus to make a contribution to GHG neutrality in industry up to 2045. This covers research, development, testing and implementation of:

- -corresponding low-GHG/GHG-neutral manufacturing processes in the respective sectors replacing previously energy-intensive manufacturing processes causing process-related emissions,
- -innovative and highly efficient processes to switch from fossil fuel to electricity-based processes, and
- -integrated production processes and innovative combinations of production processes.

Funding is also going towards the research, development and testing of products whose manufacture does not generate process-related emissions. Further to this, funding goes towards bridging technologies which represent a substantial step towards largely GHG-neutral production processes and which make it possible in the long term to switch fully to the use of renewable energy and raw materials. To be eligible to apply for funding, applicants must be commercial enterprises that are planning or are operating installations licensed under the provisions of the Federal Immission Control Act in sectors that are covered by the scope of EU emissions trading and generate process-related greenhouse gas emissions. The beneficiaries must have a permanent establishment or branch in Germany. Projects for which funding is requested must be implemented in Germany. Consortia of companies are also eligible to apply.

In 2023, funding amounted to approx. €36.2 million (actual spending); the planned figure for 2023 is approx. €659 million.

At the time of modelling the projection data for 2024, the requirements imposed on the granting of the funding were still generally subject to little definition. The following key points were used in the modelling:

- Funding from carbon contracts for difference and the Decarbonisation in Industry programme cannot be combined for a project (mutual exclusion)
- Decarbonisation in Industry is only to fund CAPEX
- Module breakdown between CCU/S and general
- Criteria: 70% funding efficiency (translated as the differential costs per avoided tonne of CO2), 30% other criteria (e.g. strategic significance, distribution across sectors)
- The Federal funding for energy and resource efficiency in business and the Decarbonisation in Industry programme are targeted at different beneficiaries (the Decarbonisation in Industry programme at larger projects and non-market-ready projects) – the modelling therefore does not assume any interaction / overlapping.
- It is assumed that the funding is deployed effectively and the funded projects are successful.

2.D.4.3 IPCEI Hydrogen (I3)

In the context of the Important Project of Common European Interest on Hydrogen Technologies and Systems (IPCEI Hydrogen), the Federal Government is planning to provide funding for integrated projects along as much of the hydrogen value chain as possible, from the production of green hydrogen to hydrogen infrastructure, through to its use in the industrial and mobility sectors. Funding is primarily intended for investment costs (CAPEX); the funding of OPEX is only possible in special cases (mainly R&D projects).

The budget is to fund national industrial projects, mainly via the IPCEI Hydrogen. The overarching aim of the planned funding is to fundamentally convert the industry sector to new technologies in order to attain the climate targets. One of the most important fields of innovation in this area is hydrogen technologies, which can be used in particular in the steel, chemical and cement industries.

The funding aims to incentivise investment in hydrogen technologies to decarbonise industrial output (especially of steel and chemicals). Relevant technologies already exist or are close to market-readiness, but entail substantially higher investment and operating costs than conventional technologies. For this reason, part of these costs is to be financed from public money, in order to support implementation of the hydrogen technologies by the private sector. An early introduction of hydrogen technologies for climate-friendly industrial production also opens up opportunities for the machinery and plant industry.

The German projects taking part in the IPCEI Hydrogen aim to save more than 13 million tonnes of CO2 a year by 2030. A precise breakdown across the budgets from which the IPCEI Hydrogen is financed is not possible for each installation, as the aforementioned GHG savings can only be attained in an interplay of investment in hydrogen production, related infrastructure and facilities to make use of it.

In the IPCEI Hydrogen, Germany and France are aiming to work with other Member States to build up large-scale electrolysis capacities to produce green hydrogen, to build up transport infrastructure for hydrogen, and to develop a European value chain, e.g. for fuel cell systems. The hydrogen projects to be funded from this budget which relate to Germany and France were selected during a call for interest for the IPCEI Hydrogen at the beginning of 2021, and are – as decided at the Franco-German technology dialogue between the German Chancellery and the Elysée on 13 October 2020 – to contribute to the

success of the European market ramp-up of hydrogen. The aim is to create a high level of potential to cut carbon emissions via the establishment of large electrolysis capacities to generate green hydrogen.

In the 2024 projection data, maximum assistance of ~50 % of the investment costs is assumed for these measures; there is no OPEX funding. Here, too, it is assumed that effective use will be made of the funding, and that assisted projects will be successful.

2.D.4.4 Carbon contracts for difference (I4)

The "carbon contracts for difference" funding programme helps industrial companies to invest in and operate climate-friendly production facilities which would otherwise be economically unviable. Carbon contracts for difference help companies protect themselves against price risks, offset additional costs and thus create a reliable investment environment in Germany. This will not only directly save on large volumes of greenhouse gases, but will also trigger the urgently needed market transformation and generate additional potential for GHG reductions: carbon contracts for difference provide incentives for launching the development and deployment of the necessary technologies and infrastructure in Germany already today. This results in production facilities and pipelines for hydrogen, expertise in the field of financing, construction and operation of climate-friendly installations, and markets for climate-friendly end-products. CCfDs are therefore not only a central climate action instrument, but are also of great importance for the future competitiveness of German industry and innovation.

Funding amounting to double-digit billions is currently available for the carbon contracts for difference.

The modelling of the reduction effect in the 2024 projection data is based on the following main assumptions:

The budgets for the carbon contracts for difference and the programme to decarbonise industry are pooled together for the modelling – see also Measure I2.

- Maximum funding: CAPEX and OPEX differential costs.
- IPCEI-funded projects in the steel sector are not permitted in the first bidding round.
- CCU/S is eligible for funding in principle, but there is no dedicated funding for it.
- 80% of the assessment of the bids is based on funding efficiency (translated in the modelling as the differential costs per avoided tonne of CO2)
- Assumption: Effective use of the funding (assisted projects are successful)

2.D.4.5 MAC Directive (air-conditioning in vehicles) (I5)

The EU MAC Directive 2006/40/EC (mobile air conditioning) defines maximum GWP (greenhouse warming potential) levels for refrigerants used in the air-conditioning systems of new cars and new types of vehicles. In the modelling of the GHG reduction effect in the 2024 projection data, account is taken of the interaction between the MAC Directive and the HFC phase-down in line with Directive 517/2014 with regard to the HFC volumes placed on the market and emitted.

2.D.4.6 HFC phase-down in line with EU F Gases Regulation 517/2014 (I6), SF6 bans in line with EU F Gases Regulation 517/2014 (I7)

The F Gases Regulation (EU) No 517/2014 on fluorinated greenhouse gases regulates an EU-wide gradual reduction of the volumes of HFCs newly placed on the market (phase-down) and also contains numerous obligations for plant operators and some bans on usage.

In order to model the greenhouse gas reduction effect, the 2024 projection data assume that the restriction on volumes of HFCs in force for 2030 will remain in place after 2030, ensuring continued

compliance with the HFC consumption limits of the Montreal Protocol beyond 2030. The F Gases Regulation is currently being revised; in April 2022 the European Commission published a proposal that includes necessary adjustments to bring it in line with the Montreal Protocol (Kigali Amendment of 2016) and that includes further measures in the context of the European Green Deal.

2.D.4.7 SF6 voluntary commitment by German industry (I8)

The voluntary commitment made by the SF6 producers, manufacturers and operators of electrical equipment >1 kV stipulated emission reduction measures for SF6. In the modelling of the GHG reduction effect in the projection data, it was assumed that, in view of the fact that SF6 remains in equipment for decades, the reduction of the SF6 volumes in the past will continue to lead to future emission reductions – even though no new emission reductions have applied in the voluntary commitment since 2020.

2.D.4.8 Concept for lead markets for climate-friendly basic materials (I9)

The Federal Ministry for Economic Affairs and Climate Action published the concept for lead markets for climate-friendly basic materials ("green lead markets") on 22 May 2024. The focus is on the steel, cement and chemical industries. The concept includes definitions of climate-friendly basic materials as a necessary precondition for the measures to establish/promote these markets. The concept is based on the outcome of a broad-based stakeholder process (2023) and takes account of relevant international and European processes like the G7 Industry Decarbonisation Agenda and the EU Ecodesign for Sustainable Products Regulation (ESPR). Definitions and labels based on these definitions create transparency on the market and permit front-runner companies to advertise and market basic materials as being climate-friendly. The labels can also be used for public and private procurement. Further to this, the definition also offers the basis for a possible introduction of minimum requirements and/or quotas for climate-friendly basic materials at EU level.

This measure is modelled in the WAMS in the 2024 projection. It is assumed that implementation can take place via the role model function of public procurement, which can incentivise further investments via increased demand for climate-friendly steel and cement. This indirect effect is only roughly estimated, and is based on standardisation and certification (i.e. it supports and makes possible a conscious decision for green products). The direct effect is restricted to public procurement. No quotas are envisaged for this; the actual proportions are estimated. Products supported by funding programmes can take part in the lead markets. Account is taken of overlapping instruments (greatly reduces the additional effect of the lead markets).

2.D.5 Policies and measures in the transport sector

2.D.5.1 GHG quota (T1)

The GHG quota rises continuously from 2022, reaching the level of ambition of 25% in 2030. There are some restrictions on imputation and some minimum quotas for the various types of fuel. Also, it is possible to impute the emission reduction resulting from the use of renewable electricity in road transport. The revision of the EU's Renewable Energy Directive (RED), which entered into force in November 2023, raises the targets for the reduction of the GHG emission intensity of the energy supply to transport to 14.5% in 2030 (excluding multiple counting) and envisages a minimum target of 5.5% for advanced biofuels and electricity-based energy sources. Also, the scope of validity of the target in the RED is extended to cover the entire transport sector.

The revision of the 10th Federal Immission Control Ordinance means that fuelling stations in Germany will in future also be able to offer paraffinic diesel fuels as pure motor fuels for use in road traffic (e.g.

HVO 100 or e-diesel). The new possibility to make use of these motor fuels in their pure form does not extend beyond the blending already used, since the emission reduction due to the marketed fuels is determined solely by the existing requirements of the GHG reduction quote of the Federal Immission Control Act.

In the modelling for the 2024 projection data, the GHG quota is complied with across the various regenerative fuel options (incl. the use of electricity). Where imputable, cheap GHG avoidance options are generally used. Indirectly, the fuel costs also change, and this contributes to GHG emission avoidance via the avoidance of traffic and shifts to other modes. Here, it is assumed on the basis of today's prices in GHG quota trading that the GHG reduction options where the imputation is not restricted have a price of €300/t CO2-eq in 2024. In view of the high level of ambition, it is assumed that the price level rises to €400/t CO2-eq by 2026 and remains constant up to 2030. For capped target fulfilment options, the price level currently stands at €250/t CO-eq. It remains constant at €250/t CO-eq. After 2030, the GHG quota price for the uncapped options gradually falls, due to rising availabilities of the fuels, down to the fuel production costs (in 2035). However, the minimum price level remains at €250/t CO-eq. Pure battery-electric cars, light duty vehicles and buses also receive a bonus which can be granted due to the imputation of the reduction to the GHG quota. In the case of buses, it is assumed that this premium supports the fulfilment of the Clean Vehicles Directive; for cars and light duty vehicles, the premium feeds into the TCO cost account in the modelling of new registrations.

2.D.5.2 EU CO2 emission standards for heavy duty vehicles (T2)

The version of Regulation (EU) 2019/1242 as regards strengthening the CO2 emission performance standards for new heavy duty vehicles as revised by Regulation (EU) 2024/1610 of 14 May 2024 has been in force since July 2024. The new rules retain the existing target for 2025, according to which the average CO2 emissions of new heavy duty vehicles with a total weight of more than 16 t are to be cut by 15%. In harmony with the EU's climate targets for 2030 and beyond, the Regulation stipulates the following new targets:

- 45% emission reduction from 2030 (raised from 30%)
- 65% emission reduction from 2035
- 90% emission reduction from 2040.

These targets apply from 2035 for medium trucks, heavy trucks of more than 7.5 t, coaches and corresponding vocational vehicles.

The new rules also introduce the target of 100% zero emissions for new urban buses by 2035, with an intermediate target of 90% for this vehicle category by 2030. Interurban buses are exempted from this, as they are categorised as coaches for the purposes of measuring emission reductions.

The modelling of the reduction effect in the 2024 projection data was undertaken before the new targets were adopted. For the modelling, it was assumed that the emissions of the newly registered trucks (restriction to the regulated truck categories) must fall by 15% by 2025, and by 30% by 2030 compared with the emission reference from July 2019 – July 2020. The EU's CO2 standards for heavy duty vehicles are complied with on average in the modelling. The deviation between the emission figures in Germany compared with the European average is derived from the EU's monitoring and is constantly retained. The reduction effect compared with a reference development without CO2 regulation is assessed. The tightening of the CO2 reduction requirements adopted in May 2024, the extension to include other vehicle groups and a continuation of the reduction targets for newly registered vehicles up to 2040 was not included in the modelling.

2.D.5.3 Higher EU CO2 emission standards for passenger cars and light duty vehicles (T3)

On 15 May 2023, Regulation (EU) 2023/851 as regards strengthening the CO2 emission performance standards for new passenger cars and new light commercial vehicles (Regulation (EU) 2019/631) entered into force in order to bring the existing rules into line with the EU's more ambitious climate targets.

Accordingly, the emissions of the newly registered cars and light duty vehicles covered by the scope of the regulation must fall by 15% each by 2025 and by 55% (cars) and 50% (light duty vehicles) by 2030 from the 2021 emission figures. Vehicles which can only be operated using carbon-neutral fuels ("e-fuels-only vehicles") and a suitable definition of these vehicles via a proposal from the European Commission have yet to be included in the rules. Also, Regulation (EU) 2023/443 of 8 February 2023 adapts the calculation method to determine carbon emissions (WLTP) of plug-in hybrid vehicles (PHEVs) so that the carbon emissions of PHEVs will be closer to the real carbon emission figures from 2025 in the type approval procedure than has been the case.

In the modelling of the reduction effect in the 2024 projection data, it is assumed that the EU's CO2 standards for cars and light duty vehicles are complied with on average by newly registered vehicles. The deviation between the emission figures in Germany compared with the European average is derived from the EU's monitoring and is constantly retained. The reference scenario uses the previous rules on CO2 fleet targets. They had envisaged a CO2 reduction requirement for new vehicles of 37.5% (cars) and 31% (light duty vehicles) from 2030.

2.D.5.4 Extension and CO2 differentiation of the truck toll (T4)

The necessary preconditions in European law for the introduction as set out in the coalition agreement of a CO2 differentiation in the truck toll were put in place when Directive 1999/62/EC on vehicle tolls was revised.

Under the revised directive, Germany had until 25 March 2024 to introduce carbon differentiation in the truck toll.

On 1 December 2023, the CO2 differentiation was introduced in the truck toll in the form of a carbon surcharge, based on a carbon price of €200/t CO2. Since 1 July 2024, the toll has been extended to vehicles with a technically permissible maximum laden mass of over 3.5 tonnes; until then, the weight limit was over 7.5 tonnes. The toll only applies to vehicles intended or used for freight haulage.

Zero-emission trucks are exempted from the toll until the end of 2025, and zero-emission trucks up to 4.25 tonnes are permanently exempted. From 1 January 2026, only 25% of the toll rate for zero-emission trucks has to be levied for infrastructure fees plus the generally also reduced toll rates for noise and air pollution.

In the modelling of the GHG reduction effect in the 2024 projection data, it was assumed that zero-emission vehicles are fully exempted from the toll until the end of 2025. Subsequently, the part of the toll levied for infrastructure costs is to be cut by 75% for zero-emission vehicles. From 2031, there is a further reduction to 50% in order to ensure the most appropriate allocation of infrastructure costs in line with the polluter-pays principle. The infrastructure cost coverage is maintained throughout the modelling period.

The design of the truck toll to cut costs for zero-emission trucks in the section of the toll intended to cover infrastructure costs from 2031 is an assumption on the part of the researchers, and does not correspond to the current draft legislation. The adaptation of the legislation is to take place in 5-year steps, and therefore has to be extrapolated by the researchers' own assumptions.

2.D.5.5 Deutschlandticket (T5)

Introduction of a ticket valid throughout Germany for the use of local public transport at an introductory price of €49/month from 1 May 2023, with the option of a discount from employers as a job ticket and the introduction of a semester ticket for students. This offer makes it easier and cheaper to use local public transport.

The Federation is providing €1.5 billion each year from 2023 – 2025 to offset financial disadvantages relating to the financing of the ticket. The Länder are contributing the same amount.

The GHG reduction effect of these measures was modelled with the aid of initial empirical data permitting an estimate of the effect of the Deutschlandticket. On the basis of Loder et al. (2024), a difference-to-difference view can be used to infer the average traffic-related impact of each Deutschlandticket. As a basis for the scenario production, publicly available data (and extrapolations) at the time of the modelling regarding the number of Deutschlandticket subscriptions (12 million) were used (Association of German Transport Companies (VDV), 1 September 2023).

2.D.5.6 Development and expansion of bicycle paths / cycling infrastructure expansion initiative – active mobility (T6)

The "cycling infrastructure expansion initiative – active mobility" encourages and finances the development of the cycling infrastructure, including the necessary communication and accompanying measures, and of pedestrian traffic. In particular, it significantly strengthens the strategic and operative link between active mobility and local public transport by means of the "Deutschlandticket". At the same time, the Road Traffic Act and the Road Traffic Regulations are being updated to ensure that, along with the aim of freely moving and safe traffic, consideration is given to the goals of climate action and environmental protection, health and urban development, in order to create scope for decision-making by the Länder and the municipalities.

2.D.5.7 Establishment of an initial rapid charging infrastructure grid for battery-electric trucks (initial charging network for e-trucks), operational charging infrastructure and hydrogen fuelling stations (T7)

The forward-looking establishment of an initial network of rapid charging infrastructure for heavy duty vehicles from 2025 – 2030 is ensured. A needs-based basic network for battery-electric trucks will be put in place along the autobahns.

The coordinated establishment of needs-based fuelling and charging infrastructure safeguards the market ramp-up of electric commercial vehicles. The planning and establishment of the charging infrastructure for electric commercial vehicles is a priority in the Charging Infrastructure Master Plan 2 (adopted by cabinet in October 2022). One measure in the Master Plan is the establishment of an initial network of public charging infrastructure for battery-electric trucks. The corresponding call for tenders was published in September 2024. In addition, funding is going towards the establishment of infrastructure at depots, industrial sites and hubs.

Also, funding is being provided for the operational charging infrastructure via the grant to purchase e.g. heavy duty vehicles with alternative drivelines (80% of the additional expenditure, see T10 below on the guidelines on the funding of commercial vehicles with alternative, climate-friendly drives and related fuelling and charging infrastructure). Efforts are also being made towards the establishment of a basic network of hydrogen fuelling stations for the use of hydrogen fuel cell trucks. As part of the National Hydrogen and Fuel Cell Technology Innovation Programme Phase II (NIP II), funding is going towards the establishment of hydrogen fuelling stations for heavy duty vehicles (80% of the expenditure). Also, individual distributed electrolysers for the supply of the fuelling stations with green hydrogen are being funded via the NIP. The National Strategy Framework is to be updated in 2024

(draft) and 2025 (final version), also regarding the establishment of hydrogen infrastructure for transport. It will also ensure the fulfilment of the infrastructure development targets set out in the Alternative Fuel Infrastructure Regulation (AFIR) for commercial vehicles.

In the current 2024 budget, funding from the Climate and Transformation Fund is earmarked for an invitation to bid for an initial rapid charging infrastructure network for battery-electric trucks in the implementation period (for grid connections and the first bidding round).

In the modelling of the greenhouse gas reduction effects in the 2024 projection data, no specific reduction is ascribed to the infrastructure itself; it is regarded as supportive. A lack of availability of infrastructure to supply electrified commercial vehicles can impede a greater market penetration of alternative drive technologies, particularly in long-distance transport. The greenhouse gas reduction generated by vehicles with alternative drivelines can only be realised if there is the necessary fuelling and charging infrastructure to permit the operation of the vehicles. The roll-out of the infrastructure is a prerequisite for a successful market ramp-up. The effect of the other instruments for the market ramp-up of alternative methods of propulsion (e.g. emissions standards, purchase premium) includes the effect of the infrastructure development.

2.D.5.8 Reduction in taxation for company e-cars (T8)

According to the German Income Tax Act, the private use of a company car must be taxed at a flat-rate 1% of the gross listed price for the vehicle per month. Until 2030, reduced company car taxation applies to the use of battery-electric vehicles (reduction of the tax rate down to as low as 0.25%) and plug-in hybrids (reduction down to as low as 0.5%).

In the modelling of the measure for the 2024 greenhouse gas projections, the various annual savings were calculated which derive from the various vehicle and purchaser segments. The saving for the private use of company cars derives from the price of the e-car and the individual tax burden.

2.D.5.9 Increased weighting of the carbon emission charge contained in the motor vehicle tax (T9)

A greater orientation of the motor vehicle tax to carbon emissions was undertaken and completed in the 7th Act Amending the Motor Vehicle Tax Act. In order to foster the switch to electric vehicles, the Act includes an extension of the 10-year exemption from motor vehicle tax for purely electric vehicles which are first registered up to the end of 2025. However, the tax exemption applies until 31 December 2030 at the latest. In order to steer demand more clearly towards cars with reduced emissions potential, the CO_2 tax rate has been given even greater weight via the introduction of a progressive CO_2 rate in motor vehicle tax for vehicles with internal combustion engines. Cars with a CO_2 type approval test of up to 95 g/km which were first registered from 12 June 2020 until 31 December 2024 are given favourable treatment worth €30 per year in motor vehicle taxation until 31.12.2025.

The amended tax rates have been included in the modelling for the 2024 projection data.

2.D.5.10 Guideline for the funding of light and heavy duty commercial vehicles with alternative climate-friendly propulsion systems and the deployment of refuelling and charging infrastructure for electric commercial vehicles (T10).

The publication of the Guideline on the funding of light and heavy duty commercial vehicles with alternative, climate-friendly drives and related fuelling and charging infrastructure for electric commercial vehicles (pure battery electric vehicles, hybrid electric vehicles that can be externally charged, and fuel cell vehicles) on 2 August 2021 by the Federal Ministry for Digital and Transport implements the measure “Procurement of heavy duty vehicles with alternative, climate-friendly drivelines including hydrogen technologies” of the 2023 Climate Action Programme.

The Guideline on climate-friendly commercial vehicles and infrastructure implements one of the three core measures from the 2030 Climate Action Programme to decarbonise (heavy) road freight traffic. The cost of purchasing commercial vehicles with alternative drivelines is still much higher than the cost of purchasing comparable vehicles with combustion engines. This barrier is to be addressed in the initial market ramp-up phase not least via state support for the purchase of commercial vehicles using alternative climate-friendly drivelines.

Funding goes towards the technology-related additional investment costs for commercial vehicles with climate-friendly drivelines and investment in the related operationally necessary fuelling and charging infrastructure (this is financed from budget item 893 02) and towards feasibility studies. The technology-related additional investment costs of commercial vehicles in EC vehicle categories N1, N2 and N3, and special-purpose vehicles with battery-electric or fuel cell-based drivelines, and also of externally rechargeable hybrid vehicles, are eligible for funding. The Guideline on climate-friendly commercial vehicles and infrastructure expires on 31 December 2024.

In total, 1,341 projects with 8,646 commercial vehicles, 679 projects for the related 3,453 charging points, 20 hydrogen fuelling points, and 60 feasibility studies have been funded since the publication of the guideline, with a total funding volume of approx. €1.198 billion up to mid-2024.

2.D.5.11 Charging Infrastructure Master Plan (T11)

In 2019, the Federal Government adopted the Charging Infrastructure Master Plan, which brings together a total of 55 measures being undertaken by the Federation to step up the roll-out of charging infrastructure. This Master Plan was continuously evaluated, and its further development was stipulated in the coalition agreement for the 20th legislative term.

The Federal Government drew up a new overall interministerial strategy in 2022, the Charging Infrastructure Master Plan 2: the roll-out and operation of charging points is to be accelerated; at the same time, charging infrastructure is to become more attractive as a business model, thus mobilising more private-sector investment.

The Charging Infrastructure Master Plan 2 serves as an overall strategy and a roadmap for the tasks in the coming years, and comprises 68 measures in the fields of funding, empowering of municipalities, area availability, electricity grid integration, charging at buildings, and heavy duty vehicles. These measures address policy-makers at federal, Länder and municipal level, investors, operators and suppliers, and the automotive and energy sectors.

In the modelling of the GHG reduction effect in the 2024 projection data, an efficient fuelling and charging infrastructure was deemed to be a prerequisite for the market ramp-up of vehicles with alternative drivelines. No specific reduction is ascribed to the infrastructure itself; it is regarded as supportive. The effect of the afore-mentioned instruments (e.g. emission standards) include the effect of the infrastructure development.

2.D.5.12 “Germany Network” investment programme to expand the charging infrastructure (T12)

The Federal Ministry for Digital and Transport is creating 9,000 additional rapid charging points for electric cars in the “Germany Network” on the basis of the Rapid Charging Act, which entered into force on 1 July 2021. These charging points are being installed in rural areas, in urban areas and at unstaffed autobahn service stations. As a result of two bidding rounds, private companies are building the 1,000-plus sites for the Germany Network. Approx. 900 sites are in urban and rural areas; 200 are directly by the autobahns.

The creation of the Germany Network ensures that the next charging point can be reached quickly and directly throughout Germany – including in areas which are currently commercially uninteresting for charging point operators, but which are important for the ramp-up of electric mobility.

The next rapid charging point along the autobahns will be no more than 15 to 30 km away, ensuring that electric mobility is suitable for medium-range and long journeys. The existing charging infrastructure was included in the determination of requirements. This means that the rapid charging network is supplemented without distorting market-based competition.

The Federal Ministry for Digital and Transport is pursuing the following aims via the Germany Network:

- Area coverage: the users are to be able to reach a charging point without making diversions and throughout Germany.
- Demand coverage: thanks to a sufficient number of charging points at the rapid charging stations, it is to be ensured that the users do not have an unreasonably long wait for a charging point.
- User-friendliness: introduction of a high standard / role model function in terms of accessibility, efficiency and reliability.

2.D.5.13 Greenhouse gas reduction in international aviation and maritime transport

International maritime transport

Under the lead of the Federal Ministry for Digital and Transport, Germany played a major role in 2023 in the successful negotiation of the revised IMO Strategy on Reduction of GHG Emissions from Ships. The revised strategy follows on from the Initial IMO Strategy of 2018, and provides for much more ambitious climate targets than before. The revised strategy requires that international maritime traffic must attain the goal of climate neutrality towards 2050. The replaced strategy from 2018 had provided for a 50% reduction in emissions from ships over the same period.

A target path with interim targets has been agreed in order to attain the goal. It provides that by 2030, greenhouse gas emissions from ships are to fall by at least 20% and if possible even by 30% compared with 2008 levels. By 2040, the emissions are to fall by at least 70%, if possible even by 80%. Germany will work with the other EU Member States and further ambitious partners to advocate an ambitious implementation of the emission reduction path which is compatible with the temperature target of the Paris Agreement.

The strategy also aims to deploy at least 5% – if possible even 10% – climate-friendly fuels by 2030. This aim is important to help the market ramp-up of sustainable driveline technologies and fuels from 2030 at the latest. It creates planning security for the shipping and fuel industry.

In order to attain the new targets, the IMO wishes to adopt binding global measures by 2025. It was also agreed that these measures are to include a standard for the gradual reduction of greenhouse gas intensity of ship fuels and a mechanism to price greenhouse gas emissions in maritime transport. The measures are being developed on the basis of a comprehensive impact assessment in order to ensure that they effectively reduce the emissions of the sector and also contribute to a level playing field and a just and balanced transition. Completion of the comprehensive impact assessment is scheduled for autumn 2024. The Federal Government will continue to work vigorously with other IMO countries in the forthcoming negotiations on specific legally binding measures by 2025 in the context of the 82nd and 83rd sessions of the Marine Environment Protection Committee in order to make the implementation of the strategy as clear and ambitious as possible.

The new climate targets take account of the greenhouse gas emissions of ship fuels on the basis of a life-cycle view in order to prevent a shift of the emissions to other sectors. The life-cycle view takes place on the basis of the guidelines on the Life Cycle GHG Intensity of Marine Fuels (LCA Guidelines), which were also adopted as part of the revised strategy.

International aviation

The International Civil Aviation Organization (ICAO) addresses technical aspects of environmental issues in the framework of its Committee on Aviation Environmental Protection (CAEP), to which various working groups report. In the past, the ICAO has also addressed GHG issues by establishing various working groups (some with high-ranking members) charged with illuminating central political questions relative to the introduction of climate change mitigation instruments.

At European level, the aviation sector was integrated within the EU Emissions Trading System, in keeping with EU Directive 2008/101/EC, in January 2012. Application of the EU-ETS to flights outside of the EEA was temporarily suspended, and these exemptions were extended when the 38th ICAO assembly agreed to develop a Carbon Offsetting and Reduction Scheme (CORSIA) for the international aviation sector.

At the 39th ICAO assembly, held in 2016, the organisation's Member States agreed on a global, market-based measure for stabilising CO2 emissions from international aviation at the level they were at in 2020. As of 2021, airlines will offset CO2 emissions over and above the level of the year 2020 by purchasing carbon credits from projects for reduction of CO2 emissions. In order to implement CORSIA, a CEAP working group drafted corresponding Standards and Recommended Practices (SARPs) and further elements of the rules, and these were adopted by the ICAO Council in 2018. CORSIA reporting obligations began on 1 January 2019. Further implementation of CORSIA is divided into three phases – a voluntary pilot phase (2021–2023), a voluntary first phase (2024–2026) and a compulsory second phase – in keeping with certain criteria oriented to the activity levels of international flights (2027–2035).

As an ICAO member, Germany has expressed its support in the negotiations on CORSIA for a measure that is environmentally effective, neutral with respect to competition and permanently robust. Germany has complemented its political support with concrete technical collaboration in the ICAO CAEP's relevant working groups.

Within the EU, CORSIA has been implemented via the Emissions Trading Directive (ETD), 2003/87/EC. In the context of the European Green Deal, it was decided to let the free allocation of allowances to airlines expire by 2026, and to replace it with auctioning of all of the emission allowances envisaged for air traffic. Where possible, air traffic is to be shifted to railways.

Also, at its 41st session in autumn 2022, the ICAO Assembly adopted a Long-term Aspirational Goal (LTAG), setting the target of net-zero carbon emissions for air transport in 2050. The relevant resolution explicitly states that the greatest potential to cut CO2 emissions in air transport lies in the use of sustainable aviation fuels. This target was backed up in 2023 at the third ICAO Conference on Aviation Alternative Fuels (CAAF/3 in Dubai) with a quantified intermediate target, according to which by 2030 5% to 8% of carbon emissions from air transport are to be saved via the use of sustainable aviation fuels.

This international target equates to the requirements deriving from the EU's ReFuelEU Aviation Regulation (Regulation (EU) 2023/2405), which was adopted in 2023 and which provides for obligatory blending ratios for sustainable aviation fuels, gradually rising from 2% in 2025 to 70% in 2050. The Regulation also provides for sub-quotas for the blending of synthetic aviation fuels.

The measures affect emission sources outside of Germany, and are therefore not modelled in the 2024 Projection Report.

2.D.6 Policies and measures in the buildings sector

2.D.6.1 Buildings Energy Act (GEG) including its 2023 revision with requirements for newly installed heating systems to use 65% renewable energy (B1)

On 1 January 2023, the Buildings Energy Act raised the statutory standard for the primary energy requirements of new buildings to the efficiency house 55 level (section 15 and section 18 of the Act). The revised Buildings Energy Act (implementation of 65% renewables requirement) contributes to energy sovereignty and climate change mitigation via the Act Amending the Buildings Energy Act, Amending the Civil Code, Amending the Heating Costs Ordinance, Amending the Operating Costs Ordinance and Amending the Sweeping and Inspection Regulation of 16 October 2023. The new rules introduce the shift away from fossil-based heating by making the use of 65% renewable energy mandatory in principle when new heating systems are installed. The rules initially apply to new buildings in new residential areas; from mid 2026/2028, the rules also apply to existing buildings in need of a new heating system, and for infilling new buildings. If a new oil- or gas-fired heating system is installed in these buildings before then, rising proportions of green fuels will have to be used from 2029 (2029: 15%, 2035: 30%, 2040: 60%). The general approach taken is technology-neutral, and it is ensured that households are not financially overburdened by this, not least via statutory hardship clauses and an addition to the Federal funding for energy-efficient buildings (BEG) of 1 January 2024 which for the first time contains bonus assistance for low-income households.

The modelling of the Buildings Energy Act in the 2024 projection data used the following parameters:

- Efficiency of the building envelope
- New-builds: minimum requirement is efficiency house 55
- Renovation of existing buildings: renovation of individual components: maximum U values (corresponds to approx. EH85-EH100).
- Full renovation of residential buildings: primary energy requirement and HT‘ at most 1.4*reference building (“EH140”); renovation of the top floor ceiling
- Heat generation

Requirement to use 65% renewable energy in new heating systems (“65% rule”)

- Obligation to use 65% renewable energy in a newly installed heating system initially only applies to new-builds in new residential areas as of 1 January 2024.
- For other new-builds and existing buildings, the rules first apply following the expiry of the deadline for the production of municipal heat plans (i.e. in 2026 or 2028, depending on the size of the municipality).
- If no heat plan is in place, gas- and oil-fired heating systems may be installed until 2026 or 2028 as long as they generate at least 15% of their heat from 1 January 2029, at least 30% from 2035 and at least 60% from 2040.
- Municipalities can designate hydrogen grid expansion areas in which gas-fired boilers may continue to be installed. This must be operated on 100% hydrogen by 2045. The minimum ratios phased in over time do not apply to these buildings.
- There are transition periods for the conversion to central heating of floor-by-floor heating systems and individual heating units.

- Further to this, there are obligatory operational checks for heat pumps following a heating period in order to check them and optimise them in multi-family houses.

Compliance options are as follows:

- Connection to a heat network
- Heat pump
- Direct electric heating
- Solar thermal energy
- Heating systems based on green fuels
- Biomass heating boiler
- Hybrid heating systems using solar thermal energy or heat pumps

Regarding the 65% rule, the modelling took account of overlaps between the Buildings Energy Act requirements and the Act on Municipal Heat Planning.

2.D.6.2 Federal funding for energy-efficient buildings (BEG) (B2)

Together with the aforementioned changes to the Buildings Energy Act (cf. Measure B1), the reformed funding for the replacement of heating systems entered into force on 1 January 2024. The funding guideline for Federal funding for energy-efficient buildings – individual measures (BEG EM) was published on 29 December 2023. Improved funding conditions supplement the rules of the Buildings Energy Act and help citizens and companies to implement the improvements.

The parts of the BEG programme administered by the Federal Ministry for Economic Affairs and Climate Action were finally oriented to funding improvement in the energy performance of existing buildings in July 2022. The BEG funds full renovations to improve the energy performance of buildings and individual measures to improve the building envelope and the technical equipment. A funding rate of up to 70% is granted towards the installation of heat pumps and other climate-friendly heating technologies. The basic funding of 30% and the available bonuses can be combined up to a funding rate of 70%. A new feature is an income-dependent component in the funding, i.e. a higher funding rate for households with low and medium incomes. In addition to the grants, it is also possible to draw on a new low-interest supplementary loan for the replacement of heating systems and for other individual energy-related measures (e.g. insulation). Both the renovation of the worst performing buildings and renovation via serial retrofitting are incentivised by additional funding bonuses of 10% and 15% respectively via the BEG.

In the economic plan of the Climate and Transformation Fund (cf. Measure CS6), approx. €11 billion was earmarked for new approvals from the BEG's renovation funding (alternatively: €11.6 billion for the entire BEG); in 2024, the forecast is for €7.7 billion of new approvals from the BEG.

The modelling used the investment and repayment grants for the specific types of buildings and levels of renovation. The available funding budgets were included as follows:

- Funding used for new approvals in 2021: approx. €18.5 billion (including the MAP and EBS predecessor programmes; approx. €13 billion for BEG itself).
- Funding used for new approvals in 2022: approx. €29 billion;
- Funding used for new approvals in 2023: approx. €11.6 billion.

- In 2024, approx. €9 billion of budget funding is likely to be made available for new approvals of renovation funding under the BEG.
- From 2025, the cabinet decision states that €7.4 billion is likely to be available for new approvals.

In the reference scenario, no funding is provided for the installation of facilities to generate heat from renewables, and no funding is provided towards the energy-related renovation of existing buildings. In the case of renovation and of the installation of facilities to generate heat from renewables, it was assumed in the reference scenario that the investment induced by the federal funding in the context of the WEMS does not take place, or corresponds to the reference mix in terms of the replacement of heating systems.

2.D.6.3 Tax concessions for the modernisation of buildings (B3)

Tax breaks are permissible for individual measures (such as replacing the heating system or insulating individual components of the shell of a building) in owner-occupied private apartments and residential buildings. Both individual measures and the possibility of a comprehensive renovation (total renovation) carried out step by step, if necessary, through several individual measures are eligible for tax breaks. A precondition is that the renovated property is used by the taxpayer for their own residential purposes, is owned by them, and is more than ten years old when the energy performance is improved. A tax concession of 20% of the attributable costs (up to €40,000 per property) under section 35c Income Tax Act promotes the improvement of the energy performance of owner-occupied buildings. Since 1 January 2020, the tax breaks have been used as an alternative to Federal funding for energy-efficient buildings (BEG).

A temporary increase in the tax break up to 2026 is assumed for the determination of the GHG reduction effect in the 2024 Projection Report.

Even if, in accordance with section 52(35a) Income Tax Act, the tax concession is restricted to measures completed before 1 January 2030, it was assumed that, similar to the Federal funding for energy-efficient buildings (BEG), the tax break will remain in place until 2040.

The modelling of the reduction effect in the 2024 projection data is based on the following parameters.

Support in the form of progression-independent deductions from the taxpayer's tax liability over a three-year period.

Deductible: 30% (2024 and 2025) or, from 2026, 20% of the spending on energy-related measures, with the funding volume restricted to €40,000.

The deductible costs of 30% in 2024 and 2025 are based on plans from the summer of 2023, but these plans were not implemented.

Even if, in accordance with section 52(35a) Income Tax Act, the tax concession is restricted to measures completed before 1 January 2030, it is assumed that, similar to the Federal funding for energy-efficient buildings (BEG), the tax break will remain in place until 2040.

In the reference scenario, there are no tax breaks for individual measures on the building envelope or for the switch renewable heat sources. Rather, it is assumed that the renovation work induced by the state support does not take place.

2.D.6.4 Funding for climate-friendly new buildings (B4)

The funding programme promotes the new-build and the first purchase of newly built climate-friendly and energy-efficient residential and non-residential buildings by private or commercial investors or territorial authorities. The funding aims to reduce the greenhouse gas emissions in the life cycle, to cut primary energy requirements in the operational phase, and to increase the use of renewable energy

whilst adhering to the principles of sustainable construction. The funding for climate-friendly new buildings offers two funding stages: the basic stage of "climate-friendly new-build", which is attained when an efficiency house / efficiency building 40 attains the greenhouse gas emission requirement in the building life cycle for new buildings awarded the "Sustainable Building PLUS quality seal" (QNG-PLUS). The second "bonus" stage is attained when an efficiency house / efficiency building 40 is issued a sustainability certificate which confirms the compliance of the measure with the QNG-PLUS requirements or the "Sustainable Building PREMIUM quality seal" (QNG-PREMIUM). The funding for climate-friendly new buildings counts towards no.3a of the principles of sustainable development of the German Sustainable Development Strategy, and here particularly towards the indicator areas relating to SDGs 7 and 13. This funding thus contributes to climate action and adherence to the national climate targets.

A funding budget of nearly €1.2 billion for 2023 is used as a basis for the modelling of the reduction effect in the 2024 projection data. Just under €0.8 billion of new federal funding has been allocated for this for 2024 in the 2024 federal budget plan.

Further parameters for the modelling are:

For **investors**, funding goes towards the purchase (including ancillary costs), planning and support during the construction, and the sustainability certification.

Two stages are funded in the case of **residential buildings**:

Climate-friendly residential building (loan of up to €100,000 per dwelling), requirements: efficiency house 40, compliance with the greenhouse gas emission requirements for the building's life cycle set out in QNG Plus, heat supply not based on oil, gas or biomass, no secondary heating systems

Climate-friendly residential building (loan of up to €150,000 per dwelling), requirements: efficiency house 40, compliance with QNG Plus or QNG Premium requirements, heat supply not based on oil, gas or biomass, no secondary heating systems

Choice between two forms of financing:

Annuity loan with a term of 4 to 35 years

Loans repayable on maturity with a term of 4 to 10 years

For **non-residential buildings**:

Climate-friendly non-residential building: up to €2,000 per square meter of net floor space, maximum of €10 million per project

Climate-friendly non-residential building – with QNG: up to €3,000 per square meter of net floor space, maximum of €15 million per project

Municipalities

Residential buildings

Climate-friendly residential building: maximum eligible costs up to €100,000 per dwelling unit / grant rate 5.0%

Climate-friendly residential building – with QNG: maximum eligible costs up to €150,000 per dwelling unit / grant rate 12.5%

Non-residential buildings

Climate-friendly non-residential building: maximum eligible costs up to €2,000 per square meter of net floor space, maximum of €10 million per project / grant rate 5.0%

Climate-friendly non-residential building – with QNG: maximum eligible costs up to €3,000 per square meter of net floor space, maximum of €15 million per project / grant rate 12.5%

€1.679 billion was provided for the funding programme in 2023, with €762.0 billion available in 2024.

The quantification of the reduction effect of the funding programme took place as a component of the Federal funding for energy-efficient buildings (BEG) in the Projection Report.

2.D.6.5 Ordinance on Securing the Energy Supply through Medium-term Impact Measures (B5)

In order to attain a more efficient supply of heat in existing buildings, existing heating systems need to be optimised in the short term to an extent that significant savings potential can be attained from fossil fuel even in the short term. Hydraulic balancing, for example, optimises the heat distribution system. It can result in significant energy savings at low cost and with little effort. Other measures which do not require investment, and other optimised settings, can also bring about savings. The Ordinance on Securing the Energy Supply through Medium-term Impact Measures, adopted by the cabinet on 24 August 2022 and in force for a specific period, requires building owners which use gas for heating to undertake a one-off heating audit and make simple improvements. Also, hydraulic balancing must be undertaken in large buildings with gas-fired central heating (non-residential and residential buildings). When the Ordinance on Securing the Energy Supply through Medium-term Impact Measures expires on 30 September 2024, a follow-up arrangement in the Buildings Energy Act (sections 60b and 60c) enters into force on 1 October 2024 on the auditing and optimisation of existing heating systems and the duty to undertake hydraulic balancing for new heating systems in buildings with more than 6 user units.

In order to quantify the GHG reduction effect in the 2024 Projection Report, the following fields of application were parameterised:

The measure was parameterised in order to determine the GHG reduction effect in the 2024 projection data in line with the fields of application described in the Ordinance on Securing the Energy Supply through Medium-term Impact Measures:

Section 2: Heating audit and heating optimisation: all buildings with gas-fired heating systems by 15 September 2024

Section 3: Hydraulic balancing: non-residential buildings and residential buildings with at least 10 residential units by 30 September 2023; residential buildings with 6-10 residential units by 15 September 2024.

Efficiency gains averaging 5% in the case of 80% (non-residential and residential above 10 units) and 50% (residential with 6-10 units) of the relevant buildings were assumed.

Efficiency gains averaging 5% in the case of 80% (non-residential and residential above 10 units) and 50% (residential with 6-10 units) of the relevant buildings are assumed.

2.D.6.6 Energy efficiency stipulations for climate-neutral new / enlargement structures and federal building renovation – “role model function of federal buildings for energy efficiency” (EEFB - Role model function of federal buildings) (B6)

In order to ensure that federal buildings can serve as role models, the energy efficiency stipulations for new/enlargement structures and building renovations by the Federation (EEFB) are being implemented as minimum construction requirements in line with the cabinet decision of 25 August 2021 (buildings of the direct federal administration and parts of the indirect administration).

The EEFB define the current energy performance standards for federal buildings so that they can serve as role models and attain the climate targets for the Federation’s buildings.

The key elements of the energy efficiency stipulations were set out in the Climate Action Programme 2030. Correspondingly, the EEFB require the efficiency building standards 40 for new-builds and 55 for renovations, in line with the system of the Federal funding for energy-efficient buildings. The corresponding EEFB requirements go beyond the statutory requirements in the Buildings Energy Act for annual primary energy demand (use of renewable energy) and thermal insulation (building envelope).

In order to attain the prescribed climate targets for the Federation's buildings, annual renovation rates are set out up to 2045. The aim is to renovate the entire building stock by 2045, taking a run-up period into account.

The EEFB therefore represent a step towards the desired greenhouse gas neutrality for the buildings of the Federation.

For the quantifying of the reduction effect in the 2024 Projection Report, it was assumed that the renovation rate of the federal buildings develops along the prescribed path, and that the corresponding standards are met.

For the modelling of the reduction effect in the 2024 Projection Report, a continuously rising desired renovation rate is stipulated (continuous rise from 1% in 2022 to 5% in the years from 2030 – 2040). It was assumed that the renovation rate of the federal buildings develops along the prescribed path, and that the corresponding standards (requirements of the EEFB) are met.

2.D.6.7 Public Buildings Initiative (B7)

The initiative aims to boost the renovation rate of public buildings. By means of this measure, a comparable level of ambition to that of the "Energy efficiency stipulations for climate-neutral new / enlargement structures and federal building renovation" is to be attained. It is to be achieved via the implementation of the requirements of Art. 6 of the revised EU Energy Efficiency Directive:

Each year, 3% of the total area of heated and/or cooled buildings in public ownership (with a total usable space of more than 250 m^2) must be renovated at least to the level of nearly zero-energy buildings or zero-energy buildings.

So that progress can be monitored, a publicly accessible buildings inventory must be compiled containing the total area, energy consumption, and energy-profile ID card of the public buildings. Rather than an annual renovation rate of 3%, an alternative approach can also be taken in the form of measures which deliver equivalent energy savings (e.g. lower rate, but higher renovation level). The choice of the alternative approach much be reported to the European Commission by 31 December 2023. With regard to the alternative approach, a renovation passport must be produced for 3% of the public buildings each year (to attain the NZEB level), and its implementation must be guaranteed by 2040.

€60,000 was available from the federal budget for the measure in 2023, and €405,000 is allocated for 2024. These amounts are not intended to cover the building work in line with Art. 6 EED.

The measure overlaps to some extent with the requirements imposed on public buildings in the Energy Efficiency Act (cf. Measure CS5) and the efficiency instruction for federal buildings (cf. Measure B6).

2.D.6.8 Federal programme "Renovation of municipal facilities in the field of sport, youth and culture" (B8)

The Federal programme "Renovation of municipal facilities in the field of sport, youth and culture" supports municipalities (and rural districts where they own the facilities) with the comprehensive energy-related renovation and modernisation of their social infrastructure. The projects to be assisted must contribute to the attainment of the goals of the Federal Climate Action Act in the buildings sector,

and meet high energy-related requirements with a view to a clear reduction in greenhouse gas emissions. In exceptional cases (economic viability and the more effective variant in terms of climate change mitigation), new replacement buildings can be eligible for funding. Further to this, measures relating to open-air swimming pools and their ancillary buildings are eligible for funding. From funding rounds starting in 2022 onwards, the buildings have been required initially to meet the efficiency building level 70 following the completion of the renovation work or, in the case of historic monuments or other structures which particular merit preservation within the meaning of section 105 Buildings Energy Act, the efficiency building level "Historic Monument" in line with Federal funding for energy-efficient buildings (BEG); new replacement buildings must attain efficiency building level 40 in line with the BEG. In the case of open-air swimming pools, measures to attain the most climate-neutral possible supply of heat, or to boost the proportion of renewable energy, are eligible for funding. This must result initially in a proportion of renewable energy and/or avoidable waste heat in the heat supply of at least 75%.

In 2023, funding amounted to approx. €6.8 million (actual spending); the planned figure for 2023 is approx. €124.6 million.

In order to quantify the reduction effect from the funding programme in the 2024 Projection Report, it was assumed that the renovation must at least attain the level of efficiency building 70, and that the available funding is €0.4 billion for every three years from 2023.

In 2023 (the "2022 funding round"), the budget committee of the Bundestag selected 148 project applications, of which 88 received a grant approval notice. 12 municipalities have withdrawn their projects. 48 projects are still passing through the application procedure. For the 2023 funding round, the Bundestag budget committee selected a further 68 project applications on 13 March 2024. These are currently (summer 2024) passing through the application procedure.

2.D.7 Policies and measures in the agriculture sector

2.D.7.1 Fertiliser Ordinance (2020) and supporting funding programmes (especially Agriculture Investment Programme in the context of the Investment and Future Programme of the Federal Ministry of Food and Agriculture) (A1)

Changes in fertiliser legislation are contributing to a further reduction in nitrogen surpluses, including the reduction of ammonia and nitrous oxide emissions, and support via the promotion of gas-tight low-emission slurry stores and emission-reducing application techniques and of the "Nutrient Management" federal programme. This is also true of the further development of the nutrient-flow balance with mandatory introduction in further farms from 2021 and a gradual orientation of the overall balance in Germany to the aims of the Sustainability Strategy (70 kg nitrogen per hectare) in 2030. The measures of the National Air Pollution Control Programme are to be implemented in order to comply with the NEC Directive.

A decision was taken during the previous legislative term to support the farmers in the forthcoming transition process caused by the changes to the Fertiliser Ordinance. On this basis, the Federal Ministry of Food and Agriculture set up an Investment and Future Programme for the 2021 – 2024 period.

The funding programme contributes to improving the production conditions in agriculture in terms of climate action and environmental protection. The focus of the measures in the Investment and Future Programme is placed on investments in low-emission application technologies for slurry and digestate, storage (expansion/covering of storage facilities) and processing via the separation of slurry in small-scale facilities and equipment to apply plant protection products or for mechanical weed control. The funding is managed by the Landwirtschaftliche Rentenbank.

In 2023, €150.8 million was available for the federal Agriculture Investment and Future Programme, and €123.6 million in 2024. The programme expires at the end of 2024.

The modelling of Measure A1 in the 2024 projection data maps the effects of the 2020 Fertiliser Ordinance and the funding programmes in place. Statistical data from the actual changes in nitrogen fertilisation in recent years were used. Measures with an effect on ammonia emissions were taken from the projections for the 2023 National Air Pollution Control Programme.

2.D.7.2 Federal Nutrient Management Programme (A2)

In the Federal Nutrient Management Programme, funding has gone towards three model and demonstration projects and one research project in the arable farming strategy. The model and demonstration projects serve in particular the dissemination of knowledge of the use of new technologies in farming which result in a more efficient deployment of organic nitrogen fertilisers and thus contribute to a reduction of ammonia and nitrous oxide emissions and to a reduction of nitrogen surpluses.

The model and demonstration project on the use of NIR sensors during the application of liquid farm manure is helping to ensure that the application of this can be adapted better and in a needs-based way to the actual nitrogen content of the liquid farm manure. In this way, nitrogen surpluses can be significantly reduced with a comparatively small yield risk. Alongside this project, funding is going towards a research project in which a quality assurance system for mobile NIR sensors is being developed in order to design the determination of the nutrient contents of liquid farm manure even more precisely. In the model and demonstration project on the acidification of farm manure, acid is added to the farm manure, thus reducing ammonia emissions during the application of the farm manure and increasing the fertiliser efficiency. In the third model and demonstration project, the processing of farm manure is demonstrated e.g. by separation. This makes it significantly easier to transport the farm manure.

These technologies are being deployed on test farms. Via an intensive transfer of knowledge, the knowledge of and the experience with the use of these technologies is disseminated amongst farmers in order to persuade as many agricultural practitioners as possible to make use of these technologies on their own farms and thus to accelerate the introduction of these processes into practice.

Approx. €2.7 million is allocated in the 2023 federal budget and approx. €2.2 million in 2024 budget for this measure.

The measure helps to reduce nitrogen surpluses, and was estimated in the 2024 projection data together with Measure A1.

2.D.7.3 Research into climate-friendly nitrogen management in arable production (A3)

Under this funding guideline, research and development projects are funded which make a demonstrable contribution to expanding knowledge of emission reductions in nitrogen management in arable farming. Here, process-related knowledge is to be improved in order to permit a site-differentiated modelling and regionalisation of the effect of measures to reduce climate-related and environmentally relevant nitrogen emissions. Priorities are to be found in the fields of reduction of ammonia emissions and direct and indirect nitrous oxide emissions in arable farming, the effect of nitrification inhibitors and urease inhibitors on nitrogen emissions from the use and implementation of synthetic and liquid organic nitrogen fertilisers, and with regard to their environmental impact and the reduction of directly and indirectly climate-impacting emissions caused by denitrification in soils used for agricultural purposes. The results of the projects are to help improve the national emission reporting on greenhouse gases and air pollutants. Also, intensive knowledge transfer is to bring about greater acceptance and use of GHG-reducing measures in farming.

In the 2023 federal budget, funding of €2.5 million was allocated to the funding programme, and the 2024 figure was €3.1 million.

The measure helps to reduce nitrogen surpluses, and was estimated in the 2024 projection data together with Measure A1.

2.D.7.4 Increasing digestion of animal-based farm manure and of agricultural crop residues (A4)

The use of energy from animal-based farm manure and agricultural crop residues in biogas plants reduces methane emissions from the storage of farm manure and provides renewable energy. A range of instruments, including both existing and new ones, is aimed at intensifying use of farm manure in biogas plants and of gas-tight storage of digestates (new funding system for new facilities, reduction of the barriers to digestion of farm manure, creation of options for follow-up use and for gas-tight digestate storage facilities, promotion of the retrofitting of existing facilities, regulatory requirements for the gas-tight storage of digestate in existing and new facilities in conjunction with a transition period for funding).

In the With Measures Scenario of the 2024 projection data, it is assumed that the volume of farm manure digestate remains stable. No further effect is quantified. The revised Renewable Energy Sources Act, which entered into force on 1 January 2023, envisages higher remuneration rates for small manure installations with an installed capacity of up to 150 kWel (22 ct/kWh up to a rated capacity of 75 kWel, 19 ct/kWh up to and including a rated capacity of 150 kWel). Previously, higher remuneration rates did not apply to plants of more than 75 kWel. Statistical data which permit conclusions about the effect of this change are not yet available. Between 2023 and 2030, a large number of biogas plants will cease to be eligible for the existing payments under the Renewable Energy Sources Act following the end of their 20-year funding period. It is not known how many of the plants may remain in operation after this time.

2.D.7.5 Small manure installations: establishment of options for follow-up use via the development of new funding and implementation models following the expiry of remuneration under the RES Act (use of farm manure for energy) (A5)

At present, biogas technology is the only technically and commercially established option to reduce methane emissions in particular from farm manure management. At the same time, the use of this substrate for energy purposes helps to boost the output of renewable energy. At present, only approx. one-third of farm manure is used in biogas plants. Alongside the increased use of additional volumes of farm manure for energy purposes, it is also important to safeguard the existing level of use. It is necessary to examine the funding and implementation models which will result in continuing use of existing plants. A major component of this measure is follow-up funding for small manure plants in the Renewable Energy Sources Act via the Climate and Transformation Fund. Also, a call for proposals for model and demonstration projects aims not least to develop new implementation models for existing plants.

In 2023, a total of €742,000, and in 2024 approx. €3.3 million is allocated in the federal budget for the follow-up arrangements to the funding for small manure plants under the Renewable Energy Sources Ordinance and for the funding of model and demonstration projects.

2.D.7.6 Expanding organic farming (A6)

The “2030 Organic Strategy - National Strategy for 30% Organic Food and Farming by 2030” describes fields of action and measures serving the 30% target. Primary measures include: boosting organic out-of-home catering, expansion of regional organic value chains, research and funding. Academia, commerce, practitioners and associations, as well as the Länder and other ministries are involved in implementing the measures. The implementation takes place via a number of funding programmes, Federation-Länder agreements and many other measures. The Organic Farming Federal Programme is

one of the implementation instruments. At present, approx. 11% of the cultivated area is organic, meaning that it is continuing to expand despite a difficult context. The aim, with the help of the measures described, is to reach a share of 30% by 2030. Via the Joint Task "Improving the Agricultural Structure and Coastal Protection" (GAK), a national funding programme, organic farming is to continue to receive assistance from the Federation and the Länder from Pillar II of the CAP.

Nearly €34 million was provided in the 2023 federal budget for the expansion of organic farming. €40 million is available for 2024.

For the quantification of the reduction effect in the 2024 Projection Report, it was assumed that the expansion depends on the development of the budget available for the funding of organic farming (EU funding under the Common Agricultural Policy, EAFRD programmes, Joint Task "Improving the Agricultural Structure and Coastal Protection"). After 2030, the share was extrapolated statically.

2.D.7.7 Rewetting of peatlands (determining the footprint of nitrous oxide emissions in the agriculture sector; of CO2 emissions in the LULUCF sector) (A7)

Measure listed under agriculture due to the reduction in nitrous oxide emissions which is ascribed to this sector. For a description of the measure, see Measure L2 in LULUCF sector.

2.D.7.8 Federal programme for energy efficiency and CO_2 emission reduction in the agricultural and horticultural sector (A8)

In order to reduce greenhouse gas emissions from energy use in agriculture, numerous measures are being funded as investment by the federal programme in order to boost energy efficiency and to use renewable energy, including the generation of renewable energy for the farm's own needs. This refers both to stationary energy use, e.g. in production buildings, facilities, livestock buildings and greenhouses, and to mobile energy use to drive mobile machinery and equipment, e.g. tractors.

The investment-based funding comprises two funding areas: "individual measures" and "investment in CO2 reductions following an energy advice session".

The individual measures are measures which are deliberately kept simple in terms of funding, such as the replacement of small energy consumers with more energy-efficient models, the installation of heat buffer storage tanks, or improved insulation of greenhouse envelopes. The individual measures for mobile machinery and equipment include funding for alternative propulsion rather than the prevailing diesel engines, e.g. electric tractors as farm loaders or small tractors, and electric feeding machines in livestock buildings. In the "investment in CO2 reductions following an energy advice session" funding area, a measure-specific energy advice session is required; it can also be funded as part of the investment. The funding is largely technology-neutral, and covers rather complex energy-related retrofitting of plant and production buildings, as well as the generation of renewable energy for on-farm needs.

Approx. €18 million was provided for the funding programme in the Climate and Transformation Fund in 2023, and approx. €25 million is earmarked for 2024.

In the 2024 projection data, the reduction effect of measures A8 and A9 (see below) are parameterised on the basis of the expected draw-down of funding. It was assumed that the current policy will be continued, and that the annually envisaged funding will continue at a similar level up to 2050. It was assumed that the available funding will have a greater effect in future as, unlike in the old version, the investment in energy saving must be preceded by an energy advice session.

In terms of modelling, it is necessary to distinguish between effects on electricity consumption and on the use of fossil heating and motor fuel in agriculture in order to map the effects on the CRF source category 1.A.4.c "Combustion of fuels in agriculture, forestry and fisheries".

2.D.7.9 Research and Innovation Programme “Climate Protection in Agriculture” (A9)

The Federal Minister of Food and Agriculture funds innovative research and development projects via the Research and Innovation Programme “Climate Protection in Agriculture”. These projects are to make a significant contribution towards cutting greenhouse gas emissions in agriculture. The Climate and Transformation Fund (CTF) is providing funding for this in the years from 2023 to 2027. The programme is addressed to higher education institutions, non-university research and development establishments, and companies.

Measures for the following five thematic priorities are being funded via calls for proposals:

1. Alternative propulsion technologies without fossil fuels and using renewable energy

The research and innovation projects in this thematic priority address, for example, alternative propulsion technologies, improved technologies for storage, processing and application of fertilisers, and for tillage. In addition, research is taking place into multifunctional land use systems (e.g. agri-photovoltaics).

2. Research into and the development of mature applications including the necessary software to optimise the determination of climate footprints at individual farm level

Support goes to projects which conduct research into the optimisation of the determination of climate footprints at individual farm level via innovative digital technologies and farm management processes. The related transfer of knowledge is supported by the establishment of thematically related digital fields of experimentation.

3. Socio-economic studies into climate change mitigation measures and other aspects of climate action in agriculture

Accompanying socio-economic research into the thematic priorities cited here is being promoted, such as economic assessment and/or sociological effects of climate change mitigation measures on farms. Further to this, additional socio-economic questions of climate change mitigation can be addressed, e.g. in relation to structural change, the role of agriculture in rural areas, and the relationship between producing and consuming persons.

4. Processes for and technical approaches to plant production and processing

Funding is going towards research and development projects focusing on the following priorities:

- Reduction in greenhouse gas emissions via adapted cultivation measures in arable farming and horticulture (e.g. emission-reducing cultivation methods, optimised fertiliser management, improved nitrogen efficiency).
- Optimisation of the CO2 footprint of albuminous foodstuffs via the increased use of and improved production and processing technology for domestic legumes (e.g. via measures along the value chain from cultivation to use and via the use of climate-friendly innovations in the field of the use and processing of pulses for human and animal nutrition).

5. Innovative procedures and technologies in animal husbandry

Funding is going towards projects which contribute not least to optimised farm manure management and to adapted feed strategies and concepts. Projects are continuing to be supported which can contribute to greenhouse gas reduction and energy conservation via appropriate process-related and technical building measures and management systems in animal husbandry.

The funding announcements were published in 2023. At present, the research and innovation programme is funding a total of 20 projects with a funding volume of up to €40 million.

In the estimate of the reduction effect in the 2024 Projection Report, it was assumed that this research funding can generate virtually no reductions in the short term. Measures A9 and A8 (see above) were therefore estimated together.

2.D.8 Policies and measures in the waste sector

2.D.8.1 Funding programme to expand landfill aeration and optimise gas collection (W1)

Funding is granted to measures for optimised landfill gas collection in municipal waste sites, sections of landfill sites and landfill layers with older waste in which substantial amounts of biodegradable waste were dumped before 1 June 2005 and in which the formation of methane is so great that it is possible to use the landfill gas to generate energy.

Funding is also granted to measures for aerobic in-situ stabilisation of municipal waste sites, sections of landfill sites and landfill layers with older waste in which substantial amounts of biodegradable waste were dumped before 1 June 2005 and in which the formation of methane has declined to such an extent that it is no longer possible to use the landfill gas to generate energy.

20 projects for the optimised collection of landfill gas have so far been approved; 12 of them are already completed. 116 projects for aerobic in-situ stabilisation have so far been approved; 77 of them are already completed (status: June 2024). The funding is provided via the municipal guideline (here, part of Measure CS1).

The funding of large-scale projects for landfill aeration is crucial for the attainment of the climate targets (reduction potential approx. 50,000 t CO2-eq/landfill site/a). In the context of the modelling for the 2024 projections, it was assumed that seven projects of this scale can be realised each year from 2021 to 2029. The calculation was made on the basis of the waste model, which breaks down the ascertained savings from landfill aeration on a percentage basis across the total results. In the modelling, the number of landfill sites with aeration and the assumptions of emission reduction (7*50,000 t CO2-eq/a) were calculated pro rata for the development of the proportion of degradable organ carbon (DOCm) in the waste model. This also takes account of the composition of the gases (approx. 50% methane, 50% CO2), and there is a time delay caused by the kinetic approach used in the waste model.

2.D.8.2 Avoidance of food waste (W2)

The National Strategy for Food Waste Reduction was adopted in 2019 and has been constantly updated since then. The Federal Ministry of Food and Agriculture aims to halve food waste from primary production through to the households. In dialogue forums for each of the five sectors, appropriate reduction measures were / are being defined along the food supply chain through to the households, and where possible targets are defined and formats agreed for monitoring of implementation and success. The Federal Ministry of Food and Agriculture's initiative, which has existed since 2012, raises awareness amongst stakeholders along the entire food supply chain of the need for sustainable use of food and to reduce their waste. The "Zu gut für die Tonne!" (Too good for the bin) campaign offers a wide-ranging supply of information, educational and advertising material, hints on how to store food correctly, recipes and tutorials on how to use left-overs, events like the nationwide action week and much more.

€1.4 million was available from the federal budget for the measure in 2023, and €2.9 million is allocated for 2024.

Current figures from the Federal Statistical Office (Federal Statistical Office 2022) were used in the 2024 Projection Report to determine the reduction effect, with the average food loss in the households

being 78 kg/inhabitant. On top of this, there are approx. 32 kg of food loss per inhabitant from the retail trade, restaurants and out-of-home catering. A reduction of 50% by 2030 would result in a total reduction of 55 kg/inhabitant. However, it is uncertain whether the existing instruments (information campaigns, documentation, etc.) are sufficient to bring about this change of behaviour. It is therefore only expected that only 30% of this target will be met by 2030. This means that food waste of at present 110 kg/person will not be reduced by 55 kg/person, but only by 16.5 kg/person. In the calculation, therefore, a linear reduction in per capita food waste to 93.5 kg in 2030 is used.

2.D.9 Policies and measures in the LULUCF sector

The Federal Government adopted the Federal Action Plan on Nature-based Solutions for Climate and Biodiversity on 29 March 2023. The central goal of the programme is to protect, strengthen and restore ecosystems. The programme combines climate action with nature conservation, and contains a host of measures to ensure that degraded ecosystems are regenerated and made resilient and diverse, so that they can make lasting contributions to the climate targets.
Further to the Federal Action Plan on Nature-based Solutions for Climate and Biodiversity, the Federal Government is using additional instruments such as the agricultural environmental protection and climate action measures of Pillar II of the Common Agricultural Policy to implement the following measures in the LULUCF sector:

2.D.9.1 Reduction of soil sealing and creation of offsetting areas for the expansion of wind power and ground-mounted PV (L1)

Where it is possible to avoid the consumption of areas for settlement and transport purposes, it is also possible to retain unfragmented open areas as an important carbon sink and to avoid carbon emissions from the use of the land, and to retain potential areas for future development opportunities of all kinds. The Federal Government's area conservation targets aim to reduce the consumption of areas for settlement and transport from more than 50 hectares a day at present to less than 30 hectares a day by 2030, and to attain "net-zero" area consumption by 2050 at the latest (circular area economy) (cf. Germany's Sustainable Development Strategy 2021; 2050 Climate Action Plan). In accordance with section 2(2) no. 6 sentence 6 of the Spatial Planning Act, the first use of undeveloped areas for settlement and transport purposes is to be reduced, in particular via quantified requirements for the reduction of the use of areas, the utilisation of the potential for making areas reusable, infilling and other measures for the inner development of urban areas and municipalities. The revision of the Spatial Planning Act which entered into force in September 2023 explicitly states that the development of brownfield sites should be preferred where possible to that of greenfield sites (section 2(2) no. 2 sentence 6 Spatial Planning Act). The Federal Building Code anchors the precedence for development measures within urban areas (section 1(5) sentence 3). According to section 1a(2) sentence 1 of the Code, sparing and conservative use should be made of land. These provisions are implemented by those responsible for spatial planning and by the municipalities in their master planning, and result in a reduction of the consumption of land for settlement and transport.

In order to determine the reduction effect in the 2024 Projection Report, experts' views of the expected impact of the changes since 2010 (Act to Strengthen Internal Development, revision of urban planning legislation, Federation-Länder programmes to promote urban planning and village development, house-building campaign) were used along with projections and studies of the development of the areas needed for settlement and transport projects up to 2030. The expansion of the areas needed for ground-mounted PV is derived from the data on the expansion of renewable energy and assumptions of the proportion of ground-mounted PV in the expansion, and of offsetting areas. A similar approach is taken (with much less relevance in terms of areas) to the expansion of wind energy. The measure is to

be mapped with effects. In the WEMS, the new consumption of land is cut to 40 ha/d by 2030 (target not attained), with a fall to zero by 2050. The sites for the expansion of ground-mounted PV come on top of this. They are considered separately since the sites are not sealed, and the impact on carbon pools is less than in the case of settlement and road building.

2.D.9.2 Rewetting of peatlands (L2)

In the Federation-Länder target agreement on climate change mitigation through peat soil conservation (2021), the Federation and the Länder agreed to cut annual greenhouse gas emissions from peatlands by 5 million tonnes of CO2 equivalents by 2030. The Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection intends to fund measures which help land owners, land users and cooperative efforts to carry out peatland protection measures with a view to the permanent wetting of peatlands. Metabolism of the peatlands is to be reduced via higher water levels. The aim is to restore peat-retaining hydrological conditions. Also, measures by individual farms are to be funded which enable them to make site-adapted wet use of the peatland. The funding is based on the principle of voluntary action and cooperation in the spirit of the Federation-Länder target agreement on climate change mitigation through peat soil conservation. The funding measure is designed in a modular fashion to take account of the very different natural circumstances and the heterogeneous target group. The funding serves to reduce greenhouse gas emissions and thus the attainment of the climate targets of the Federal Climate Action Act and to establish integrated use management under wet conditions. Positive side-effects for species protection and nature conservation, biodiversity, nutrient retention and water management and quality are explicitly desired.

In order to estimate the sink effect, the 2024 projection data assumed that agricultural environmental measures for peatland-preserving impoundment and peatland protection projects of the Länder are being implemented in line with the planned measures documented in the CAP Strategic Plan from 2023. The budgets of the measures are extrapolated beyond the current planning period. Rewetting measures are undertaken on about 54,000 ha in 2030, primarily of agricultural land, and on approx. 141,000 ha in 2050. Mapping of complete and partial rewetting via adjustment of water levels and emissions of the corresponding areas. Reference: without this measure.

The planned funding for peatland protection under the new funding programme in the Federal Action Plan on Nature-based Solutions for Climate and Biodiversity is not yet included in the modelling of the projection data for 2024 in the WEMS, as the funding terms were not yet known at the time of the modelling.

2.D.9.3 Reduction of use of peat as substrate in gardening (implementation of the peat reduction strategy, extraction permits expiring up to 2040) (L3)

With funding from the Federal Ministry of Food and Agriculture, the Agency of Renewable Resources is assisting a) projects to research substitute materials, supporting processes and plant suitability; b) model and demonstration projects and c) projects to support young talents at higher education institutions. The aim of the measures is to reduce GHG emissions from the use of peat against the background of the targets of the Peat Reduction Strategy of the Federal Ministry of Food and Agriculture from 2022. This places the focus on the voluntary substitution of peat in potting soils and substrates. The actual availability of the substitute materials in Germany is of considerable importance. The implementation of the strategy in the coming years aims to resolve issues of substrate production, horticultural use, competing forms of use, price, economic viability, the environmental footprint and sustainability, including the question of transport routes.

Approx. €3.6 million is allocated in the 2023 federal budget and approx. €6 million in 2024 budget for various measures relating to the peak reduction strategy.

In order to determine the reduction effect in the 2024 Projection Report, it was assumed that the implementation of the Federal Ministry of Food and Agriculture's peat reduction strategy (BMEL 2022) and the expiry of extraction permits up to 2040 result in the cessation of peat extraction in Germany. There are no official statistics on the extraction of peat in Germany. Former peat extraction sites are being fully rewetted. Emissions from the use of peat are reduced in linear form to 0 by 2040; the area of peat extraction sites is reduced correspondingly, the assumption being full rewetting. The current level of peat use is continued in the reference development.

2.D.9.4 Logging ban in old beech forests (L4)

In the coalition agreement, the Federal Government stipulated the common goal of "halting logging in old, near-natural beech forests in public ownership". This is being implemented in a first step on the areas owned by the Federation (the Federation acting as a pioneer for biodiversity and climate action). To this end, a joint agreement was concluded between the Federal Environment Ministry and the Institute for Federal Real Estate in March 2024. In a first step, approx. 200 hectares were removed from use; the figure is to rise to 500 by 2030 and 1,000 hectares by 2045.

2.D.9.5 Climate-adapted forest management (L5)

Only climate-resilient forests are in a lasting position to fulfil the important climate change mitigation functions. The goal of strengthening the resilience and adaptability of forest ecosystems can only be attained if forest owners live up to their responsibility in the development of their forests to greater resilience as part of sustainable forest management. The aim is to change forest management by introducing and making widespread use of forest management which is particularly adapted to climate change, which maintains and develops resilient, adaptable and productive forests. Climate-adapted forest management in the meaning of the funding programme entails a total of 11 or 12 criteria which are stipulated in the funding guideline and which go beyond the requirements of the existing forest certification systems in Germany. Funding is granted to private and municipal forest owners which commit for 10 or 20 years to complying with the 11 or 12 criteria of the climate-adapted forest management on the whole of their managed forest area. Proof of compliance with the criteria is provided via the certificates issued in line with the guidelines on recognised certification systems and monitoring procedures developed specifically for this.

The funding guideline entered into force in November 2022. To date, more than 10,000 applications for funding for more than 1.6 million hectares of private and municipal forest areas have been submitted (covering around 21% of the total eligible private and municipal forest area). In 2023, €103.5 million was provided in grants; the planned figure for 2024 is €131 million.

The climate change mitigation effect is determined by measures to ecologically stabilise the forests which aim to bolster their climate adaptability and to continue to safeguard or strengthen the climate change mitigation function. According to the 2024 Projection Report, the effect of these measures is not quantifiable. It is only possible to quantify the effects of refraining from forest management on a minimum proportion of the area (criterion 12). Since precise figures for the corresponding areas are not available, the projection assumes that the minimum area for operations of 100 ha or more in size can also be applied to the total area. It is assumed that no further use is made of 5% of the area for which funding is applied during the period of funding (plus the period of voluntary commitment). The additionality of the decision not to make use of the area is not ensured. The set-aside commitment might have no additional effect at all.

2.D.10 Transformation to greenhouse gas neutrality

2.D.10.1 Transformation of the energy sector to greenhouse gas neutrality

The energy sector plays a key role on Germany's path to climate neutrality. The transformation of the energy system is crucial. It requires the expansion of renewable energy and the grids. The sufficient availability of renewable electricity is an essential platform for the decarbonisation of transport, industry and buildings via the electrification of applications.

For this reason, a crucial role is played by the accelerated expansion of, in particular, wind energy and photovoltaics (PV). In the case of onshore wind turbines, there is a statutory target of increasing installed capacity from 58 gigawatts in 2022 to 115 gigawatts in 2030 and 160 gigawatts in 2040; in the case of offshore wind energy, the increase is to be from 8.5 gigawatts (2023) to a total of at least 30 gigawatts in 2030, 40 gigawatts in 2035 and 70 gigawatts in 2045. For PV, the target is installed capacity of 215 gigawatts by 2030 (2022: approx. 67 gigawatts) and 400 gigawatts by 2040.

By 2030, according to current forecasts, around 600 terawatt-hours of renewable electricity will be needed (compared to around 250 terawatt-hours in 2022) in order to attain the target set by the 2023 Renewable Energy Sources Act of having at least 80% of gross electricity consumption covered by renewable electricity. This signifies more than a doubling of the existing quantity in just a few years. Compared with the new-build in the last legislative term, the current planning in the RES Act requires an increase in the level of new-build by a factor of three to four in the period to 2030.

In fact, electricity generation from PV rose clearly, particularly in 2022 (approx. 7.5 gigawatts, up 23% over 2021). The rate of new-build actually nearly doubled in 2023. Adding around 15 GW of capacity, more installations were built last year than ever before in the space of a year in Germany. Onshore wind turbines generated much more electricity in 2023 than in the year before (up 11%). The expansion of generation capacities saw a year-on-year rise of 44% in 2023, with 3.0 gigawatts of net new-build.

2.D.10.2 Transformation of the transport sector to greenhouse gas neutrality

The Federal Government has set itself the aim of placing 15 million battery electric vehicles (BEVs) on the roads by 2030. In order to achieve this, considerably more BEVs must be registered in the next few years. The Federal Government has decided to closely monitor the development and, if necessary, to take further measures. Another aim of the Federal Government is to have one-third of the kilometres travelled by heavy duty vehicles powered by electricity by 2030.

2.D.10.3 Transformation of the industry sector to greenhouse gas neutrality

German industry requires a fundamental transformation of production processes, which must build on technical solutions for decarbonisation, electrification, flexibilisation, energy, material and resource efficiency, the circular economy and carbon management. It is therefore of central importance to make use the forthcoming reinvestment window for the climate-friendly conversion and deployment of innovative technologies so that the existing value creation can be made fit for the coming decades.

The climate-friendly conversion of industry still poses numerous challenges, especially in the short term, but also offers medium- to long-term opportunities for German industry: new business models and technologies can create and safeguard prosperity and employment. The Federal Government is putting an appropriate policy environment in place for small, medium-sized and large companies to cope with this transformation process. The massive expansion of renewable energy is being advanced, competitive energy prices are to be ensured, and the supply of sustainable raw materials, electricity, heat and hydrogen and carbon will be safeguarded and adapted to the new situation and goals. Also, the aim is to have rapid and non-bureaucratic permitting procedures.

With a blend of carbon pricing (EU ETS 1 and the nETS via the Fuel Emission Allowance Trading Act), targeted funding and proportionate regulation, the Federal Government is putting the conditions in place to attain the target and for greenhouse gas neutrality by 2045 at the latest.

2.D.10.4 Transformation to climate-friendly agriculture

The significance of the agriculture sector for climate change mitigation will grow substantially in the coming decades.

The most important levers for the reduction of greenhouse gas emissions continue to be more efficient fertilisation and the reduction of nutrient surpluses, the restructuring of animal husbandry and improvements in its climate-related efficiency, the covered storage of farm manure and digestate residues, the expansion of organic farming and the increased use of farm manure for energy in biogas plants. Changes in consumer behaviour also make an important contribution.

2.D.10.5 Transformation of the buildings sector to greenhouse gas neutrality

In order to orient the buildings sector to the goal of greenhouse gas neutrality, the Federal Government has already put key preconditions in place in the past two years and implemented measures in the following subsectors: 1) decarbonisation of the heat supply; 2) heat planning and the expansion and decarbonisation of the heat networks; and 3) focus of funding on improving the energy performance of existing buildings and more serial retrofitting. The public buildings initiative (role model function of public buildings in line with Article 6 EED) and the role model function of federal buildings play an important part in the implementation of the measures.

2.E Summary of emissions and sinks

Table 4: Development of emissions in Germany, by greenhouse gas, in kilotonnes of CO2 equivalents [kt CO2-eq]

Year	CO2 emissions (not including LULUCF)	Net CO2 emissions / removals	CH4 emissions (not including LULUCF)	With LULUCF	N2O emissions (not including LULUCF)	With LULUCF	F gases, total	GHG emissions without LULUCF	GHG emissions / removals, with LULUCF
1990	1,054,796	1,080,534	133,610	139,785	49,928	50,895	12,324	1,250,658	1,283,538
1991	1,016,929	984,463	127,235	133,406	48,596	49,561	11,890	1,204,651	1,179,319
1992	969,464	931,016	123,196	129,391	50,016	50,990	12,382	1,155,058	1,123,778
1993	959,386	921,459	123,920	130,094	47,564	48,526	15,008	1,145,879	1,115,086
1994	943,228	910,810	119,434	125,605	49,645	50,605	15,449	1,127,756	1,102,469
1995	939,934	914,117	116,641	122,809	48,002	48,957	16,022	1,120,598	1,101,905
1996	959,690	930,383	113,547	119,720	49,413	50,369	15,210	1,137,860	1,115,682
1997	931,508	902,880	108,400	114,568	46,772	47,727	15,425	1,102,106	1,080,600
1998	923,499	895,577	102,770	108,937	35,457	36,408	15,911	1,077,636	1,056,832
1999	895,442	864,260	101,594	107,761	32,161	33,106	14,201	1,043,399	1,019,328
2000	898,976	887,998	97,007	103,175	31,714	32,665	12,736	1,040,433	1,036,574
2001	915,255	894,793	92,881	99,058	33,543	34,705	13,411	1,055,090	1,041,966
2002	898,834	911,253	88,165	94,358	32,920	34,094	13,440	1,033,359	1,053,145
2003	894,501	902,955	84,161	90,382	33,097	34,289	12,967	1,024,725	1,040,593
2004	876,570	881,589	77,349	83,590	33,919	35,119	13,387	1,001,225	1,013,684
2005	867,881	869,262	73,442	79,711	32,621	33,834	13,579	987,522	996,386
2006	886,434	881,222	69,026	75,311	32,001	33,139	13,537	1,000,998	1,003,210
2007	846,116	844,565	66,470	72,769	34,529	35,666	13,634	960,749	966,633
1990	856,607	843,164	65,102	71,419	33,267	34,406	13,623	968,599	962,612
2009	789,951	771,953	62,296	68,631	33,528	34,647	14,028	899,803	889,260
2010	826,680	818,099	60,965	67,315	26,578	27,693	13,689	927,912	926,796
2011	804,514	788,656	59,365	65,718	26,545	27,673	13,884	904,308	895,932
2012	814,090	790,771	59,723	66,083	26,584	27,731	14,100	914,498	898,684
2013	831,743	810,256	58,774	65,140	26,835	27,990	14,123	931,474	917,509
2014	792,579	778,894	57,253	63,626	26,937	28,127	14,118	890,887	884,765
2015	800,844	785,431	56,758	63,143	27,231	28,441	14,550	899,384	891,565
2016	798,014	780,687	55,033	61,417	27,020	28,194	14,643	894,710	884,941
2017	784,594	770,873	54,172	60,560	26,448	27,627	14,628	879,842	873,688
2018	760,046	753,100	51,894	58,403	25,954	27,149	13,801	851,695	852,453
2019	709,827	699,756	49,077	55,491	24,789	25,981	13,067	796,759	794,296
2020	648,357	646,544	47,870	54,275	23,976	25,178	11,552	731,755	737,550
2021	678,777	673,808	46,598	53,012	23,327	24,504	10,897	759,600	762,220
2022	671,472	668,219	45,539	51,994	23,007	24,184	9,948	749,965	754,345

Table 5: Development of emissions in Germany, by UNFCCC CRT category, in kilotonnes of CO2 equivalents [kt CO2-eq]

Year	1. Energy	2. Industrial processes	3. Agriculture	4. LULUCF	5. Waste	GHG emissions without LULUCF	GHG emissions / removals, with LULUCF
1990	1,044,279	93,278	71,582	32,879	41,520	1,250,658	1,283,538
1991	1,007,346	89,611	64,626	-25,332	43,067	1,204,651	1,179,319
1992	958,918	89,591	62,886	-31,280	43,663	1,155,058	1,123,778
1993	949,663	90,855	61,977	-30,792	43,384	1,145,879	1,115,086
1994	926,923	96,379	62,147	-25,287	42,307	1,127,756	1,102,469
1995	922,711	94,809	62,037	-18,693	41,041	1,120,598	1,101,905
1996	943,139	92,920	62,549	-22,178	39,252	1,137,860	1,115,682
1997	911,248	93,512	61,393	-21,506	35,952	1,102,106	1,080,600
1998	901,290	81,046	61,873	-20,805	33,428	1,077,636	1,056,832
1999	876,372	73,446	62,139	-24,071	31,442	1,043,399	1,019,328
2000	872,680	76,697	61,488	-3,859	29,568	1,040,433	1,036,574
2001	892,300	73,091	62,134	-13,123	27,565	1,055,090	1,041,966
2002	875,932	71,515	60,068	19,786	25,844	1,033,359	1,053,145
2003	866,666	74,109	59,891	15,868	24,059	1,024,725	1,040,593
2004	845,529	75,852	58,359	12,459	21,486	1,001,225	1,013,684
2005	836,702	72,688	58,304	8,864	19,827	987,522	996,386
2006	852,926	73,026	57,291	2,211	17,755	1,000,998	1,003,210
2007	810,587	76,126	57,803	5,884	16,234	960,749	966,633
2008	823,819	71,967	57,976	-5,987	14,837	968,599	962,612
2009	764,110	64,003	58,246	-10,543	13,443	899,803	889,260
2010	795,922	61,783	58,017	-1,116	12,190	927,912	926,796
2011	771,803	63,193	58,005	-8,376	11,307	904,308	895,932
2012	785,089	60,409	58,518	-15,813	10,482	914,498	898,684
2013	802,073	60,270	59,446	-13,966	9,686	931,474	917,509
2014	760,931	60,545	60,350	-6,122	9,061	890,887	884,765
2015	770,583	59,778	60,581	-7,819	8,442	899,384	891,565
2016	765,220	61,485	60,101	-9,769	7,903	894,710	884,941
2017	747,674	65,347	59,297	-6,154	7,524	879,842	873,688
2018	723,835	62,437	58,294	758	7,130	851,695	852,453
2019	673,685	59,352	57,118	-2,464	6,605	796,759	794,296
2020	614,334	55,255	56,046	5,795	6,120	731,755	737,550
2021	642,442	57,046	54,308	2,620	5,803	759,600	762,220
2022	638,895	52,061	53,349	4,380	5,660	749,965	754,345

Table 6: Development of emissions in Germany in 2022, by UNFCCC CRT category and gas, in kilotonnes of CO2 equivalents [kt CO2-eq]

Emission source and sink categories	CO2[(1)]	CH4	N2O	F gases	Total
Total Emissions (without LULUCF)	**671,472**	**45,539**	**23,007**	**9,948**	**749,965**
Total Emissions (with LULUCF)	**668,219**	**51,994**	**24,186**	**9,948**	**754,347**
1. Energy	**627,977**	**6,592**	**4,326**		**638,895**
A. Fuel Combustion	626,142	4,667	4,325		635,133
1. Energy Industries	247,455	2,800	1,817		252,073
2. Manufacturing Industries and Construction	114,780	315	708		115,803
3. Transport	146,992	253	1,384		148,629
4. Other Sectors	116,076	1,297	412		117,785
5. Other (military)	839	2	3		844
B. Fugitive Emissions from Fuels	1,835	1,925	1		3,761
1. Solid fuels	656	114	NO,NA		770
2. Oil and Natural Gas	1,179	1,811	1		2,991
C. CO2 Transport and Storage	NO				NO
2. Industrial processes and product use	**40,953**	**568**	**593**	**9,948**	**52,061**
A. Mineral Industry	18,610				18,610
B. Chemical Industry	4,288	539	349	24	5,201
C. Metal Industry	15,933	7	11	143	16,094
D. Non-Energy Products from Fuels	2,121	n/a	1		2,122
E. Electronics Industry				233	233
F. Product Uses as Substitutes for ODS				7,590	7,590
G. Other Product Manufacture and Use	IE,NA	22	231	1,848	2,101
H. Other	NO,NA	NO,NA	NO,NA	110	110
3. Agriculture	**2,542**	**34,124**	**16,683**		**53,349**
A. Enteric Fermentation		26,082			26,082
B. Manure Management		6,585	2,297		8,882
C. Rice cultivation		NO			NO
D. Agricultural Soils			14,220		14,220
E. Prescribed burning of savannas		NO	NO		NO
F. Field burning of agricultural residues		NO	NO		NO
G. Liming	2,005				2,005
H. Urea Application	372				372
I. Other Carbon-containing Fertilizers	165				165
J. Other	NO,NA	1,457	166		1,623
4. Land Use, Land Use Change and Forestry	**-3,252**	**6,455**	**1,179**		**4,382**
A. Forest Land	-40,238	47	430		-39,761
B. Cropland	15,059	93	344		15,496
C. Grassland	21,195	914	36		22,145
D. Wetlands	4,326	5,373	39		9,738
E. Settlements	389	NO	97		486
F. Other Land	NO	NO	NO		NO

G. Harvested Wood Products	-3,984				-3,984
H. Other	NO,IE	29	111		140
5. Waste	**NO,NE,NA**	**4,254**	**1,406**		**5,660**
A. Solid Waste Disposal	NO,NA	2,375			2,375
B. Biological Treatment of Solid Waste		890	199		1,090
C. Incineration and open burning of waste	NO	NO,NA	NO,NA		NO,NA
D. Wastewater Treatment and Discharge		987	1,179		2,165
E. Other	NE,NA	3	28		31
Memo Items:					
International Bunkers	31,171	4	277		31,452
Aviation	27,184	3	228		27,415
Marine	3,988	1	48		4,037
CO2 Emissions from Biomass	115,662				115,662

2.F Projections

The greenhouse gas projections presented here for 2025, 2030, 2035, 2040, 2045 and 2050 are based on the 2024 Projection Report. A research consortium from Öko-Institut, the Fraunhofer Institute for Systems and Innovation Research (ISI) and IREES GmbH has prepared these projections on behalf of the German Environment Agency. The projections for the agriculture and LULUCF sectors were calculated by the Thünen Institute. As a Member State of the European Union, Germany is required to report national projections of anthropogenic greenhouse gas emissions each year, by 15 March of the relevant year (most recently by 15 March 2024) (Harthan et al. 2024[27]). By doing so, Germany fulfils EU requirements pertaining to European emissions reporting pursuant to Article 18 of EU Regulation 2018/1999 and section 10 of the Federal Climate Action Act in its 2024 version. The German projection report includes both a With Existing Measures Scenario (WEMS) and a With Additional Measures Scenario (WAMS). Both scenarios include the climate and energy policy measures which had been introduced or significantly altered by 31 July 2023. The relevant methods are described in Chapter 2.F.2.

2.F.1 Projections of the greenhouse gas emissions per GHG and sector

As can be seen from 2030 in the WEMS. This represents an emission reduction of nearly 64% compared to the reference year of 1990. It means that the target under section 3(1) Federal Climate Action Act – to cut greenhouse gas emissions by 65% between 1990 and 2030 – is missed by just over a percentage point. In the WAMS, the projected emissions in 2030 of approx. 454 Mt CO2-eq are only slightly lower than in the WEMS; as in the WEMS, the emission reduction is approx. 64%. By 2050, the WEMS projects an emission reduction of over 87%; the figure for the WAMS is nearly 88%. From 2020 – 2023, the historic emissions were always below the annual emission volumes as adjusted under the 2021 Federal Climate Action Act. In the period from 2024 – 2030, the projected total emissions, both in the WEMS (a light red line) and in the WAMS (a dark red column) are higher than the annual emission volumes as adjusted in the 2021 Federal Climate Action Act. In the WEMS, the total annual emission volume (in accordance with the 2024 Climate Action Act) from 2021 – 2030 is more than fulfilled, by approx. 47 Mt CO2-eq. The overachievement is slightly higher again in the WAMS.

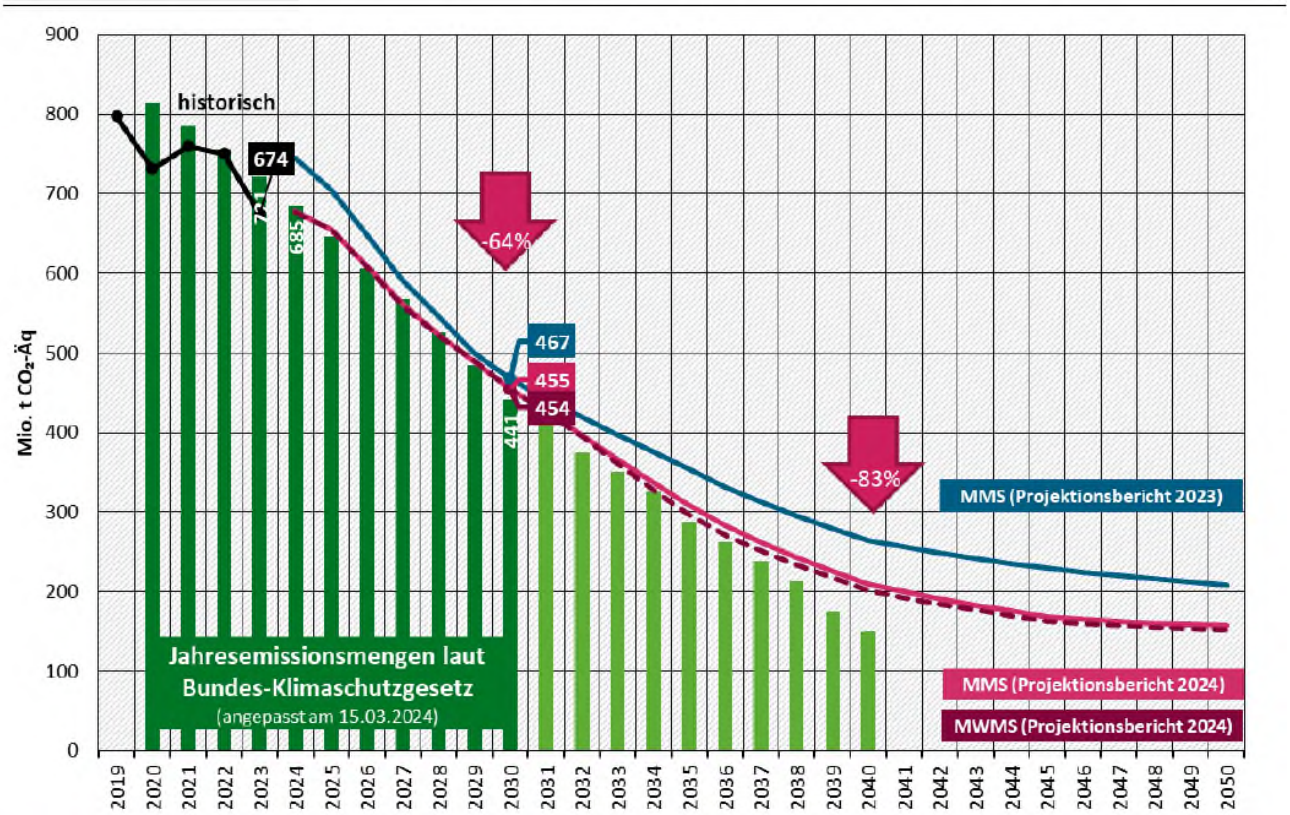
For the years after 2030, the projected total emissions in both scenarios are higher than those emissions deriving from the annual reduction targets set out in the . The Act does not stipulate any targets for the years after 2040. However, net greenhouse gas neutrality must be attained by 2045, taking account of the removal of CO2 from the atmosphere, especially in the LULUCF sector.

Figure 29, greenhouse gas emissions (excl. LULUCF) of approx. 455 Mt CO2-eq are projected for 2030 in the WEMS. This represents an emission reduction of nearly 64% compared to the reference year of 1990. It means that the target under section 3(1) Federal Climate Action Act – to cut greenhouse gas emissions by 65% between 1990 and 2030 – is missed by just over a percentage point. In the WAMS, the projected emissions in 2030 of approx. 454 Mt CO2-eq are only slightly lower than in the WEMS; as in the WEMS, the emission reduction is approx. 64%. By 2050, the WEMS projects an emission reduction of over 87%; the figure for the WAMS is nearly 88%. From 2020 – 2023, the historic emissions were always below the annual emission volumes as adjusted under the 2021 Federal Climate Action Act. In the period from 2024 – 2030, the projected total emissions, both in the WEMS (a light red line) and in the WAMS (a dark red column) are higher than the annual emission volumes as adjusted in the 2021 Federal Climate Action Act. In the WEMS, the total annual emission volume (in accordance with the 2024 Climate Action Act) from 2021 – 2030 is more than fulfilled, by approx. 47 Mt CO2-eq. The overachievement is slightly higher again in the WAMS.

[27] Technischer Anhang der Treibhausgas-Projektionen 2024 für Deutschland (2024 Projection Report) | German Environment Agency

For the years after 2030, the projected total emissions in both scenarios are higher than those emissions deriving from the annual reduction targets set out in the Federal Climate Action Act. The Act does not stipulate any targets for the years after 2040. However, net greenhouse gas neutrality must be attained by 2045, taking account of the removal of CO2 from the atmosphere, especially in the LULUCF sector.

Figure 21: Development of greenhouse gas emissions in Germany between 2019 and 2050 in the WEMS and the WAMS (excl. LULUCF)[28]



Quelle: Modellierung: Öko-Institut, Fraunhofer ISI, IREES, Thünen-Institut; Inventardaten und Jahresemissionsmengen: UBA (2024b)

In the following section, the aggregated development of the GHG emissions in the WEMS is presented in two ways. In one, the contributions of the various greenhouse gases are shown; in the other, the contributions of the individual source categories are shown. In both cases, the total GHG emissions are shown excluding the emissions contributed by maritime shipping and international aviation, since these are not covered by the territorial principle, and both with and without the release or storage of greenhouse gases in the LULUCF sector. The two types of international transport are included in the national GHG inventories, but only as memo items. As a rule, emissions from international fuel bunkers (maritime shipping and international aviation) and LULUCF do not count towards meeting climate targets in Germany; this projection report follows this convention.

2.F.1.1 Projection of emissions by type of greenhouse gas

Table 7 presents the summarised data on the emissions of carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), partly fluorinated hydrocarbons (HFCs), perfluorinated hydrocarbons (PFCs),

[28] UBA - German Environment Agency (ed.) (2024b): Development of greenhouse gas emissions in Germany, using the sector definitions of the Federal Climate Action Act. Available online at https://www.umweltbundesamt.de/sites/default/files/medien/361/dokumente/2024_03_13_em_entwicklung_in_d_ksg-sektoren_thg_v1.0.xlsx, last checked on 01.08.2024.

sulphur hexafluoride (SF6) and nitrogen trifluoride (NF3), subdivided into the two scenarios WEMS and WAMS, including and excluding LULUCF.

Table 7: Development of GHG emissions by gas type from 2024 – 2050[29]

			2024	2025	2030	2035	2040	2045	2050
Total excluding LULUCF	**WEMS**	**CO2 (kt)**	602798.179	582243.715	389056.063	248081.014	151109.112	110861.900	99591.187
		CH4 (kt)	1571.061	1552.844	1467.174	1391.021	1344.137	1336.573	1330.567
		N2O (kt)	82.520	81.436	76.197	71.279	68.627	67.642	67.131
		SF6 (kt)	0.082	0.077	0.037	0.028	0.032	0.036	0.038
		NF3 (kt)	0.001	0.001	0.001	0.001	0.001	0.001	0.001
		HFC (ktCO2-eq)	6506.288	5866.302	3516.757	2489.421	1787.831	1550.806	1496.106
		PFC (ktCO2-eq)	240.040	215.143	224.856	226.858	229.466	232.044	234.385
	WAMS	**CO2 (kt)**	602532.535	582341.403	389179.867	237468.285	146028.075	107536.827	97718.197
		CH4 (kt)	1566.884	1548.666	1470.078	1371.366	1323.628	1314.043	1304.062
		N2O (kt)	81.676	81.454	74.206	68.682	65.700	64.392	63.540
		SF6 (kt)	0.082	0.077	0.035	0.025	0.028	0.030	0.030
		NF3 (kt)	0.001	0.001	0.001	0.001	0.001	0.001	0.001
		HFC (ktCO2-eq)	6458.820	5725.618	3092.077	1695.959	822.632	558.476	451.603
		PFC (ktCO2-eq)	240.040	215.143	224.856	226.858	229.466	232.044	234.385

[29] Source: Article 38 Reporting on national projections, Table 1a (Reportnet 3 2024): Reportnet 3 (europa.eu)

			2024	2025	2030	2035	2040	2045	2050
Total including LULUCF	**WEMS**	**CO2 (kt)**	595675.858	576673.436	380059.214	237217.328	143195.386	104702.142	96375.527
		CH4 (kt)	1802.140	1783.834	1700.455	1625.953	1580.531	1574.217	1569.340
		N2O (kt)	86.854	85.767	80.613	75.444	72.766	71.727	71.182
		SF6 (kt)	0.082	0.077	0.037	0.028	0.032	0.036	0.038
		NF3 (kt)	0.001	0.001	0.001	0.001	0.001	0.001	0.001
		HFC (ktCO2-eq)	6506.288	5866.302	3516.757	2489.421	1787.831	1550.806	1496.106
		PFC (ktCO2-eq)	240.040	215.143	224.856	226.858	229.466	232.044	234.385
	WAMS	**CO2 (kt)**	595262.028	576650.965	379244.287	224463.843	134940.103	97212.295	89721.970
		CH4 (kt)	1797.904	1779.589	1705.078	1611.963	1568.929	1563.206	1556.519
		N2O (kt)	85.982	85.756	78.562	72.782	69.773	68.409	67.510
		SF6 (kt)	0.082	0.077	0.035	0.025	0.028	0.030	0.030
		NF3 (kt)	0.001	0.001	0.001	0.001	0.001	0.001	0.001
		HFC (ktCO2-eq)	6458.820	5725.618	3092.077	1695.959	822.632	558.476	451.603
		PFC (ktCO2-eq)	240.040	215.143	224.856	226.858	229.466	232.044	234.385

2.F.1.2 Development of GHG emissions by the Federal Climate Change Act sectors

The projected course of greenhouse gas emissions develops differently between the sectors, as can be seen in Table 8. The annual emission volumes for 2030, as adjusted on 15 March 2024, are exceeded both in the WEMS and the WAMS. In the case of the industry and buildings sectors, the cumulated annual emission volumes are exceeded in the WEMS in 2030; in the case of the WAMS, industry falls below the target, and the target is met in the buildings sector. In the other sectors, the 2030 annual emission volumes are complied with in both scenarios.

The projected total emissions, as a sum of all sectors, are higher than the annual emission volumes for 2030, as adjusted on 15 March 2024, both in the WEMS and the WAMS.

The LULUCF sector fluctuates around zero emissions over the course of the projected period. In the WAMS, the LULUCF sector is a slightly smaller source / a slightly larger sink than in the WEMS, but nevertheless clearly fails to meet its interim targets for 2030 (25 Mt), 2040 (35 Mt) and 2045 (40 Mt).

In international aviation and maritime transport, which are modelled in the projections but included in the reporting only as memo items, no annual emission volume has been set. A clear growth in emission is to be expected in both scenarios between the base year of 2021 and 2030; thereafter, the emissions fall.

Table 8: Development of the greenhouse gas emissions in a comparison of the scenarios, 2024-2050[30]

Sector according to Climate Action Act	Unit	2024	2025	2030	2035	2040	2045	2050
Total								
Reduction target in 2021 Federal Climate Action Act	% reduction			65%	77%	88%		
WEMS total (not including LULUCF)	Mt CO2-eq	677	655	455	309	210	169	157
WEMS total (not including LULUCF)	% reduction	-46%	-48%	-64%	-75%	-83%	-87%	-87%
Difference between WEMS/Cl Act	Mt CO2-eq	-7	9	14				
WAMS total (not including LULUCF)	Mt CO2-eq	677	655	454	296	202	163	152
WAMS total (not including LULUCF)	% reduction	-46%	-48%	-64%	-76%	-84%	-87%	-88%
Difference between WAMS/Cl Act	Mt CO2-eq	-8	9	13				
Energy sector								
Annual emission volume as per C.A. Act	Mt CO2-eq	220	201	108				
WEMS	Mt CO2-eq	212	202	92	60	38	37	40

[30] Source: Assumptions and calculations by Öko-Institut, Fraunhofer ISI, IREES, Thünen Institute (Harthan et al. 2024) Technischer Anhang der Treibhausgas-Projektionen 2024 für Deutschland (2024 Projection Report) | German Environment Agency

Sector according to Climate Action Act	Unit	2024	2025	2030	2035	2040	2045	2050
Difference between WEMS/Cl Act	Mt CO2-eq	-7	0	-16				
Difference from 1990	% reduction	-55%	-58%	-81%	-87%	-92%	-92%	-92%
WAMS	Mt CO2-eq	213	203	99	57	37	37	40
Difference between WAMS/Cl Act	Mt CO2-eq	-7	1	-9				
Difference from 1990	% reduction	-55%	-57%	-79%	-88%	-92%	-92%	-91%
Industry								
Annual emission volume as per C.A. Act	Mt CO2-eq	169	161	122				
WEMS	Mt CO2-eq	151	149	122	82	60	52	50
Difference between WEMS/Cl Act	Mt CO2-eq	-17	-11	1				
Difference from 1990	% reduction	-46%	-46%	-56%	-71%	-79%	-81%	-82%
WAMS	Mt CO2-eq	151	149	117	78	58	49	47
Difference between WAMS/Cl Act	Mt CO2-eq	-17	-12	-4				
Difference from 1990	% reduction	-46%	-47%	-58%	-72%	-79%	-82%	-83%
Buildings								
Annual emission volume as per C.A. Act	Mt CO2-eq	96	91	66				
WEMS	Mt CO2-eq	101	96	68	40	22	8	4
Difference between WEMS/Cl Act	Mt CO2-eq	6	5	2				
Difference from 1990	% reduction	-52%	-54%	-68%	-81%	-90%	-96%	-98%
WAMS	Mt CO2-eq	101	96	66	37	19	7	4
Difference between WAMS/Cl Act	Mt CO2-eq	5	5	0				
Difference from 1990	% reduction	-52%	-54%	-68%	-83%	-91%	-97%	-98%
Transport								
Annual emission volume as per C.A. Act	Mt CO2-eq	125	120	82				
WEMS	Mt CO2-eq	147	144	111	67	33	15	6
Difference between WEMS/Cl Act	Mt CO2-eq	22	24	29				
Difference from 1990	% reduction	-10%	-12%	-32%	-59%	-80%	-91%	-96%

Sector according to Climate Action Act	Unit	2024	2025	2030	2035	2040	2045	2050
WAMS	Mt CO2-eq	147	143	110	66	32	15	6
Difference between WAMS/Cl Act	Mt CO2-eq	22	24	28				
Difference from 1990	% reduction	-10%	-12%	-32%	-59%	-81%	-91%	-96%
Agriculture								
Annual emission volume as per C.A. Act	Mt CO2-eq	67	65	58				
WEMS	Mt CO2-eq	60	59	57	56	54	54	53
Difference between WEMS/Cl Act	Mt CO2-eq	-7	-6	-1				
Difference from 1990	% reduction	-28%	-29%	-31%	-33%	-35%	-35%	-36%
WAMS	Mt CO2-eq	60	59	57	55	53	53	52
Difference between WAMS/Cl Act	Mt CO2-eq	-8	-6	-2				
Difference from 1990	% reduction	-28%	-29%	-32%	-34%	-36%	-37%	-38%
Waste management sector, and other areas								
Annual emission volume as per C.A. Act	Mt CO2-eq	8	8	5				
WEMS	Mt CO2-eq	5	5	4	4	3	3	3
Difference between WEMS/Cl Act	Mt CO2-eq	-3	-3	-1				
Difference from 1990	% reduction	-88%	-88%	-90%	-91%	-92%	-92%	-92%
WAMS	Mt CO2-eq	5	5	4	4	3	3	3
Difference between WAMS/Cl Act	Mt CO2-eq	-3	-3	-1				
Difference from 1990	% reduction	-88%	-88%	-90%	-91%	-92%	-92%	-92%
Memo items:								
LULUCF								
Contribution of the LULUCF sector[31]	Mt CO2-eq			25		35	40	
WEMS	Mt CO2-eq	0	2	-1	-3	0	2	5
WAMS	Mt CO2-eq	0	2	-2	-5	-3	-2	0

[31] The contribution is calculated as the average of the annual emission balances of the respective target year and the three preceding calendar years.

Sector according to Climate Action Act	Unit	2024	2025	2030	2035	2040	2045	2050
International aviation and maritime transport								
WEMS	Mt CO2-eq	35	37	42	40	40	40	36
Difference between WEMS/Cl Act	Mt CO2-eq							
Difference from 1990	% reduction	84%	91%	119%	110%	109%	108%	87%
WAMS	Mt CO2-eq	35	37	42	40	40	40	36
Difference between WAMS/Cl Act	Mt CO2-eq							
Difference from 1990	% reduction	84%	91%	119%	110%	109%	108%	87%

In Table 8, the GHG emissions are shown in total excluding LULUCF and broken down amongst the sectors covered by the Climate Action Act over time from 2024 to 2050.

The energy industry accounts for the largest share of the emissions reductions achieved from 2024 through 2050. In this sector, the emissions fall by 120 Mt CO2-eq by 2050 in absolute figures. This corresponds to a reduction of 92% in 2050 compared to 1990. In 2030, the energy-related industrial emissions stand at 122 Mt CO2-eq, roughly 56% below the 1990 level. After this, they fall to 50 Mt CO2-eq by 2050, 82% down from 1990. The GHG emissions from the buildings sector fall by 64 Mt CO2-eq by 2030, 68% down on 1990. Between 2030 and 2050, they fall by 64 Mt CO2-eq, 98% down from 1990. The third largest contribution to the forecast emission reduction is in the transport sector: compared with 2024, emissions fall by 36 Mt CO2-eq by 2030 (32% down from 1990) and to 6 Mt CO2-eq by 2050 (-96% down from 1990). Viewed in historic terms, the proportion of total emissions accounted for by transport-related emissions has been rising; whilst transport accounted for a little over 13% of total emissions in 1990, this figure rose to 18% by 2024. In the projection, this trend is halted, and the proportion of emissions from the transport sector does not rise further. However, it is necessary to note that the roll-out of electric mobility shifts some of the emissions from the transport sector to the energy industry, since public electricity generation is included there, and is not yet fully converted to renewable energy. While emissions from agriculture did decrease between 1990 and 2024, their decrease was considerably smaller, and slower, than the decreases seen in all other sectors. Further to this, agriculture is the sector with the smallest forecast emission reduction: up to 2030, the emissions fall to 57 Mt CO2-eq, 31% down from 1990, whilst up to 2050, the emissions drop only by a further 5 Mt CO2-eq. The emissions from the waste sector are primarily historic in nature. Up to 2050, the emissions from the waste sector fall by 92% compared with 1990, compared with 88% in 2024.

The emissions from the share of international aviation and international maritime transport which is ascribed to Germany are at a similar level in 2024 and 2050, i.e. 35 Mt CO2-eq, but rise in the intervening years to a higher level of 40 Mt CO2-eq. Compared with 1990, these emissions will rise by 119% up to 2030, but will fall to 87% by 2050.

2.F.2 Methodological approach

The 2024 Projection Report, which forms the basis for this report, shows how German greenhouse gas emissions might develop up to 2050, assuming the framework data in place and the parametrisation of the instruments. Two scenarios are projected. The With Existing Measures Scenario (WEMS) includes

all climate action measures that, by the reference date 31 July August 2023, had already been adopted and implemented to the extent that all data and other information required for parametrisation of the measure are available. Measures that were only planned up to the reference date but not implemented are additionally built into the With Additional Measures Scenario (WAMS).

The projection report is based on model calculations by a research consortium consisting of the Öko-Institut, the Fraunhofer Institute for Systems and Innovation Research (ISI) and the Institute for Resource Efficiency and Energy Strategies (IREES). The consortium draws up this report on behalf of the German Environment Agency (UBA). The model-based analysis in the field of land use, land use change and forestry (LULUCF) was carried out by the Johann Heinrich von Thünen Institute. The results are presented in line with the sectors as defined in the Climate Action Act: energy, industry, buildings, transport, agriculture, LULUCF and waste/other. The results of the sectoral models are integrated with the assistance of an overarching model.

Framework data, instruments to be included, and major assumptions for their parametrisation were coordinated with the relevant ministries in the autumn of 2023. The coordinated papers for framework data and instruments were published on the German Environment Agency's website in December 2023 (Harthan et al. 2024; Mendelevitch et al. 2024[32]).

2.F.2.1 Methodological approach to GHG emissions and changes from the last Biennial Transparency Report

The projections for (German) greenhouse gas emissions up to 2050 are made on the basis of assumptions, agreed on by the various participating ministries, for

- population trends,
- economic development,
- energy and carbon price developments, and
- technical and sector-specific factors. (e.g. efficiency grades).

In principle, the modelling is instrument-driven. To this end, climate policy instruments are parameterised, e.g. laws, regulations, economic instruments (e.g. carbon pricing) or budget funding. The climate policy instruments address a broad spectrum of climate change mitigation measures and related greenhouse gas reductions. The ascertainment of the effects resulting from the climate change mitigation instruments, such as the development of the sales of electric vehicles or heat pumps, or electricity generation broken down by energy source, takes place on a model-endogenous basis.

Alongside quantifiable instruments, there are supporting instruments whose effect cannot be quantified in the models used. Supporting instruments support the implementation of quantifiable instruments. For example, information-related instruments can reduce barriers affecting other instruments in certain sectors. The effect of the instruments is assigned to the quantifiable instrument.

The process of analysing and evaluating the different instruments, calculating sectoral greenhouse gas emissions by source category and ascertaining the background information and indicators needed for this report is based on different methodological approaches and sets of models for the different sectors – approaches and models which permit an adequate analysis based on the data and information available for the sectors concerned.

[32] Mendelevitch, R.; Repenning, J.; Matthes, F. C.; Deurer, J. (2024): Treibhausgas-Projektionen 2024 für Deutschland – Rahmendaten (2024 greenhouse gas projections for Germany – Framework data). Öko-Institut; IREES. Umweltbundesamt (ed.). Dessau-Roßlau. Available online at https://www.umweltbundesamt.de/publikationen/treibhausgas-projektionen-2024-fuer-deutschland, last checked on 12.03.2024.

For energy-related greenhouse gas emissions from combustion processes, the analyses are based on a complex system of different models (cf. Figure 22):

a) Electricity generation from fossil fuels and from renewable energy sources is analysed using the Öko-Institut's PowerFlex-Model. Heat generation in CHP systems is also modelled with this model.

b) Final energy consumption figures are integrated, and primary energy consumption and the energy used in other energy conversion sectors are determined, using Öko-Institut's ENUSEM integration model.

c) Modelling for the transport sector is carried out with Öko-Institut's TEMPS model.

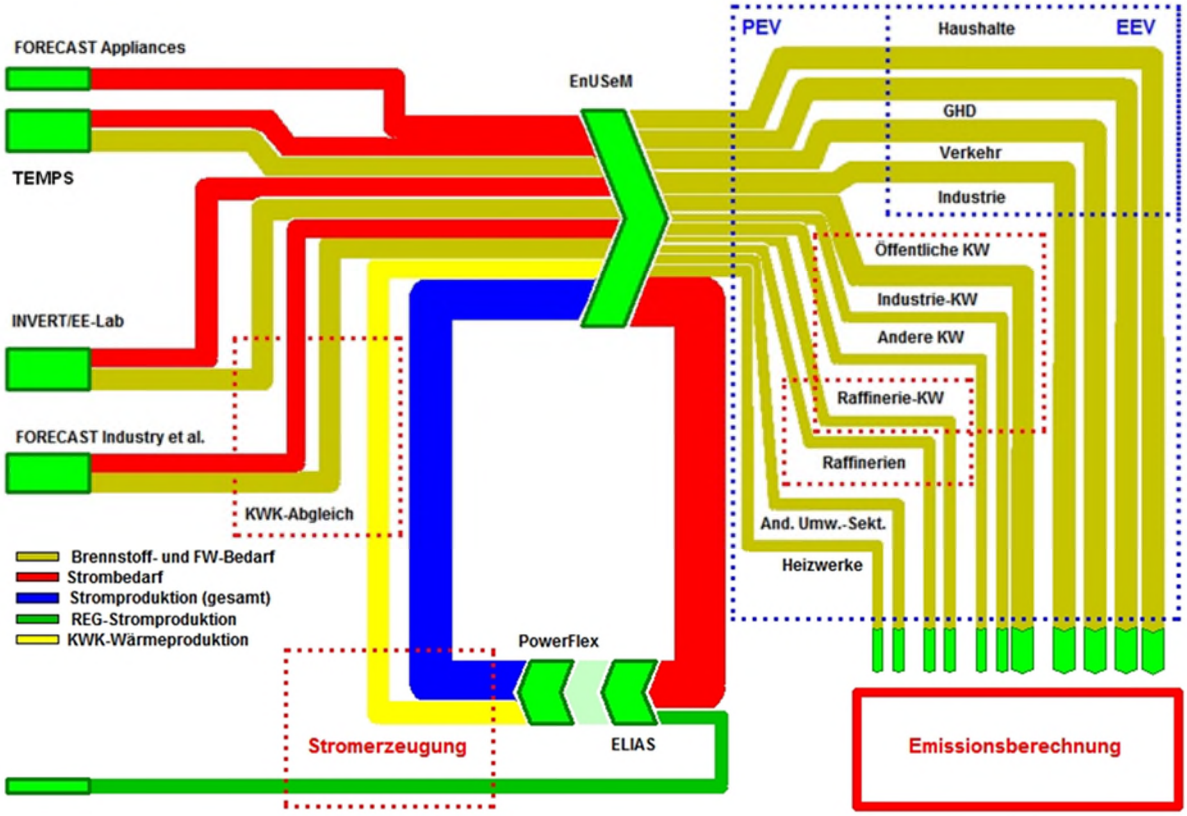
d) For the buildings sector (residential and non-residential buildings), the INVERT/EE-Lab model of IREES is used. The effects of individual policy instruments are assessed by Öko-Institut, on the basis of the policy instruments effect model.

e) Analyses for the remaining fuel and electricity demand in the buildings sector are carried out using the FORECAST model platform of Fraunhofer ISI.

f) The analyses for the electricity and fuel requirements of industry and the trade, commerce and services sector are carried out using Fraunhofer ISI's FORECAST model platform, which is based on individual sector models.

g) Greenhouse gas emissions from combustion processes are determined using Öko-Institut's emissions model, which evaluates emissions aspects of the energy demand projections aggregated in ENUSEM for the various end-use and transformation sectors within the national greenhouse gas emissions system.

Figure 22: Overview of models used to analyse energy-related greenhouse gas emissions



Source: Harthan et al. (2023)[33]

For fugitive emissions in the energy sector, source category-specific modelling is based on energy-demand and supply volumes and the methods used in the National Greenhouse Gas Inventory.

The following approaches are used for emissions from industrial processes:

a) Process-related emissions of the mineral industry and the chemical industry (with the exception of the petrochemical industry) are modelled with the help of the FORECAST model.

b) For the remaining process-related emissions connected with the energy sector, emissions are determined with Öko-Institut's ENUSEM emissions model, on the basis of energy-demand and supply volumes, and using the methods employed for the National Greenhouse Gas Inventory.

c) For the remaining process-related emissions that are not connected with the energy sector, emissions are determined with Öko-Institut's ENUSEM emissions model, on the basis of production estimates, and on the basis of the methods employed for the National Greenhouse Gas Inventory.

d) For HFC, PFC, SF6 and NF3 emissions, existing projections are updated and adjusted in the ProFI model.

Projections of GHG emissions from agriculture, with regard to agricultural soils, animal husbandry and other areas, are calculated by the Thünen Institute. Energy consumption in agriculture is determined by the Öko-Institut, using the LaWiEnMod model. Emissions of the Land Use, Land Use Change and Forestry (LULUCF) sector are calculated by the Thünen Institute.

[33] Harthan, R. O.; Förster, H.; Borkowski, K.; Böttcher, H.; Braungardt, S.; Bürger, V.; Emele, L.; Görz, W. K.; Hennenberg, K.; Jansen, L. L.; Jörß, W.; Kasten, P.; Loreck, C. et al. (2023): Projektionsbericht 2023 für Deutschland (2023 Projection Report for Germany) (2nd edtion) (Climate Change, 39/2023). Öko-Institut, Fraunhofer ISI, IREES; Thünen-Institute German Environment Agency (ed.). Dessau-Roßlau. Available online at https://www.umweltbundesamt.de/publikationen/projektionsbericht-2023-fuer-deutschland, last checked on 29.07.2024.

With regard to GHG emissions from the waste management sector, Öko-Institut's IPCC Waste_Mod Model, which is used for preparation of National Greenhouse Gas Inventories, is used for the necessary projections.

The calculations of the scenarios in the projection report are based on the national Greenhouse Gas Inventory. The current Greenhouse Gas Inventory available at the time this scenario was calculated is the provisional Greenhouse Gas Inventory from the 2024 reporting year. It was prepared in accordance with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006[34]) in keeping with the current guidelines for inventories (UNFCCC 2013[35]). The data for the years from 1990 to 2022 were used. The primary data source used to prepare this report is data – consistent with the Greenhouse Gas Inventory of 2024 – downloaded from the Central System for Emissions (ZSE) at the German Environment Agency (UBA 2023a[36]). The Greenhouse Gas Inventory is not completely compatible with the Energy Balance for the Federal Republic of Germany (in part, due to differences in sector definitions and fuel aggregations). Therefore, there are some differences between the Inventory and the Energy Balance. The Greenhouse Gas Inventory contains only activity data on fuel-based energy sources. The Energy Balances are the primary source of data for non-fuel-based energy sources.

The greenhouse gas potentials used for the 2014 projections correspond to those of the 5th Assessment Report of the IPCC (AR5) (IPCC 2014[37]).

2.F.2.2 Summary of the framework data and sensitivities

In advance of the modelling of the greenhouse gas projections, the consortium coordinates and stipulates numerous framework data, and these are then discussed and coordinated with the ministries. These framework data range from demographic to macroeconomic assumptions, price assumptions for national and European carbon allowance trading, energy prices for all energy carriers, including final energy prices, and finally assumptions about hydrogen imports. They are published in a separate report each year (most recently Mendelevitch et al. 2024[38]). Figure 9 the framework data in the projection period from 2022 – 2050. Also, some of the framework data are varied in sensitivity calculations. The sensitivity analysis was only carried out for the WEMS.

[34] IPCC (2006): 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds.). IGES, Japan. Available online at http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html, last checked on 29.07.2024.

[35] UNFCCC - United Nations Framework Convention on Climate Change (ed.) (2013): Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention, Decision 24/CP.19. Available online at http://unfccc.int/national_reports/annex_i_ghg_inventories/reporting_requirements/items/2759.php, last checked on 11.08.2023.

[36] UBA - German Environment Agency (2023a): Data drawn from UBA "Central System of Emissions (CSE)" database. Email with Öko-Institut, 06.10.2023.

[37] IPCC - Intergovernmental Panel on Climate Change (ed.) (2014): Climate Change 2014: Synthesis Report, Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Geneva, Switzerland. Available online at https://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_FINAL_full_wcover.pdf, last checked on 29.07.2024.

[38] Mendelevitch, R.; Repenning, J.; Matthes, F. C.; Deurer, J. (2024): Treibhausgas-Projektionen 2024 für Deutschland – Rahmendaten (2024 greenhouse gas projections for Germany – Framework data). Öko-Institut; IREES. Umweltbundesamt (ed.). Dessau-Roßlau. Available online at https://www.umweltbundesamt.de/publikationen/treibhausgas-projektionen-2024-fuer-deutschland, last checked on 12.03.2024.

Table 9: Summary of framework data (Part 1 from 2022 to 2035)

	Parameter	Unit	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
1	**Population**	Millions	84.4	84.6	84.7	84.9	85.0	85.1	85.2	85.2	85.3	85.3	85.3	85.3	85.2	85.2
2	**Gross domestic product**	In €bn (2022)	3885.3	3868.3	3916.7	3977.2	4002.3	4027.6	4053.1	4079.8	4107.5	4138.2	4173.6	4213.0	4255.5	4301.9
2	**Annual GDP growth rate**	%	1.8	-0.4	1.3	1.5	0.6	0.6	0.6	0.7	0.7	0.7	0.9	0.9	1.0	1.1
3	**Energy price for natural gas**	€(2022)/MWh (LCV)	83.8	57.7	56.3	48.0	37.1	31.5	28.6	25.7	22.8	22.6	22.4	22.2	22.0	21.9
3	**Energy price for Brent crude oil**	€(2022)/MWh (LCV)	57.9	43.4	39.6	36.5	34.0	32.0	30.5	29.4	28.6	28.3	28.0	27.8	27.5	27.2
3	**Energy price for hard coal**	€(2022)/MWh (LCV)	29.4	16.0	15.2	14.4	13.6	13.2	12.8	12.5	12.2	12.0	11.9	11.8	11.6	11.5
4	**Energy price for hydrogen**	€(2022)/MWh (LCV)	212.0	202.5	193.0	183.5	174.0	164.5	155.0	145.5	136.0	132.0	128.0	124.0	120.0	116.0
5	**Energy price for biomethane**	ct(2022)/kWh	21.6			19.1					14.2					13.9
5	**Energy price for biomass chips - MC 20**	ct(2022)/kWh	3.9			3.5					2.6					2.5
5	**Energy price for biomass chips - MC 35**	ct(2022)/kWh	3.1			2.8					2.1					2.0
5	**Energy price for wood pellets**	ct(2022)/kWh	10.8			7.5					5.6					5.4
5	**Energy price for firewood**	ct(2022)/kWh	9.5			9.6					7.2					7.0
6	**Energy price for district heating**	ct(2022)/kWh	10.8			10.4					9.3					9.3
7	**CO2 price in real terms (EU-ETS)**	€(2022)/EUA	81.0	82.0	81.9	84.2	95.7	105.0	110.7	116.4	122.1	125.7	129.3	132.9	136.6	140.2
8	**CO2 price in nominal terms (nETS)**	€(nominal)/t CO2	30.0	30.0	40.0	50.0	65.0	80.0	95.0	110.0	125.0	140.0	155.0	170.0	185.0	200.0
8	**CO2 price in real terms (nETS)**	€(2022)/t CO2	30.0	28.3	36.7	44.9	57.1	68.9	80.1	90.9	101.3	111.2	120.6	129.6	138.3	146.5
8	**Deflator**	1.00=(2022)	1.0	0.9	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7

Summary of framework data (Part 1 from 2036 to 2050)

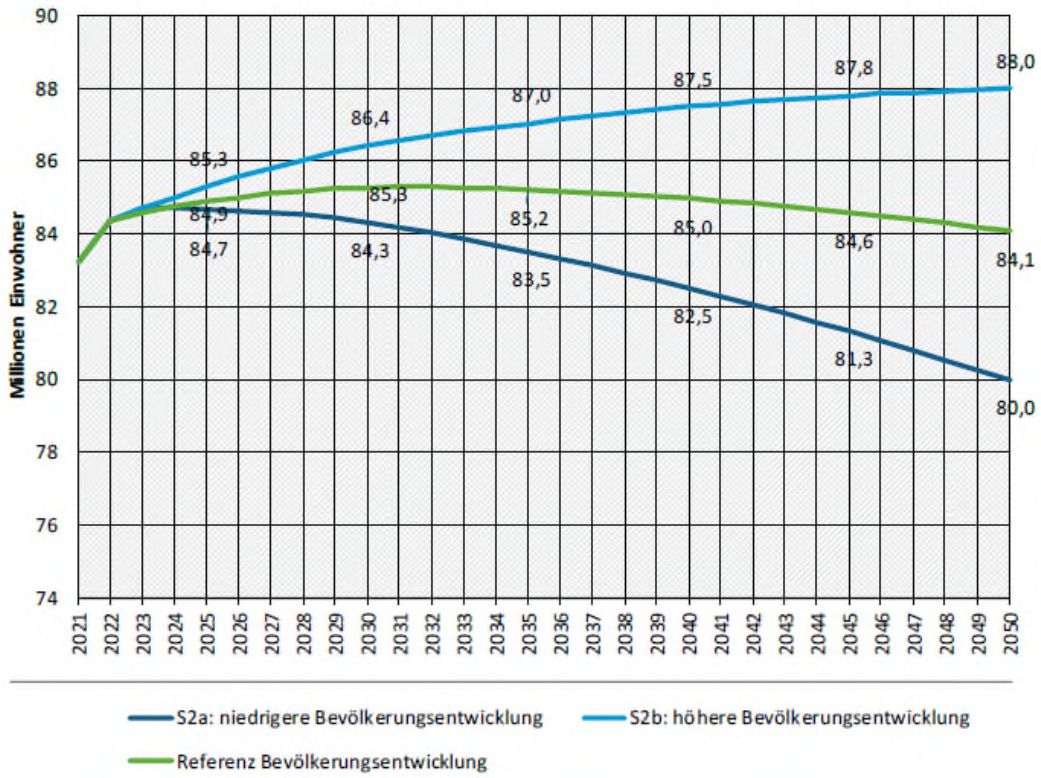
	Parameter	Unit	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
1	**Population**	Millions	85.2	85.1	85.1	85.0	85.0	84.9	84.8	84.8	84.7	84.6	84.5	84.4	84.3	84.2	84.1
2	**Gross domestic product**	In €bn (2022)	4352.5	4407.4	4465.1	4526.3	4590.6	4648.5	4707.1	4766.4	4826.4	4887.2	4948.8	5011.2	5074.3	5138.2	5203.0
2	**Annual GDP growth rate**	%	1.2	1.3	1.3	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
3	**Energy price for natural gas**	€(2022)/MWh (LCV)	21.7	21.5	21.3	21.1	20.9	20.7	20.5	20.3	20.1	19.9	19.7	19.5	19.3	19.2	19.0
3	**Energy price for Brent crude oil**	€(2022)/MWh (LCV)	26.9	26.7	26.4	26.1	25.9	25.6	25.3	25.1	24.8	24.5	24.2	24.0	23.7	23.4	23.2
3	**Energy price for hard coal**	€(2022)/MWh (LCV)	11.4	11.2	11.1	11.0	10.8	10.7	10.6	10.4	10.3	10.2	10.0	9.9	9.8	9.6	9.5
4	**Energy price for hydrogen**	€(2022)/MWh (LCV)	112.0	108.0	104.0	100.0	96.0	95.0	94.0	93.0	92.0	91.0	90.0	89.0	88.0	87.0	86.0
5	**Energy price for biomethane**	ct(2022)/kWh					13.7					13.4					
5	**Energy price for biomass chips - MC 20**	ct(2022)/kWh					2.5					2.4					
5	**Energy price for biomass chips - MC 35**	ct(2022)/kWh					2.0					1.9					
5	**Energy price for wood pellets**	ct(2022)/kWh					5.3					5.2					
5	**Energy price for firewood**	ct(2022)/kWh					6.9					6.7					
6	**Energy price for district heating**	ct(2022)/kWh					9.6					9.8					
7	**CO2 price in real terms (EU-ETS)**	€(2022)/EUA	143.8	147.4	151.0	154.7	158.3	160.5	162.8	165.1	167.3	169.6	171.8	174.1	176.4	178.6	180.9
8	**CO2 price in nominal terms (nETS)**	€(nominal)/t CO2	215.0	230.0	245.0	260.0	275.0	290.0	305.0	320.0	335.0	350.0	365.0	380.0	395.0	410.0	425.0
8	**CO2 price in real terms (nETS)**	€(2022)/t CO2	154.3	161.8	168.9	175.6	182.0	188.1	193.9	199.4	204.5	209.4	214.0	218.4	222.5	226.3	229.9
8	**Deflator**	1.00=(2022)	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5

2.F.2.2.1 Demographic development

For the population figures in Germany, it is assumed that there will be a very steady development in them up to 2050. Up to 2030, a slight increase of 600,000 people to 85.5 million is assumed, followed by a slight fall to 84.1 million up to 2050.

Since the population development can be influenced for example by higher or lower immigration, this was subjected to a sensitivity analysis. Figure 23 shows both studied sensitivities. The figures in Table 23 show that a lower population increase is related to reduced emissions (-4,5 Mt CO2-eq in 2030 and -5.9 Mt CO2-eq in 2050). In contrast to this, a higher population increase causes a rise in emissions, of +5.4 Mt CO2-eq in 2030 and +5.7 Mt CO2-eq in 2050.

Figure 23: Population development used



Source: In-house data of Öko-Institut; Federal Statistical Office (2023a[39])

[39] - Federal Statistical Office (2023e): Verkehr. Luftverkehr (Transport. Aviation), Fachserie 8, Reihe 6. Statistisches Bundesamt (ed.). Available online at https://www.destatis.de/DE/Themen/Branchen-Unternehmen/Transport-Verkehr/Personenverkehr/Publikationen/Downloads-Luftverkehr/luftverkehr-2080600231035.xlsx?__blob=publicationFile, last checked on 01.11.2023.

Table 10: Development of GHG emissions in the sensitivity calculation 2 (WEMS)

	1990	2024	2025	2030	2035	2040	2045	2050
	Mt CO2-eq							
Total emissions, without int. transport and LULUCF)	1,251.3	734.0	734.0	655.2	454.7	309.1	209.7	168.8
	Sensitivity S2: Development of population (difference)							
2a: Lower population trend		-0.3	-1.4	-4.5	-5.3	-5.1	-5.3	-5.9
S2b: Higher population trend		1.9	2.8	5.4	5.7	5.2	5.2	5.7

Source: In-house data, Öko-Institut, calculations: Öko-Institut, Fraunhofer ISI, IREES

2.F.2.2.2 Macroeconomic development

For the 2024 projections, growth rates indicated in the autumn projection of the Federal Government up to 2028 are taken, and for the following years until 2050 the growth rates provided by the European Commission (EC 2022[40]) are used. A smaller development in economic growth can also impact the course of emissions, hence the use of a sensitivity. As can be seen from Table 11 and Table 12, a lower GDP development results in reduced greenhouse gas emissions compared with the WMS. As shown in Table 12, this would lead to a cut in greenhouse gas emissions of -1,4 Mt CO2-eq in 2030 und -0,4 Mt CO2-eq in 2050 compared with the WMS. This lower economic growth results in a reduction of greenhouse gases of an additional 0.1% in 2030 and of 0.03% in 2050, in each case compared with the 1990 figures.

Table 11: Assumed GDP growth rates

	2024	2025	2026	2027	2028	2029	2030
Reference GDP development	1.3 %	1.5 %	0.6 %	0.6 %	0.6 %	0.7 %	0.7 %
S1: Lower GDP development	0.6%	1.1 %	1.6 %	0.6 %	0.6 %	0.7 %	0.7 %

Source: In-house data, Öko-Institut, based on Deutsche Bundesbank (15.12.2023)

[40] European Commission (EC) (2022): Recommended parameters for reporting on GHG projections in 2023, April 2022. Email to members of WG II of the Climate Change Committee. PDF.

Table 12: Development of GHG emissions in the sensitivity calculation 1 (WEMS)

	1990	2024	2025	2030	2035	2040	2045	2050
				Mt CO2-eq				
Total emissions, without int. transport and LULUCF)	1,251.3	734.0	734.0	655.2	454.7	309.1	209.7	168.8
Sensitivity S1: Economic growth (difference)								
S1: Lower GDP development		-4.8	-7.2	-1.4	-0.9	-0.6	-0.5	-0.4

Source: In-house data, Öko-Institut, calculations: Öko-Institut, Fraunhofer ISI, IREES

2.F.2.2.3 Energy price projection for oil, hard coal, natural gas and hydrogen

For modelling purposes the current futures prices and the current international projection of the WEO 2023 (International Energy Agency (IEA) 2023[41]) at the time the framework data are specified have been used for development of prices for the Brent crude oil marker. For the implementation of the projection, the figures in line with the current futures are used up to 2030. From 2030, the rates in the WEO-2023-AP scenario are used.

The sensitivity analyses were carried out for the energy, industry, buildings and transport sectors. When interpreting the results, it is necessary to note that no overall integration of the sector results was undertaken; rather, these are isolated results from the sector models, as is customary in the sensitivity analyses. For this reason, the results from the various sectors cannot be added together; they must be viewed separately. The results are shown in Table 13.

Table 13: Development of GHG emissions in the sensitivity calculation 3 (WEMS)

	1990	2024	2025	2030	2035	2040	2045	2050
				Mt CO2-eq				
Total emissions, without int. transport and LULUCF)	1,251.3	734.0	734.0	655.2	454.7	309.1	209.7	168.8
Sensitivity S3: varied fuel prices (difference)								
S3a: Energy sector		-39.5	-36.8	1.8	0.8	0.0	0.0	0.0
S3b: Industry		-0.6	-2.1	-2.5	-1.5	0.0	0.4	0.6
S3c: Buildings (equipment and processes)		-0.3	-0.3	-0.6	-0.8	-0.6	-0.3	-0.1
S3e: Transport		-0.9	-1.6	-3.6	-4.3	-1.2	-0.5	-0.4

Source: In-house data, Öko-Institut, calculations: Öko-Institut, Fraunhofer ISI, IREES

[41] International Energy Agency (IEA) (ed.) (2023): World Energy Outlook 2023, Paris. Available online at https://www.iea.org/reports/world-energy-outlook-2023, last checked on 25.10.2023.

2.F.2.2.4 Development of the prices for greenhouse gas emission allowances in the EU ETS

Up to 2025, the current price path of the Cabinet draft of the Budget Financing Act is used for the 2024 projections. For the year 2026, the upper boundary of the price range (€65/t) is assumed. As of 2027, the CO2 price will be determined by the market, if no maximum and minimum prices are agreed in 2025. For the period after 2027, it is assumed that the price will increase by €15 (nominal) annually, and that it will amount to €275/t CO2 in 2040. This is a much higher figure than the approx. €162/t (nominal) used in, for example, the "2040 Traffic Forecast" (Kluth et al. 2023[42]). For the post-2040 period, no figures are available from the scenario used. A further annual increase of €15 in the nominal price is assumed.

For this reason, a price path is assumed for the 2024 projections which uses the expert recommendation up to 2030. From 2030, the rates in the WEO-2023-AP scenario are used. According to the scenario description, this already maps the Fit for 55 package and parts of the REPowerEU Plan (International Energy Agency (IEA) 2023[43]).

The EU ETS is one of Europe's main instruments to cut greenhouse gas emissions. The projected influence of the assumed carbon price on emissions reductions is substantial. Two different sensitivity scenarios are considered: Sensitivity S4a, based on the assumption of a lower carbon price development, and Sensitivity S4b, assuming rising carbon prices from 2030 compared with the WMS parameters. The findings and their impact on selected sectors are presented in Table 14.

Table 14: Development of GHG emissions in the sensitivity calculation (WEMS)

	1990	2024	2025	2030	2035	2040	2045	2050
				Mt CO2-eq				
Total emissions, without int. transport and LULUCF)	1,251.3	734.0	734.0	655.2	454.7	309.1	209.7	168.8
Sensitivity 4a: changed EU ETS price (low) (difference)								
S4a: Energy sector		7.3	10.6	23.0	8.1	-0.1	0.1	0.0
S4b: Industry		1.2	2.6	6.5	17.7	21.8	12.4	6.6
Sensitivity 4b: changed EU ETS price (high) (difference)								
S4b: Industry		-0.1	-1.7	-3.9	-3.5	-1.8	-1.9	-2.0

Source: In-house data, Öko-Institut, calculations: Öko-Institut, Fraunhofer ISI, IREES

[42] Kluth, Tobias; Rudolf, Alexandra; Kotzagiorgis, Stefanos (2023): Gleitende Langfrist-Verkehrsprognose 2021-2022 (Sliding long-term transport forecast). Status 01.03.2023. Ed. Federal Ministry for Digital and Transport (BMDV). Intraplan Consult (Intraplan); TTS Trimode Transport Solutions (Trimode). Available online at https://bmdv.bund.de/SharedDocs/DE/Anlage/K/prognose-berichtgleitende-langfrist-verkehrsprognose.pdf?__blob=publicationFile, last checked on 22.06.2023.

[43] International Energy Agency (IEA) (ed.) (2023): World Energy Outlook 2023. Paris. Available online at https://www.iea.org/reports/world-energy-outlook-2023, last checked on 25.10.2023.

2.F.2.2.5 Final energy prices: framework data in the projections

The measures and interventions included in the projections are cited and fleshed out below. Further changes in the field of taxes and charges are not considered, since these – if they exist at all – are still too vague in terms of scope and design.

- Abolition of the EEG surcharge: the EEG surcharge was abolished from 1 July 2022 as part of the 1st Relief Package (Federal Government 2022a[44]).
- Grant towards electricity grid charges from EEG account: the increased redispatch, grid reserve and balancing energy costs were offset by a grant in 2023 so that they remained structurally (adjusted for inflation) constant.
- Increase in electricity grid charges: in the 2024 projections, an overall rise of grid use fees is assumed on the basis of the necessary expansion of the grid infrastructure. Derived from the TN-45 scenarios of the long-term scenarios 3 requirements (Sensfuß et al. 2022[45]), a structural rise in charges of 21% (from 2022) is assumed up to 2030, of 33% by 2035, and of 36% by 2040, remaining at this level post-2040.
- For other grid charges (especially natural gas and oil products), it is assumed that they remain structurally constant.
- Reduction of VAT on natural gas to 7% from October 2022 until the end of February 2024.

The Federal Government took wide-ranging measures to mitigate the impact of Russia's war of aggression against Ukraine on final energy prices. Particular mention should be made here of the "electricity price brake" and the "gas price brake". Both instruments expired at the end of 2023. The instruments are designed in such a way that, despite the government intervention and the corresponding relief from the intervention, there are no distortions of deployment, consumption or investment incentives, and rather that these are still driven by the available (uncompensated) price signals. On the revenue side of the electricity price brake, only surplus revenues are skimmed off, but there is no intervention in the price mechanism itself.

2.F.2.2.6 Hydrogen imports: bandwidths

The 2024 projections are also a major input for the final updated National Energy and Climate Plan (NECP), which Germany must submit to the European Commission in June 2024. The NECP must report on shares of renewable energy in line with the methodology of the EU Renewable Energy Directive. To this end, shares of green hydrogen and derivatives in the imports of hydrogen must be assumed. Since hydrogen plays a role in all of the sectors to be reported, the shares are only calculated when there is evidence of these shares of green hydrogen imports.

The Cabinet adopted an update of the National Hydrogen Strategy at the end of July 2023. At the time, the import strategy did not form part of this. The National Hydrogen Strategy makes it

[44] Federal Government (ed.) (2022a): EEG-Umlage fällt weg: Stromkunden werden entlastet (EEG surcharge ends: relief for electricity customers). Available online at https://www.bundesregierung.de/breg-de/suche/eeg-umlage-faellt-weg-2011728, last checked on 15.08.2023.

[45] Sensfuß, Frank; Tersteegen, Bernd; Müller-Kirchenbauer, Joachim (2022): Langfristszenarien für die Transformation des Energiesystems in Deutschland. Ergebnisse zur Entwicklung der Strom- und Gasnetzinfrastruktur in fünf treibhausgasneutralen T45-Szenarien. Treibhausgasneutrale Szenarien T45 (Long-term scenarios for the transformation of the energy system in Germany. Results on the development of the electricity and gas infrastructure in five GHG-neutral T45 scenarios. GHG -neutral scenarios T45). Available online at https://www.langfristszenarien.de/enertile-explorer-wAssets/docs/Consentec-TUBER_BMWK_LFS3_Webinar_Netze_T45_final_v2.pdf, last checked on 22.09.2023.

possible to derive the total share of imported hydrogen, but not the share of green hydrogen / derivatives. This share could be part of the promised Hydrogen Import Strategy.

The modelling of the 2024 projections shows the shares of imported hydrogen and derivatives for each sector. However, it does not reveal the share of green hydrogen / derivatives, or else it is not possible to predict the extent to which volumes of non-green hydrogen will be imported in the period up to 2050.

In order nevertheless to map the data on the shares of renewables required in the NECP, two extreme variants of the shares of imported green hydrogen have been compiled, in order to enable reporting across the entire bandwidth of shares of renewables:

- Once assuming a 0% share of green hydrogen / derivative imports throughout the entire period
- Once assuming a 100% share of green hydrogen / derivative imports throughout the entire period

The two extreme variants merely cover the entire field of theoretical possibilities. The actual future share will lie within this field.

2.F.2.2.7 Sensitivity for the production volumes of industry

Industrial output is a key driver of greenhouse gas emissions. In the reference development, it is expected that the production volumes will return to the 2018 level by 2028. However, the S5 sensitivity analysis considers the effects if the production volumes attain 90% of the 2018 level by 2028. This lower output performance results in lower emissions compared with the WMS. The emissions are reduced by 6.2 Mt CO2-eq in 2025, and by 13.2 Mt CO2-eq by 2030 (Table 15)

Table 15: Development of GHG emissions in the sensitivity calculation 5 (WMS)

	1990	2024	2025	2030	2035	2040	2045	2050
				Mt CO2-eq				
Total emissions, without int. transport and LULUCF)	1,251.3	734.0	734.0	655.2	454.7	309.1	209.7	168.8
Sensitivity S5: Industry (difference)								
S5: changed production volume		-2.6	-6.2	-13.2	-10.0	-7.2	-5.4	-5.3

Source: In-house data, Öko-Institut, calculations: Öko-Institut, Fraunhofer ISI, IREES

2.F.2.2.8 Sensitivity for the buildings sector

Further sensitivities are considered for the buildings sector; these relate to the Buildings Energy Act and the Federal funding for energy-efficient buildings (BEG), and to effects on the implementation of the 65% rule for the use of renewable energy. Table 15 presents the development of greenhouse gas emissions in the sensitivity calculations. In total, four sensitivities are calculated, considering both a delayed implementation (wait-and-see attitude) of the replacement of heating systems, and greater enthusiasm for the heat transition.

Sensitivities S6a and S6b show the change in total emissions given a delayed replacement of heating systems. Here, the lifetime of fossil-fuel boilers is increased and reduced by 10% and 20%. Given an average lifetime of 25 years assumed in the WMS, if there is a 5% reduction, the lifetime is 23.8 years, and 22.5 years in the case of a 10% reduction. If the lifetime is lengthened by 10%, there is a lifetime of 27.5 years, and a lifetime of 30 years when extended by 20%. The logic used in the model for the replacement of heat supply systems is described in Annex A.4.3.

Here, consideration is given to the changes that arise if heating systems are repaired rather than replaced up to 2028. It is assumed that building owners do not make use of the speed bonus for heating systems in the BEG until 2028, and rather await the heat planning up to 2028. Greenhouse gas emissions rise by 0.8 or 1.1 Mt CO2-eq up to 2030.

In contrast, sensitivities S6c and S6d look at the changes in total emissions where the replacement of heating systems is brought forward by 5 and 10% (enthusiasm for the heat transition). Here, consideration is given to the changes that arise if the number of replaced heating systems is much higher in the period from 2024 – 2028. It is assumed that building owners make use of the speed bonus for the replacement of heating systems until 2028. Greenhouse gas emissions fall by 0.8 or 1.3 Mt CO2-eq up to 2030.

Table 16: Development of GHG emissions in the sensitivity calculation 6 (WMS)

	1990	2024	2025	2030	2035	2040	2045	2050
				Mt CO2-eq				
Total emissions, without int. transport and LULUCF)	1,251.3	734.0	734.0	655.2	454.7	309.1	209.7	168.8
Sensitivity S6: Buildings (difference)								
S6a: Wait-and-see attitude before replacing heating (delayed replacement, 10% extended lifetime)		0.8	1.1	0.8	0.8	0.0	0.0	0.0
S6b: Wait-and-see attitude before replacing heating (delayed replacement, 20% extended lifetime)		1.0	1.7	1.1	1.0	0.0	0.0	0.0
S6c: Enthusiasm for heat transition (replacement of heating brought forward, 5 % reduction in lifetime)		-0.6	-0.8	-0.8	-0.6	0.0	0.0	0.0
S6d: Enthusiasm for heat transition (replacement of heating brought forward, 10 % reduction in lifetime)		-1.1	-1.7	-1.3	-1.1	0.0	0.0	0.0

Source: In-house calculations by IREES

3 Vulnerability, climate impacts and adaptation measures

The impacts of climate change can already be felt and measured in Germany today. Both in Germany and worldwide, 2023 was the hottest year since measurements began in 1881. Since then, the average air temperature in Germany has already increased by 1.8° Celsius (linear trend). At the same time, Germany has experienced disastrous effects of heavy rain and flooding events, particularly in 2021 and also recently in the early summer of 2024. In the future, all regions in Germany will be affected by a further temperature increase, by an increase in the numbers of hot and dry days, and by an increased risk of heavy rainfall events.

Consequently, in this 20th legislative term, alongside ambitious climate change mitigation the Federal Government has taken up adaptation to the impacts of climate change as a central challenge. It has created a new, binding basis for this in the Federal Climate Adaptation Act[46], which entered into force on 1 July 2024. This Act obligates the Federation, Länder and municipalities nationwide to address the consequences of climate change and to identify adaptation measures. With the new, precautionary climate adaptation strategy currently under discussion, the Federal Government is therefore presenting for the first time a climate adaptation strategy with measurable targets – pursuant to Section 3 of the Federal Climate Adaptation Act – in its sphere of responsibility.

In light of the ongoing strategy review process, Germany is providing information for this Biennial Transparency Report from its Eighth UNFCCC National Communication[47] and reporting for the EU Governance Regulation 2018/1999[48], as well as content from the last Monitoring Report and the EPR Germany Report of the OECD[49]. This information is from 2023. Information from the Progress Report on the German Strategy for Adaptation to Climate Change is from 2020.

Information on the new precautionary climate adaptation strategy and initial experiences with the new Climate Adaptation Act will be available from around mid-2025 in the periodic report, pursuant to the EU Governance Regulation. This will be provided in the next Biennial Transparency Report, and is expected to be combined with the next UNFCCC National Communication.

3.A National circumstances and institutional arrangements

3.A.1 National circumstances relevant to adaptation actions

3.A.1.1 Biogeophysical characteristics relevant to adaptation actions[50]

Germany is located in the warm temperate climate zone of the mid-latitudes at the point of transition between the maritime climate of Western Europe and the continental climate of Eastern Europe. The Central European climate is influenced by humid, mild Atlantic air masses and dry continental air, which is hot in summer and cold in winter. The prevailing air mass depends on the large-scale circulation pattern. This means that the seasons can vary greatly from year to year. Consequently, the climate in Germany is characterised by a high degree of variability. Germany's topography, with its low mountain ranges and the different types of

[46] Federal Climate Adaptation Act (Bundes-Klimaanpassungsgesetz – KAnG) of 20 December 2023 (bmuv.de)

[47] Germany National Communication (NC). NC 8. Biennial Reports (BR). BR 5. | UNFCCC

[48] https://climate-adapt.eea.europa.eu/en/countries-regions/countries/germany

[49] OECD Environmental Performance Reviews: Germany 2023 | OECD

[50] Data and information pulled from DWD (2022): Nationaler Klimareport (National Climate Report); 6th revised edition, Deutscher Wetterdienst, Deutschland, 53 pages. Nationaler Klimareport (dwd.de)

landscape they encompass, has a strong influence on the highly varied structure of the climate. The altitude of the terrain and the distance from the coast are the dominant factors affecting the temperature. The oceanic influence, which diminishes from north-west to south-east, is responsible for Germany's relatively mild winters and moderately hot summers.

3.A.1.2 Temperature

The annual air temperature as an aggregated mean for Germany between 1881 and 2022 was determined statistically to have risen by 1.7°C. A comparison of the climate reference period (1961-1990) with the current reference period (1991-2020) confirms that the average air temperature in Germany rose from 8.2°C to 9.2°C. This change went hand in hand with a decrease in the number of frost days and ice days and an increase in summer days and hot days. The frequency of hot days with a maximum temperature of at least 30°C has increased nationwide in Germany, while icy days have become less and less frequent over the last 60 years. At the same time, both the frequency of intense heat waves and the heat intensity have increased throughout Germany. Since 1951, the average number of hot days in terms of surface area mean in Germany has risen from a mean of around three days per year to a current mean of around ten days per year. The years with the highest number of hot days were 2018, 2003, 2015, 2022 and 2019. This increase is backed up by statistics, notwithstanding great variability of this index from year to year.

3.A.1.3 Precipitation

Unlike temperature, there are significant differences in precipitation in Germany, particularly by season, but also spatially. In summer, the mean precipitation has remained largely unchanged, while especially in winter conditions have become significantly wetter. Similarly, the amount of precipitation has also increased at times of sea level change, although this increase is much smaller and is not statistically proven. Overall, the surface area mean for Germany since 1881 shows a 7.3% increase in mean annual precipitation. The most significant changes have so far been observed for the winter season. The surface area mean for average precipitation levels has increased by 25% since the winter of 1881/1882. So far there have been barely any changes in the summer months. However, it is more difficult to make reliable statements regarding trends for heavy precipitation events. On the one hand, such events display great variability both spatially and temporally. On the other hand, especially during summer months, convective events (showers and thunderstorms) are considered significant when they occur within an hour or less. Although a tendency towards a greater frequency of heavy precipitation events can be observed over the last 65 years, it has so far not been possible to draw any statistically verified climatological inferences on changes in heavy precipitation events, due to a lack of available data.

3.A.1.4 Sea level rise

Since records began, the mean sea level along the entire North Sea coast has risen by around 2 to 4 mm per year. North Sea: Sea level records in the German Bight go back to 1843 (Cuxhaven), although most date back to the 1930s. Depending on geographical location, there are large differences in the rate of relative sea level rise, ranging from 1.7 mm/year to 4.1 mm/year.

The Baltic Sea: The absolute sea level on the Baltic Sea coast has risen by around 1.4-2.0 mm/year. Apart from the south-western Baltic Sea, the relative sea level is falling in all other coastal regions as a result of the ongoing post-glacial rebound.

3.A.1.5 Demographic situation as relevant to adaptation measures

3.A.1.5.1 Population [51]

Information on population development can be found in section 2.A.1.2. Population

3.A.1.6 Economic and infrastructural situation as relevant to adaptation measures[52]

In Germany, industry (defined as the manufacturing sector) is a key basis for growth, prosperity and jobs. In 2022, it generated gross value added of around €710 billion and employed around 7.5 million people. Industry is the central pillar of Germany's export strength. Germany is one of the world's leading suppliers in industrial sectors such as the automotive industry, mechanical and plant engineering, and the chemical and pharmaceutical industries. Germany's industrial structure is dominated by products from the automotive, machinery, electrical, chemical and pharmaceutical, metal-producing and metal-processing industries, and the food industry. These account for 80% of its gross value added and employment. Numerous other industrial sectors each contribute 5% or less to gross value added. In the face of global challenges such as climate change, resource scarcity, digitalisation of the economy and society, and demographic change, German industry needs to be able to change and adapt. At the same time these challenges hold great opportunities for German industry, which can play a key role in successfully overcoming them with new products and processes.

The economic situation in Germany in winter 2022/23 was characterised by persistently high inflation, related purchasing power losses and restraint in private consumption and investment. A noticeable economic slowdown is expected for winter 2022/23, but not a broad-based, profound downturn. Industry has managed to cut its gas consumption significantly since the start of the Russian war of aggression against Ukraine, and the German economy has become almost completely independent of direct energy imports from Russia. A large part of these savings can be attributed to high energy prices and improved efficiency, as economic output is holding up comparatively well. The inflation rate remained comparatively high in February 2023 at 8.7%. The core inflation rate (excluding food and energy) rose to +5.7%, as the rise in energy prices was increasingly passed on to other goods and services. However, thanks to the Federal Government's energy price brake and falling global market prices for energy, the inflation rate will slow over the course of the year.

3.A.1.7 The situation in the transport and transport infrastructure sectors

Climate change will affect the modes of transport and infrastructure facilities in Germany, including the associated operational processes, in various ways and to differing degrees. The proper functioning of transport is extremely important for German business, and can be significantly disrupted by the impacts of climate change. For example, heat, frost events, droughts, storms, sea level rise or water levels in rivers affect the various modes of transport in different ways.

3.A.1.8 The situation in the construction industry

Climate change is affecting the built environment. Extreme weather events such as storms or flooding demonstrate how vulnerable all kinds of buildings can be. Changes in precipitation and temperatures, sea level rise, storms and other extreme weather events can severely damage

[51] The text presented in this chapter has been taken, with minor changes, from the Datenreport 2021 (2021 Data report) of the Federal Statistical Office (https://www.destatis.de/DE/Service/Statistik-Campus/Datenreport/Downloads/datenreport-2021.pdf?__blob=publicationFile). As far as the data themselves are concerned, however, more recent data of the Federal Statistical Office have been used (https://www-genesis.destatis.de/genesis/online).

[52] Preliminary figures from destatis and the BMWK update on "The economic situation in Germany in March 2023".

buildings and infrastructure in certain regions. Heat will have an impact on the urban and city center climate.

3.A.1.9 The situation in trade and industry

The impact on business of climate hazards such as extreme weather events and the gradual rise in temperature depends on factors such as the use of raw materials, the (global) interconnectedness of value chains and the dependence of companies on very precise logistics processes. The specific impact depends on the business model, the spatial situation and the condition of the facilities and infrastructure, as well as the water and energy requirements of the companies.

3.A.1.10 The situation in the energy sector

Gradual and extreme temperature changes and other extreme weather events will impact the energy industry. The actual impacts of climate change, however, are largely dependent on the current and future composition of the energy infrastructure. This is because the location, condition and performance of sensitive infrastructure such as power plants, and the location of urban centers, are especially important for the sensitivity of the energy industry. Diversification and decentralisation play an important role here. For example, the energy supply is more resilient to drought if it is generated from renewables rather than by thermal power plants. Urban centers in particular are affected by climate change due to their energy needs.

3.A.2 Institutional arrangements and governance

3.A.2.1 History of the German Strategy for Adaptation to Climate Change (DAS)

To date, the long-term aims of the DAS are to reduce the vulnerability of natural, social and economic systems to climate change impacts, to increase the ability of such systems to adapt, and to increase exploitation of possible opportunities. The Strategy is divided into 15 fields of action in the following areas: building, biodiversity, soil, the energy industry, the finance and insurance industry, fisheries, forestry, trade and industry, agriculture, human health, tourism, transport and transport infrastructure, water, flooding and coastal protection, and the cross-cutting areas of a) civil protection and disaster management and b) spatial, regional and physical development planning.

In order to flesh out the DAS, the federal cabinet approved a first Adaptation Action Plan (APA I) in 2011[53]. APA I underpins the DAS with specific activities of the Federation and identifies links with other national strategy processes. The First DAS Progress Report[54] and an Action Plan II were adopted by the Federal Government in December 2015. In October 2020, the Adaptation Action Plan III (APA III) was adopted, along with the Second DAS Progress Report.

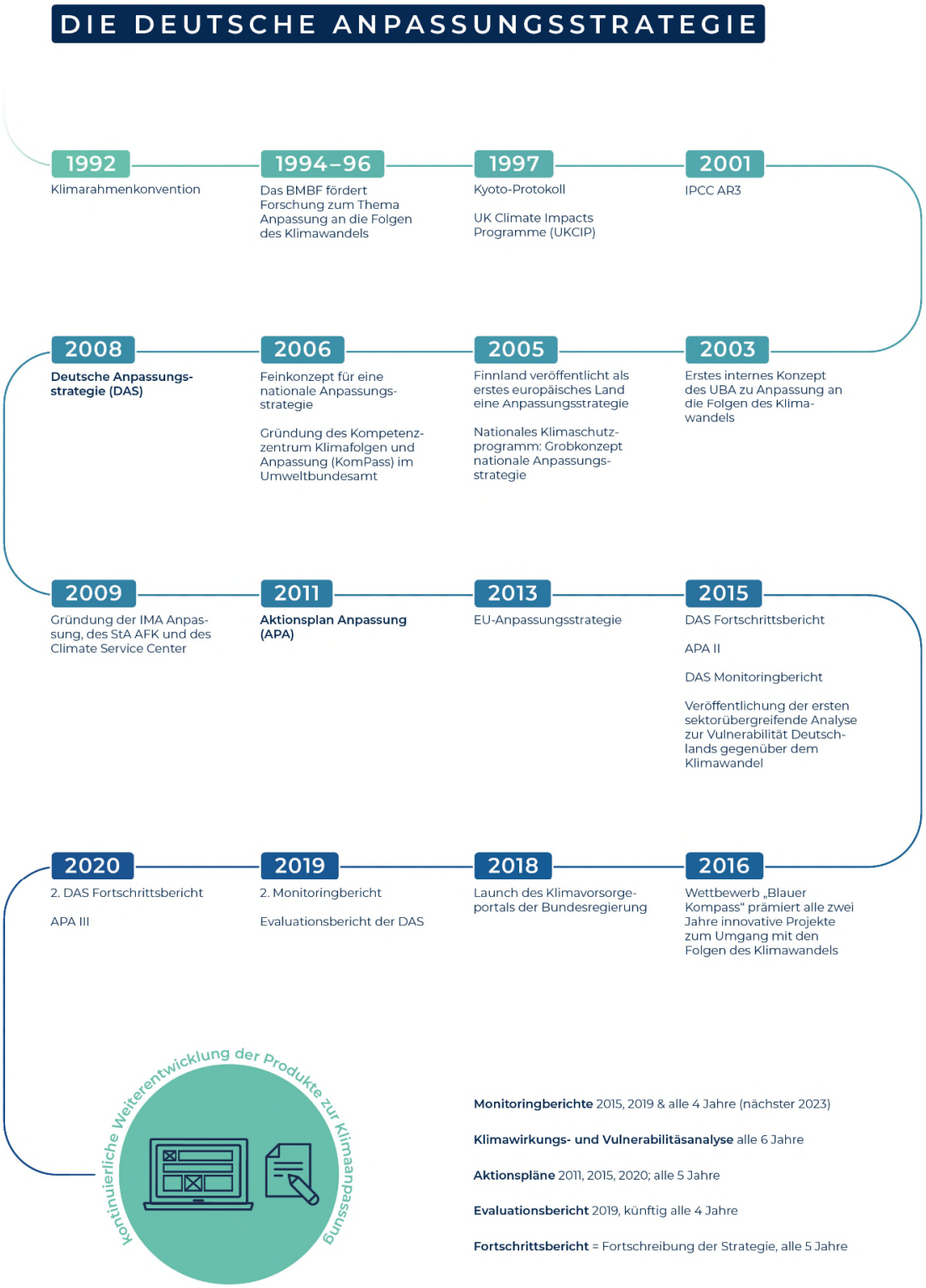
In this 20th legislative term, alongside ambitious climate change mitigation the Federal Government has taken up adaptation to the impacts of climate change as a central challenge. It has created a new, binding basis for this in the Federal Climate Adaptation Act, which entered into force on 1 July 2024. This Act obligates the Federation, Länder and municipalities nationwide to address the consequences of climate change and to identify adaptation measures. With the new, precautionary climate adaptation strategy currently under discussion, the Federal Government is therefore presenting for the first time a climate adaptation strategy with

[53] Federal Government (2011): https://www.bmuv.de/fileadmin/Daten_BMU/Download_PDF/Klimaanpassung/aktionsplan_anpassung_klimawandel_bf.pdf

[54] Federal Government (2015): https://dserver.bundestag.de/btd/18/071/1807111.pdf

measurable targets – pursuant to Section 3 of the Federal Climate Adaptation Act – in its sphere of responsibility.

Figure 24: Chronology of the DAS, APA and progress report (source: German Environment Agency (UBA), authors' own draft)



(Source: German Environment Agency (UBA), authors' own draft)

At the end of 2015, the Federation began to establish a comprehensive portfolio of climate services and climate adaptation services, to support the implementation of the DAS; their main task is to deliver the required climate services reliably over the long term.

3.A.2.2 Coordination of work for the DAS

Within the Federal Government, the work is supported and coordinated under the leadership of the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV), through the Interministerial Working Group on Adaptation to Climate Change (IMAA). Within the IMAA, which is chaired by the BMUV, all federal ministries work together, coordinate their activities and continually set new goals, in order to put in place the prerequisites for climate change adaptation in Germany. The collaborative structures in place have proven to be successful. Furthermore, the Conference of Federal and Länder Environment Ministers (UMK) set up a Standing Committee on Adaptation to the Consequences of Climate Change (StA AFK), which is part of the Joint Working Party of the Federation and the Länder on Climate, Energy, Mobility and Sustainability (BLAG KliNa). This committee supports cooperation with the Länder. Through the StA AFK[55], the specific strategies and measures of the Land administrations are taken into account in the work for the DAS.

Key DAS products and updates are adopted through federal cabinet decisions.

In 2006, to support the design and further development of a national strategy for adaptation to climate changes, the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) established a Competence Centre on Climate Impacts and Adaptation (KomPass), within the German Environment Agency. KomPass provided the technical-strategic groundwork for drafting and updating the DAS. KomPass is an information platform for specialised expertise on climate change impacts and adaptation and for Germany's adaptation activities.

Based on the methods agreed on by the IMAA, a reporting system for the climate adaptation planning process in Germany was established. The process can be divided into four phases that are aligned with the policy cycle[56] for adaptation.

[55] For additional information about the precise composition of the IMAA and StA AFK, see Bundesregierung (2015).

[56] For further information about the policy-cycle model for adaptation, see: Vetter A., Chrischilles E., Eisenack K., Kind C., Mahrenholz P., Pechan A. (2017): Anpassung an den Klimawandel als neues Politikfeld (Adaptation to climate change as new policy field). In: Brass€G., Jacob D., Schuck-Zöller S. (eds.) Klimawandel in Deutschland. Springer Spektrum, Berlin, Heidelberg.

Figure 25: Reporting system for DAS (Source: German Environment Agency (UBA), authors' own draft)

Source: 2020 Progress Report, pp. 32-39 et seq.

3.A.2.3 Adaptation measures by other actors

At Federal Government level, climate adaptation is not only dealt with in the Interministerial Working Group on Adaptation to Climate Change (IMAA) and the Vulnerability Network. It is also addressed as a cross-sectional task in a large number of other bodies, such as in the areas of sustainability, rural development, urban development, etc.

3.A.2.3.1 Interministerial Working Group for the Implementation of the Sendai Framework (IMAG Sendai)

For the IMAG Sendai, climate change and its consequences are of increasing importance for disaster risk management at national level. The Federal Republic of Germany has committed to implementing the United Nations Sendai Framework for Disaster Risk Reduction 2015 - 2030.

Germany's National Focal Point for the Sendai Framework was therefore established in April 2017 by the Federal Office of Civil Protection and Disaster Assistance (BBK) on behalf of the Federal Ministry of the Interior (BMI), the Federal Foreign Office (AA) and the Federal Ministry for Economic Cooperation and Development (BMZ). Its task is to coordinate implementation of the Sendai Framework in Germany.

The National Focal Point is the main point of contact for the United Nations on the Sendai process in Germany. It is tasked with ensuring the required reporting to the United Nations International Strategy for Disaster Reduction (UNISDR). It coordinates and supports national

implementation of the Sendai Framework in Germany and the associated networking, public relations and administrative activities. When doing so it takes particular account of the principle of coherence that is intrinsic to the Sendai Framework. This means that climate change, sustainable development, humanitarian aid and disaster prevention are now linked more closely than before in both the international and national context.

At the federal level, civil protection is embedded as a cross-cutting issue in the German Strategy for Adaptation to Climate Change (DAS) adopted by the Federal Government in 2008 and updated in 2015. Collaboration between the IMAG Sendai and the IMAA is ensured through reciprocal representation in the respective bodies and intensive dialogue.

3.A.2.3.2 National Water Dialogue

In October 2018 the BMU launched the 1st National Water Forum, a two-year process of dialogue on the future of water resources management in Germany – the National Water Dialogue. The Water Dialogue was conducted with the broad participation of stakeholders from industry, administrators, practitioners, interest groups and the scientific community. The components of the water dialogue are designed to make the German water industry sustainable and fit for the future (see https://www.bmu.de/wasserdialog/). The discussions focused on the period to 2030 for the adoption of measures, with targets and impacts to be achieved by 2050.

Areas where needed actions were identified and impacts are expected include

- water management infrastructures: making them climate-resilient design, and closely integrating them with urban development;
- preserving or restoring at least a near-natural water balance; improving conditions for water body development in rural areas that maintains the water bodies' natural functionality, plus closer integration of specialised water management planning with spatial planning and land-use planning;
- responding to the predicted regional increase in competition for access to water resources.

Building on the results of the National Water Dialogue, the BMU presented a water strategy[57] at the beginning of 2024. The strategy focuses on the adaptation requirements in water management and the associated areas.

3.A.2.3.3 The Länder (federal states)

Following the earlier progress report on the DAS 2015, the Länder increased their focus on the thematic area of climate change adaptation. By the time the 2020 progress report had been adopted, nine Länder had expanded and consolidated their legal frameworks for climate change adaptation. This involved either introducing climate action legislation or an element thereof, or including additional provisions on climate change adaptation in other specialised legislation. In nearly all Länder, adaptation strategies and/or action plans had been adopted or updated. Inter-departmental and inter-agency bodies had also been set up to facilitate cooperation within the administration. And more and more network structures outside of administrations – for example, structures including companies or representatives of civil society – are being established, in addition to the structures of this type that were already in place.

Some Länder make use of funding programmes that exist at the federal level (such as the Urban Development Support Programme, which was redesigned as of 2020, and the BMUV funding programme "Measures for adapting to climate change") and EU level (such as the European

[57] BMUV: National Water Strategy | Download

Social Fund). In some cases, the Länder supplement these programmes with their own specific funding schemes. The challenges presented by climate change have increased the need to fund adaptation measures at the regional level. In order to provide better support for the regions and municipalities, further coordination of the funding programmes existing at EU, Federal and Land level is required.

Almost all the Länder carry out or are currently developing indicator-based monitoring of climate change, its impacts and adaptation measures. Many Länder use the Federation's Monitoring Report as a frame of reference here, complementing it with their own region-specific indicators. In 2017, the Standing Committee on Adaptation to the Consequences of Climate Change of the BLAG KliNa (StA AFK) requested the Expert Dialogue on Climate Impacts[58] to align the Federal and Land indicators as far as possible, mainly to improve the comparability of monitoring results. While most such indicator systems focus on climate impacts – "impact indicators" – some Länder are also developing "response indicators", which focus on adaptation measures.

As with monitoring, wherever possible, the Länder make use of existing methodological baseline studies conducted at federal level, such as the Guidelines for Climate Impact and Vulnerability Assessments (which were developed with input from the Länder) (Buth et al. 2017)[59]. The purpose of the Guidelines is to provide methodological recommendations on conducting climate impact and vulnerability analyses in order to standardise and improve the comparability of sectoral and cross-sectoral studies, results and assessments at federal and Land level. The Länder set their own priorities their analyses and research projects, based on regional needs.

Methodological work already performed at federal level can also be used by the Länder to develop methods for evaluation of adaptation strategies. The methodology developed for the first DAS evaluation (such evaluations are to be carried out regularly in future) has been published as set of guidelines[60]. This enables the Länder to benefit from evaluations carried out at the federal level[61].

The German Climate Preparedness Portal (KLiVO[62]) is a further example of good cooperation between the Federation and the Länder. This Federal Government web portal collects data and information on climate change and adaptation to its effects. The Länder helped design the portal. They also provide their own climate adaptation services and, for example, participate in the KlimAdapt[63] network. This collaboration will be continued and expanded, in order to build regional actors' capacities to adapt to the impacts of climate change.

[58] The Expert Dialogue on Climate Impacts is an informal forum for discussion of climate impacts and adaptation. It brings together the German Environment Agency (UBA), the German Meteorological Service (DWD) and the Land environment agencies/institutes. It is led by the UBA.

[59] The guidelines on vulnerability were published in 2017, as recommendations of the Interministerial Working Group on Adaptation to Climate Change. They are regularly revised.

[60] Kind, C., Kaiser, T., Gaus, H. (2019) https://www.umweltbundesamt.de/publikationen/methodik-fuer-die-evaluation-der-deutschen

[61] Due to the differing structures of the adaptation process, not only between the federal and Land levels but also among the Länder themselves, the methodology developed for the DAS evaluation cannot be applied directly to other levels. The guidelines therefore include general advice on strategy evaluation and, on this basis, offer an overview of points that should be considered when designing an evaluation; they conclude by identifying key elements of an evaluation.

[62] www.klivoportal.de

63 The KLiVO Portal, which stems from the First DAS Pprogress Report (2015), currently comprises the German Climate Service (DKD) and the service for climate adaptation services (KlimAdapt). The DKD office is hosted by the German Meteorological Service (DWD), with the BMDV as lead ministry. The KlimAdapt office is located at the KomPass Competence Centre – Climate Impacts and Adaptation in Germany at the Federal Environment Agency (UBA), with the BMUV as lead ministry All the services provided by the DKD and KlimAdapt are presented on the KLiVO Portal.

Strategic cooperation between the Federation and the Länder has also intensified in recent years. It ranges from work initiated by the StA AFK itself to tasks that are mainly carried out by other Federation-Länder bodies with the involvement of the StA AFK. In spring 2017, for example, the Federal/Länder Ad hoc Working Group on Adaptation to the Impacts of Climate Change in the Health Sector (GAK), led by the Federal Environment Ministry and Federal Ministry of Health, published "Recommendations for Action: Heat Action Plans to Protect Human Health", which were developed on behalf of the StA AFK (BMUB 2017). These recommendations are aimed at the local authorities and are intended to serve as a basis for drawing up regional heat action plans. The objective of a heat action plan is to avoid heat- and UV-related illnesses and deaths by preventing exposure. The ad-hoc working group has been made a permanent part of the "Health in Climate Change" dialogue platform for public authorities.

As a further example of closer cooperation between the Federal and Land levels, joint approaches are agreed wherever possible in order to improve the response to the challenges posed by future climate hazards, such as faster sea-level rise. More vertical (Federation-Länder-municipalities) and horizontal (cross-sectoral) policy integration are extremely important. For example, the climate-relevant bodies of the Conferences of Ministers of the Federation and the Länder are being integrated more systematically into the work of the StA AFK. Increased coordination of strategic objectives across the Federal and Land levels offers potential to intensify climate change adaptation in Germany in future.

One opportunity for more "joined-up" cooperation across the Federal and Land levels is the permanent establishment of climate change adaptation as a topic for the bodies of the Conferences of Ministers of the Länder. For example, following a decision by the Conference of Environment Ministers (UMK) at its 90th session, a permanent committee on climate change was established by the German Working Group on Water Issues of the Federal States and the Federation (LAWA). The committee (LAWA-AK) examines the impacts of climate change on the water sector and identifies and prioritises needed actions. This includes identifying conflicts of interest between the water sector, agriculture and forestry against the background of climate change, with the aim of developing possible solutions. The LAWA-AK is intended to complement the work of the StA AFK and support the further development of the German Adaptation Strategy.

Currently, LAWA AK's Subgroup on Climate Indicators is preparing a concept for climate impacts monitoring in the water sector; this is being coordinated with relevant work at the Federal level. In the medium term, this will enable coherent climate impact monitoring to be developed for the water sector, coordinated across the Federal and Land levels. The Subgroup on Climate Indicators has developed six application-ready DAS indicators; four are based on data from the Länder, covering the whole of Germany. All six indicators were integrated into the 2019 DAS Monitoring Report.

In April 2019, the Conference of Agriculture Ministers adopted the Agenda for Climate-change Adaptation in Agriculture, Forestry, Fisheries and Aquaculture.[64] The Agenda identifies areas that are most affected by climate change and where there is a need for practical action. A programme of measures is currently being drafted on behalf of the Conference of Agriculture Ministers.

[64] The agenda is available on the Federal Ministry of Food and Agriculture (BMEL) website: https://www.bmel.de/SharedDocs/Downloads/DE/_Landwirtschaft/AMK-12-04-19-Agenda-Anpassung-Klimawandel.html.

3.A.2.3.4 Municipalities

Municipalities are among the key players in the development of adaptation measures. The municipalities provide essential public services such as drinking water supply, wastewater disposal, flood control, energy and local transport infrastructure. Key elements of our infrastructure, including roads, drainage, public buildings and hospitals, are, in many instances, under local authority control. This means that cities and municipalities have numerous opportunities to press ahead with adaptation. They can also capitalise on the commitment of local stakeholders and initiatives and actively support self-provision by local citizens.

The local government associations have an important role to play in climate change adaptation at the municipal level. For example, the Association of German Cities promotes dialogue on climate change adaptation among its member cities through its specialist commission on the environment, which meets twice a year. In March 2019, the association published a position paper on adaptation to climate change, setting out key demands, guidance and proposals (Dt. Städtetag 2019). The paper is based on the association's 2012 position paper, which was mentioned in the earlier DAS Progress Report.

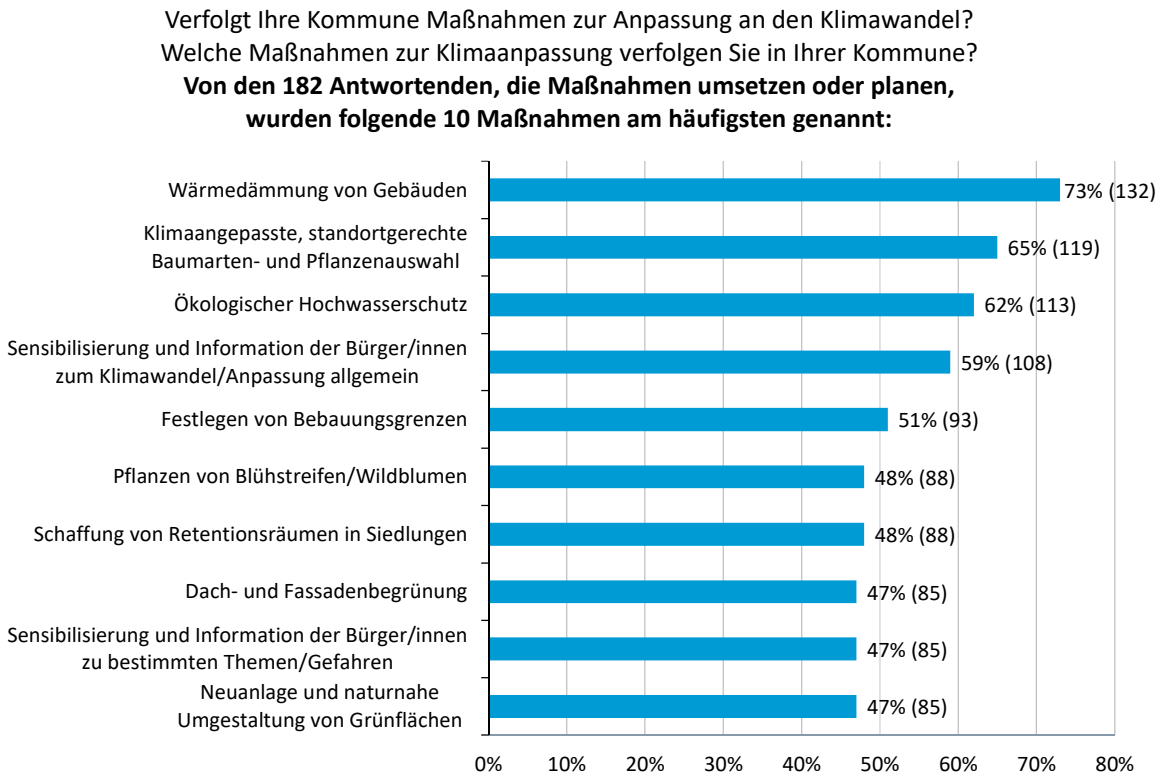
Adaptation to the consequences of climate change has also become increasingly established at municipal level since 2015. In 2018, a nationwide online municipal survey[65] investigated how the DAS was affecting municipalities, how the instruments, (funding) programmes and publications of the Federal and Land governments were being used, and what support the municipalities believed they needed from the Federation and possibly the Länder, in order to implement local climate adaptation[66].

The evaluation of the survey revealed that municipalities were most likely to take action if they themselves were affected by extreme weather events. They were also likely to act if political leaders and senior figures within the administration were convinced of the need for action and identified overlaps with topics already being addressed. In order for municipalities to initiate adaptation measures, a basic policy framework was required. More than a third of the municipalities surveyed stated that a political decision had been adopted, or was in preparation, mandating the drafting of adaptation strategies or policies. Approximately 50% had conducted or were currently working on an internal stocktaking exercise on climate change adaptation within their administration. More than a quarter of respondents had adopted or were preparing a decision on the implementation of existing adaptation strategies or policies. Overall, the majority of municipalities surveyed are already planning or implementing climate change adaptation measures. The measures mentioned most frequently are shown in Figure 26.

[65] See UBA (2019). The survey, which is not statistically representative, was conducted by the German Institute of Urban Affairs (Difu) on behalf of the German Environment Agency.

[66] 249 responses were analysed for the study. In addition, a focus group discussion and expert interviews were conducted. The participating municipalities varied in size. They were also spread across almost all Länder.

Figure 26: Implemented or planned climate change adaptation measures most frequently mentioned



Source: UBA (2019)

Although many municipalities are already moving forward proactively with climate change adaptation, the results also show that in at least one third of the municipalities surveyed, adaptation is not being addressed at all. In these municipalities, no decisions on adaptation have been taken at political level, no action programmes are in place and no other adaptation policies or mechanisms exist (and in some cases, none are planned). Furthermore, a third of the municipalities surveyed have no human capacities available to deal with climate change adaptation at the local level. Very few have designated more than one full-time position to deal with this issue. This reveals the gap between smaller municipalities and larger cities: the latter are generally able to appoint more staff to deal with climate change adaptation, whereas this is often impossible for smaller municipalities. In such cases, climate change adaptation has to be addressed within the scope of the available capacities. A more comprehensive strategic approach is not achievable in these cases and adaptation measures can only be implemented sporadically.

Accordingly, the municipalities identify lack of resources for the preparation (55%) and implementation (49%) of adaptation measures as the most significant obstacle. Other obstacles also exist, such as lack of experience in climate change adaptation or poor availability of baseline data. A low level of acceptance on the part of the public, local politicians or the municipal administration can also obstruct adaptation activities.

According to the survey, public funding is most likely to come from federal programmes, the funding programme for the German Strategy for Adaptation to Climate Change (DAS), the various funding schemes for urban development, or specific funding programmes established by

individual Länder. As well as accessing public funding programmes, three quarters of municipalities that responded stated that they used their own funds to support adaptation. Funds from research projects or third parties account for a relatively minor proportion of financial resources. With regard to staffing, 30% of the municipalities that responded have no full- or part-time positions dedicated to climate change adaptation. 19% have a part-time position amounting to at most half of a full-time post; and 26% have one equivalent to between half and a full post. Less than one in two of these posts is longer-term or permanent. "Lack of experience and inadequate baseline data" and "lack of acceptance on the part of the public, politicians and the local administration" also have a dampening effect on the implementation of adaptation measures.

Many municipalities – albeit less than half – are aware of the goals and principles set out in the DAS and the Adaptation Action Plan. Among the wide range of federal instruments and services, the municipalities are most familiar with the BMUV's DAS funding programme and the "Climate Navigator"[67]. Among the other products enquired about, the UBA's website on climate impacts and adaptation was best known. The municipalities identify shortcomings in the use of these tools, services and publications.

3.A.2.3.5 Non-governmental initiatives for adaptation to climate change

In addition to the federal and municipal activities described above, public- and private-sector companies, research and education institutions and societies, associations and foundations across Germany make a significant contribution to building capacity for adaptation to climate change. For example, regional chambers of industry and commerce, chambers of crafts and chambers of agriculture offer their members **training and awareness-raising on dealing with the impacts of climate change**. Support in responding to specific extreme weather events is also a focus of some associations' work. For example, the German Association of Local Public Utilities (VKU) provides advice for its members on how to cope with heavy rainfall, offering a range of training and process management services.

Adaptation to climate change impacts is also increasingly being considered in the context of standardisation. The German Institute for Standardization (DIN e. V.) develops standards for managing the impacts of climate change and shares German expertise in international standard-setting bodies[68]. The Institute also supports the integration of aspects of climate change into existing national and European standards, e.g. by developing practical guidance and support for standardisation bodies[69]. The Institute's environmental protection coordination unit offers support with the systematic assessment of relevant standards and projects. One current example of an adapted standard is VDI 3787, issued by the **Association of German Engineers (VDI)** on urban and regional planning and building. APA III lists the contributions made at the federal level to this field of work.

The German Environment Agency (UBA) regularly recognises highly innovative adaptation projects implemented by businesses, research institutes and associations through its **Blue**

[67] The Climate Navigator is a guide that supports municipal decision-makers in assessing the risks of climate change and developing appropriate adaptation policies. Online: https://www.umweltbundesamt.de/klimalotse

[68] For example, ISO 14090:2019-06 is an international standard which sets out principles, requirements and guidelines to help organisations adapt to climate change. This standard was developed with substantial support from Germany and was published as a European and national standard in early 2020 (DIN EN ISO 14090:2020-02). Another international standard, ISO 14091, is currently being developed; it provides guidelines for assessing the risks related to the potential impacts of climate change. This standard draws substantially on experience with the Federal Government's Vulnerability Analysis. Its publication as an international, European and national standard (DIN EN ISO 14091) is expected in late 2020.

[69] See, for example, CEN-CENELEC Guide 32 ("Addressing climate change adaptation in standards") and DIN SPEC 35220 ("Adaptation to climate change – Projections on climate change and ways for handling uncertainties").

Compass[70] awards. The purpose of this competition is to identify outstanding initiatives and publicise them nationwide in order to demonstrate what climate change adaptation might look like in practice. Within the DAS framework, it is an important communication tool for promoting self-provision in relation to climate risks.

3.A.2.4 Stakeholder engagement

When designing and implementing its adaptation policies and measures, Germany acknowledges the importance of engaging with all relevant stakeholder groups, including those that are particularly vulnerable to the impacts of climate change.

Throughout the development of the new National Adaptation Strategy, the Federal Government undertook comprehensive efforts to involve and consult a wide variety of stakeholders from the subnational level, private sector as well as civil society and citizens. Among others, and at a very early stage of the policy and strategy design, the Federal Government consulted the science and research community as well as representatives of the private sector, reached out to relevant representatives of vulnerable groups through specific channels (for example the German Disability Council), implemented separate outreach activities tailored specifically to young people to seek their views and input, and held organised dialogues with citizens in five different regions of Germany. The results of these dialogues are available here: https://www.umweltbundesamt.de/publikationen/empfehlungen-von-buergerinnen-buergern-fuer-die . The up-coming reporting under Article 19 (1) of the Governance Regulation will provide more details on this overall engagement.

The new Climate Adaptation Law includes the policy goal § 1 […] "to avoid an increase of social inequalities due to the adverse impacts of climate change". Germany is therefore already in the process of increasing its research and activities to identify and protect, and collaborate with, vulnerable groups.

The federal support programme "Climate change adaptation in social institutions" funds measures that help protect against the impacts of climate change. It targets municipalities and welfare associations as providers of social institutions such as nursing homes, hospitals, facilities for the elderly, schools, childcare centers, homeless shelters and more. These are especially vulnerable groups of society whose health and quality of life are particularly affected by the impacts of climate change.

To enhance coordination, communication and co-operation between the different levels of governance (national/regional/local), Germany has created several vertical coordination platforms. The Standing Committee on Adaptation to the Consequences of Climate Change (StA AFK) is the most important one, and has been in place since 2009. It encourages a structured and institutionalised collaboration and exchange between the Federal and Länder levels on adaptation matters, and meets regularly.

Together with the leading local government organisations (the Association of German Cities, the German Association of Towns and Municipalities and the German County Association,) the Federal Government in 2021 developed a 3-point action plan for climate adaptation in municipalities. The three main elements of the plan are:

- the establishment of the center for climate adaptation to support cities and municipalities in their adaptation efforts,

[70] For more information and details of the 2018 award winners, see: www.umweltbundesamt.de/blauerkompass

- federal support for climate adaptation managers in municipalities to strengthen adaptation on the ground, and
- the inclusion of the category "municipalities" in the **Blue Compass** National Adaptation Award– the highest government award for adaptation projects in Germany.

3.A.3 Legal requirements and strategic documents

Adaptation to climate change has become increasingly embedded as a task at the level of the Länder. By the end of 2022, 11 out of 16 federal states had expanded and consolidated their legal frameworks, either in the form of climate legislation or an element thereof, or by including additional provisions on climate change adaptation in other specialised legislation. Adaptation strategies and/or action plans have been adopted or updated by almost all the Länder. Inter-ministerial and inter-agency bodies have been set up to facilitate cooperation within the administration. Furthermore, an increasing number of networks exist or are being established outside the administration, e.g. with business or civil society representatives.

The coalition agreement of the current Federal Government is the background for updating the German Strategy for Adaptation to Climate Change (DAS) of 2008. This is currently being further developed into a precautionary climate adaptation strategy within the scope of the available budget funds. This includes the following combination of three measures: a legal framework in the form of a Climate Adaptation Act; the development of concrete, measurable climate adaptation targets; and the provision of joint Federal/Länder funding for climate change mitigation and adaptation measures on an appropriate scale. Greater latitude for innovation, digitalisation and private-sector initiatives in the area of climate adaptation is also envisaged. The BMUV is currently reviewing the options for implementing such efforts. The measures in this framework will require long-term, careful preparation. For this reason, and in a first step, the BMUV has launched an emergency climate adaptation programme.

3.B Impacts of climate change, risks and vulnerabilities due to climate change

This section largely presents results of simulation calculations based on a climate action scenario (RCP 2.6) and a high emission scenario (RCP 8.5) of IPCC AR5 from 2014. This is because the current IPCC AR6 scenarios are not yet available for Germany's regions. The climate action scenario (RCP 2.6) is based on assumptions in keeping with the political 2-degree upper limit. For this purpose, a scenario development is assumed that involves very sharp and very rapid reductions of GHG emissions relative to the current situation. The maximum value of the radiative forcing (3.0 W/m^2) is reached before the year 2050. From then on, it sinks continuously, to a value of 2.6 W/m^2 in 2100.

The high-emission scenario (RCP8.5) describes a world in which the energy system is based primarily on burning of fossil coal reserves. The GHG emissions in that scenario, relative to today, increase, in conjunction with a continual increase of the radiative forcing, until the year 2100. For comparison purposes, an additional scenario is mentioned in the text, the SRES scenario A1B (with regard to more-recent scenarios, see the most-recent IPCC reports – from 2021 (working group 1) and 2022 (working group 2; www.ipcc.ch). This describes a world with strong economic growth and a population increase until the middle of the century that is then followed by a decrease. That is the scenario on which the climate projection calculations of the 4th IPCC Assessment Report are based.

For Germany, simulations with a spatial grid width of 5 km x 5 km are currently available. For the present report, the results of 32 climate projections have been used that cover the period 1971 to 2100. The regional climate projections used represent the DWD reference ensemble. This serves as the basis for all other evaluations. To calculate the difference between the current state and the future state, two 30-year time periods are used for each state. An average state is calculated for each time period. The reference period for the observed climate consists of the years 1971 through 2000, from the models. For the future, two time periods are analysed. Below, these are referred to as the medium-term ("middle of the century") and long-term ("end of the century") planning horizons. The medium-term planning horizon describes the average state in the years 2031 to 2060. The years 2071 to 2100 serve as the basis for the long-term planning horizon. The future changes are given as a mean value and a range. The range is described in terms of the lowest and the highest change values in the data sets[71].

3.B.1 Temperature

From 1881 to 2021, Germany warmed by about 1.6 degrees. In keeping with this trend, the numbers of cold and very cold days have decreased, and the numbers of warm and very warm days have increased.

Further temperature increases can be expected in Germany. For the medium-term planning horizon (2031–2060), the increase amounts to an average of about 1.1 or 1.9°C (median of the ensembles of the two scenarios). The difference between the changes forecast by the climate projections (climate action scenario and high emission scenario) is small. The range of the results lies between 0.8 and 2.6°C. The warming is somewhat more pronounced in southern Germany. The temperature development for the long-term planning horizon to the end of the century depends strongly on which scenario is chosen. Based on the climate action scenario, an increase of 1.1°C can be expected. The stabilisation at the level of the medium-term planning horizon is achieved through the very sharp reduction –as defined for the scenarios – of GHG

[71] DWD (2022)

emissions. Hardly any regional differences occur. Under the conditions of the high emission scenario, the warming amounts to an average of about 3.9°C. The range of the results lies between 2.8 and 5.2°C. The warming is somewhat more pronounced in southern regions.

3.B.1.1 Regional differences

In the Alps in particular, the projected warming rates, for both the climate action scenario and the high emission scenario, are even higher than those projected for Germany as a whole. In this case, the change for the medium-term planning horizon amounts to between +1.2°C (climate action scenario) and +2.1°C (high emission scenario), with respect to the reference period 1971–2000. For the long-term planning horizon, average warming rates between 1.1°C (climate action scenario) and 4.5 °C (high emission scenario) are projected.

In the coastal region of the north-western and north-eastern German plain, the changes projected for the long-term planning horizon are somewhat below the average values. In this case, average warming rates between 1.1°C (climate action scenario) and 3.7°C (high emission scenario) are projected.

3.B.1.2 Seasonal differences

The warming is similarly pronounced throughout the seasons, with the exception of spring, when it is less pronounced. The temperature increase is accompanied by a marked increase in extreme temperatures. Low-temperature extremes decrease sharply, and high-temperature extremes increase sharply. The frequency of heat waves increases as a result.

In all seasons, the warming in the Alps and the Alpine Foreland is more strongly pronounced than the warming for Germany as a whole. The winter warming in the long-term planning horizon, at an average of 4.0°C (high-emission scenario), is considerably higher than the warming rates projected for Germany as a whole, which average 3.9°C (high emission scenario)

3.B.2 Precipitation

Precipitation quantities increased in the period from 1881 through 2021. This is especially true in the winter and spring. On an annual-total basis, the increase amounts to an average of 8%. By contrast, the changes in the numbers of days with at least 10 litres of precipitation per square meter are hardly noticeable.

In the medium-term planning horizon (2031–2060), Germany's average annual total precipitation is not expected to change. A 5% average increase in the average annual precipitation is calculated. The differences between the scenarios are small. The range of the results lies between a change of -5% and a change of +14%. The changes are about equally pronounced throughout Germany. In general, it must be noted that a modelled change below 10% cannot be distinguished from the natural climate variability. This threshold applies to all of the following values.

3.B.2.1 Regional differences

In the long-term planning horizon (2071–2100), and in the high emission scenario, a +8% increase in annual precipitation is expected for Germany. The range of the results lies between -15% and +19%. The changes will be about equally pronounced throughout Germany. With regard to the change in the number of days with at least 20 mm of precipitation per day, an increase is expected for all regions, both in the medium-term planning horizon and in the long-term planning horizon. Only in the Alps region do some models project a decrease in the number of such days. A less-pronounced increase is projected for days with precipitation of 30 mm or more. For heavy rainfall events, however, the range within the ensemble is very large in some

cases, meaning that the results are not reliable. Regional differences in the changes in the average annual total precipitation are not pronounced at all.

3.B.2.2 Seasonal differences

For the medium-term planning horizon 2031–2060, and with use of the aforementioned RCP scenarios for winter, average increases of +10% in precipitation quantities are calculated. Ii is not possible to forecast trends reliably for the summer months. The results range from a small increase to a slight decrease. In the spring and autumn, average-precipitation-quantity increases of +3% (autumn) and +8% (spring) emerge in this planning horizon. In the spring and in the autumn, the change in the long-term planning horizon (2071–2100) can amount to +1 to +14%, while the change in the winter can be up to +17%. For summer months, in this planning horizon decreases of between -2% in the climate action scenario (±0%) and -6% in the high emission scenario are calculated. The range for the summer, in the high emission scenario, ranges between an increase of +12% and a decrease of -60%. In individual regions, the ranges for the summer results are also large, so they do not seem to be particularly reliable. The results of the high-emission scenario differ from those of the climate projections used to date, which are based on the SRES scenario A1B. In the long-term planning horizon, the high emission scenario does not exhibit the large decreases in summer rainfall that are described in the SRES scenario A1B.

3.B.3 Sea levels

Rising sea levels are also a result of anthropogenic climate change. In addition to worldwide melting of glaciers and ice sheets, the causes include thermal expansion of seas and oceans as they warm.

In Cuxhaven, for example, the relative sea level has already risen by about 40 centimetres since the middle of the 19th century (while the German North Sea coast has been sinking locally by about 0.1 cm per year, as an after-effect of the last ice age). At the gauge in Travemünde, the increase amounts to about 25 centimetres. The consequences of this sea level rise include higher storm surges.

The relative sea level rise in the North Sea and Baltic Sea, until the end of the 21st century, can be taken from the SSP1-2.6 and SSP5-8.5 scenarios of the IPCC AR 6 Assessment for sea level rises. The projected rises for German towns and cities, by the end of the century, are about the same along the North Sea and the Baltic Sea. In the SSP1-2.6 scenario for Cuxhaven, for example, a rise of 0.51m is projected, while for Travemünde a rise of 0.5m is projected. In the SSP5-8.5 scenario for Cuxhaven, a rise of 0.51m is projected, while for Travemünde a rise of 0.5m is projected.

3.B.4 Climate impacts, vulnerabilities and climate hazards

3.B.4.1 Observed impacts of climate change

While in Germany the temperature warmed by an average of 0.11°C per decade during the period 1881-2019, the warming rate in the years 1970-2019 was 0.37°C per decade. This means that warming has accelerated considerably in recent decades. For example, in the most recent decade, 2011-2020, the temperature anomaly with respect to the long-term average for 1891-1920 was a full 2 degrees, after having been 1.4 degrees in the previous decade. The observed accelerated warming also manifests itself very strongly in extremes such as the number and

intensity of heat waves. The effects it leads to include greater health risks, associated with heat stress[72].

Unusually high summer temperatures in three successive years – 2018 through 2020 – have led to a marked increase in numbers of deaths. The unusually long heat wave in 2018 (7.3 weeks long, in the average for all German Länder) resulted in about 8,700 heat-related deaths. That figure is of the same order of magnitude as the corresponding figures for the hot years 1994 and 2003 (10,100 and 9,500 deaths, respectively). For the years 2019 and 2020, about 6,900 and 3,700 such deaths are estimated.

The rising temperatures have led to shifts in seasons and vegetation periods. The duration of the vegetation period increased from 222 days (1951-1981) to 232 days (1988-2017). Animal and plant species from warmer regions of the globe have been spreading; for example, sardines and anchovies have appeared in the North Sea, and the (Asian) tiger mosquito has been spreading on land. That mosquito is known to be a carrier of diseases that were not previously known to have been transmitted in Germany, such as Chikungunya fever and dengue fever.

Water supplies are also being affected by climate change: In the last ten years, low groundwater levels have occurred more and more frequently, and some municipalities have already experienced water-supply problems as a result. Increasing dry periods, and more-frequent (extremely) low water levels in rivers, stress ecosystems, lead to restrictions for shipping and reduce the quantities of cooling water available to power plants and industry. In the last 50 years, the available water in agricultural soils has decreased considerably. In 2018, heat and drought caused damages of €700 million in agriculture.

Global warming also affects the economy, since it depends on having functioning traffic routes (roads, waterways). Such infrastructures are vulnerable especially to extreme weather events such as storms and torrential rainfall – or heat and drought.

In 2018, storms and heavy rainfall led to insurance claims of about €3.1 billion, for damage to houses, vehicles, household goods, commerce, industry and agriculture. According to the insurance industry, 2018 was one of the four worst storm years of the last 20 years.

3.B.4.2 Future climate impacts and climate risks

In connection with the German Strategy for Adaptation to Climate Change (DAS), the Federal Government is planning to carry out cross-cutting vulnerability and risk analyses at six-year intervals, with a view to refining the DAS and taking account of new challenges and new scientific findings. In 2015, a vulnerability analysis (VA 2015) was published. In 2021, a climate impact and risk assessment for Germany (KWRA 2021), which built on that earlier analysis, was published. These analyses show, for different types of climate impacts, and for different regions, what special types of risks, options for adaptation and needed actions apply. They provide information about Germany's overall vulnerability with respect to climate change.

The KWRA 2021 analysis was prepared within the federal authority climate adaptation network, with input from over 180 experts[73]. It answers the following questions:

1. How will climate change affect nature, our everyday lives, our vital resources, our health and our economy in the future?
2. In what areas can we adapt in ways that will reduce climate risks?

[72] German Environment Agency (2019b): Press release of the German Environment Agency on publication on the Federal Government's monitoring report (45/2019). At: https://www.umweltbundesamt.de/en/press/pressinformation/climate-change-in-germany-new-monitoring-report [accessed on 11 October 2022]

[73] German Environment Agency - Klimawirkungs- und Risikoanalyse für Deutschland 2021 (Climate impact and risk analysis for Germany 2021) (publ. 2022) URL: https://www.umweltbundesamt.de/publikationen/KWRA-Zusammenfassung

3. Where do we urgently need to act?

As a result, the KWRA 2021 provides an important basis for the further development of the DAS, and it supports the development of concrete measures, such as the Federation's action and measures plans for climate change adaptation. In addition, the KWRA can support a wide range of stakeholders – in particular, decision-makers at the Länder and municipal levels – in climate change adaptation. The methods outlined in the KWRA can serve as a template for regional and local climate impact and risk assessments. For this reason, it was used as a basis for preparing methodological recommendations for municipalities and companies.

The KWRA 2021 is based on two future scenarios, one covering the middle of the century (2031 to 2060), and one covering the end of the century (2071 to 2100). Using projections of the IPCC (IPCC 2014), the KWRA 2021 analyses a pessimistic case (referred to in the following as "pronounced climate change"; it includes a +3°C increase in the average annual temperature in Germany by the middle of the century, in comparison to the pre-industrial era (1881-1910)), and an optimistic case (referred to in the following as "slight climate change"; it includes a +2.4°C increase in the average annual temperature in Germany by the middle of the century). Where possible, the climate projections were combined with projections of socio-economic data (up to 2045, for factors such as population growth, population density, urbanisation), in order to obtain the best-possible estimates of the future impacts.

In the KWRA 2021, over 100 climate impacts – divided into 13 DAS areas of action – were analysed and assessed in terms of the severity of the related climate risks. Both a sectoral and a cross-sectoral analysis were carried out. The latter of the two analyses considered 5 system areas (natural systems and resources; economic systems that rely on nature; economic systems that do not rely on nature; infrastructures and buildings; and people and social systems) and their interactions.

Natural systems and resources (such as soil, water, species, ecosystems in the water and on land) and economic systems that rely directly on natural resources (such as fisheries, agriculture and forestry, water-resources management), could be especially affected by the middle of the century. The reasons include such factors as severe decreases in soil moisture and groundwater; poor water quality in seas, rivers and lakes; intensified soil erosion; shifting of cultivation regions; changes in ranges of species and varieties; damages to ecosystems such as forests, wetlands, mountains and coastlines; and the appearance of new types of pests and plant diseases.

Natural systems and resources are the basis for fisheries, agriculture and forestry and water-resources management – and for many types of human recreation. Protection of natural systems and resources is vitally important in light of the need to prevent negative domino effects on economic systems and on human health – as well as of the need to develop sustainable forms of use.

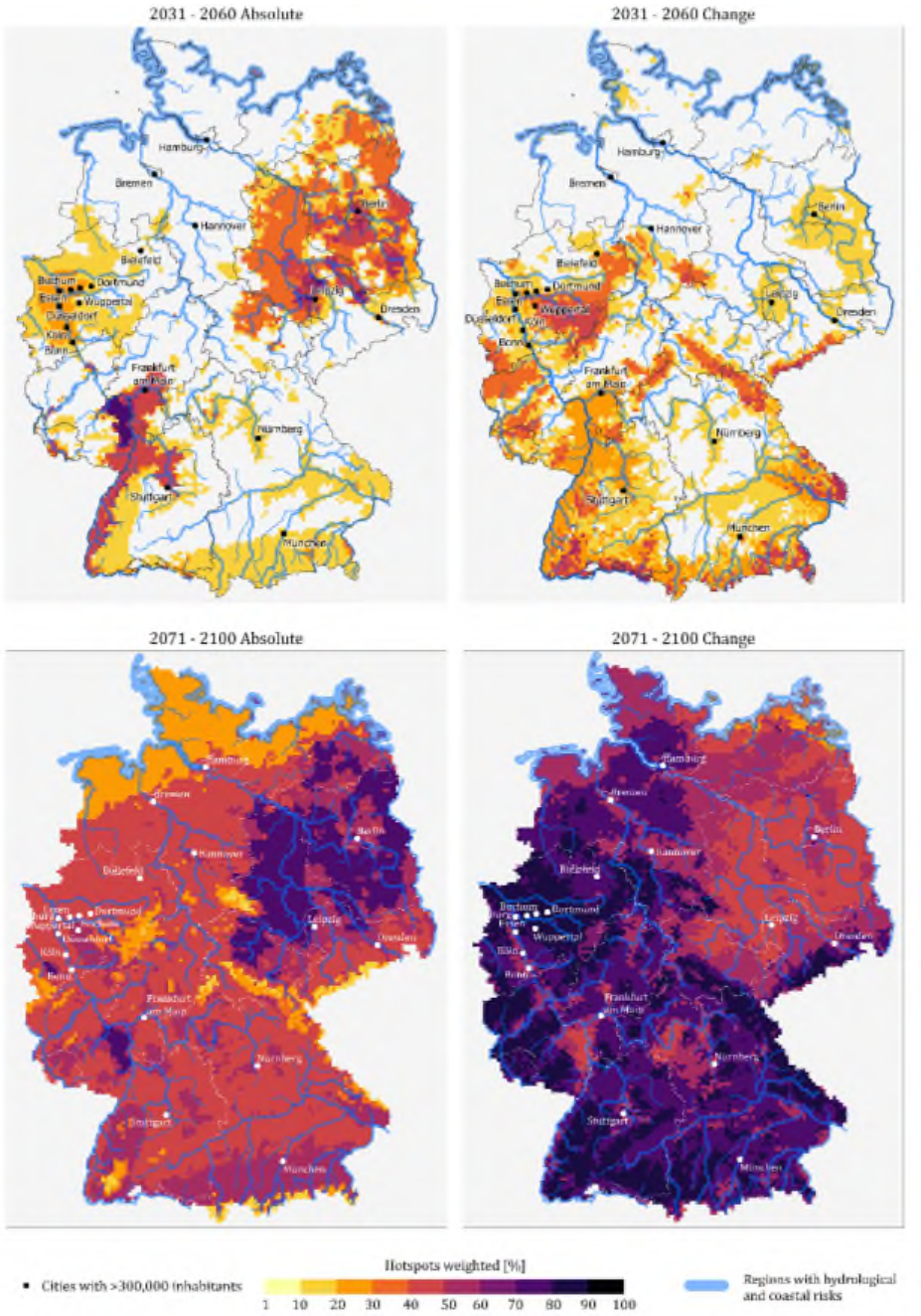
In the future, humans could find themselves facing increasing heat stresses; more-severe UV-related problems such as skin cancer; and more-frequent occurrences of allergic reactions from airborne allergens; and a number of other climate impacts on their health.

Buildings and infrastructures, such as traffic routes, can also be affected by climate change. For example, they can be damaged by river floods and heavy rainfall. More-frequent, longer-lasting (extremely) low-water events can reduce or disrupt the navigability of waterways.

In the long term, all systems in coastal regions will be affected by rising sea levels. In addition, transnational impacts of climate change, such as supply chain disruptions, will become more and

more significant – and strongly affect even those economic systems that do not depend directly on nature.

Figure 27: Spatial distribution of climatic hot spots in the middle and at the end of the century[74]



Left (absolute values): regions that could be affected by a particularly large number of climatic extremes; right (change values): regions that could be affected by particularly high changes in climate parameters. 100 percent means maximum applicability, i.e. exceeding the threshold values for all climatic parameters considered. The climate parameters high average annual temperature, number of hot days, number of tropical nights, low annual precipitation, number of dry days, days with heavy rain as well as the significance that these climate parameters have for all investigated climate effects were taken into account. Data basis: 85th percentile of the prepared DWD reference ensemble (Brienen et al. 2020) for the RCP8.5 scenario of the IPCC AR5 (IPCC 2013).

[74] Source: Eurac Research

The KWRA 2021 summarises as follows:

- Climate change is becoming increasingly visible: Even in the case of slight climate change, all regions in Germany will be affected by further temperature increases, by increases in the numbers of hot and dry days and by heavy rainfall events.
- Differences are seen between different areas: As climate change progresses, Germany's warmest regions will experience an additional temperature increase and additional warming. The country's drier regions will both become hotter and experience more heavy rainfall. In mountain regions, increases in the average temperature, and in heavy rainfall and drought, are expected. Coastal regions will be exposed to hazards resulting from rising sea levels, and areas near rivers will experience more flooding and more low-water events as a result of climate change.
- By the end of the century, the climatic changes could increase markedly in all areas.
- The climate risks could become considerable already by the middle of the century, especially if climate change is pronounced and no adaptation measures are taken.
- Natural systems and resources, and economic systems that depend on nature, could already be strongly affected by the middle of the century. The changes in natural systems and resources will affect many other systems.
- If climate change is pronounced, the climate risks will increase significantly by the end of the century. At that point, more than half of the climate impacts studied could lead to large climate hazards, and thereby affect many areas of our lives.

As a key message, the report noted that while all living things and systems in Germany will be affected by climate change, the effects will differ both spatially and chronologically. Climate change poses a threat to both a) natural systems and resources, and b) future generations. Protection of natural systems and resources plays a vital role in the prevention of domino effects.

3.C Adaptation priorities and obstacles

3.C.1 Adaptation capacities, and needed action

In the KWRA 2021, assessments were carried out, for selected climate impacts, regarding the degree to which adaptation could reduce the climate risks, and how quickly. For that purpose, a distinction was made between adaptation measures that have already been adopted, and more extensive measures that have not. The adopted adaptation measures were taken from the list of actions contained in the current federal Adaptation Action Plan (APA III), which is part of the Second Progress Report on the German Strategy for Adaptation to Climate Change. The additional (not yet adopted) measures are more extensive than the adopted measures, and they could be implemented under the conditions prevailing today. Also, measures lists were prepared for each climate impact / each area of action studied. A comparison of climate risks with and without adaptation measures made it possible to derive and characterise needed action.

With regard to adaptation capacities and the urgency of adaptation, the KWRA 2021 summarised as follows:

- Many climate risks can be considerably reduced through adaptation measures, especially if climate change proves to be slight. Economic systems that depend on nature should especially strive to use their resources in sustainable, climate-resilient ways.
- If climate change is pronounced, some high risks must be expected. Only with more-extensive measures can such risks be adequately reduced.
- For some climate risks, the effectiveness of more-extensive measures could be limited. For such scenarios, it seems necessary to develop farther-reaching adaptation measures – i.e. innovative measures that would not be feasible from a current perspective.
- Germany also faces absolute limits on its ability to adapt, i.e. points at which high climate risks can be prevented only through extremely strong climate action. Such limits would apply to the impacts of climate change on mountain ecosystems, for example.
- For only about one third of all climate impacts considered could adaptation measures begin to take effect in the short term (in less than ten years). Most of the measures involved take considerably longer – in some cases, more than 50 years.
- Immediate action is required especially with regard to high climate risks. The fraction of such risks/impacts for which adaptation measures could take effect in less than ten years is only 5%.

Table 17: Climate risks with and without adaptation, for slight and pronounced climate change, and for 13 action areas listed in the DAS (middle of the century)

Action field	Climate risks without Adaptation			Climate risks with adaptation					Certainty of evaluation (climate risks with adaptation)	
				with APAIII+ measures			with more far-reaching adaptation			
	Present	Middle of the century		2020-2030	Middle of the century				2020-2030	Middle of the century
		Optimistic	Pessimistic		Optimistic	Pessimistic	Optimistic	Pessimistic		
Biodiversity	low	medium	medium-high	low	low-medium	medium-high	low	medium	medium	low
Soil	low medium	low-medium	medium-high	low-medium	low	medium	low	low-medium	medium	low
Agriculture	medium	medium	high	medium	low-medium	high	low	medium	medium	medium
Forestry	medium	medium	high	medium	low-medium	high	low	medium-high	medium	low
Fisheries	low medium	medium	high	low-medium	low-medium	medium-high	low	medium-high	medium	low
Coastal and marine protection	medium	medium	high	low-medium	low-medium	medium-high	low	medium	medium	medium
Water balance, water management	medium	medium	high	low-medium	low-medium	medium-high	low	medium	medium	low
Construction	medium	medium	medium-high	low-medium	low-medium	medium	low	low-medium	medium	low
Energy industry	low	low	low	low	low	low	low	low	medium	medium
Transport, transport infrastructure	low medium	low	medium	low	low	low-medium	low	low	medium	low
Industry and commerce	medium	low	medium	low-medium	low	medium	low	low	medium	low
Tourism	low	low	medium	low	low	medium	low	low-medium	low	very low
Human health	medium	medium	high	low-medium	low	medium	low	medium	medium	low

The climate risks were grouped into 5 levels (low, low-medium, medium, medium-high, high) by experts working in the federal authority climate adaptation network, and on the basis of current scientific findings. Source: Own description, adelphi

Table 18: Climate impacts for which action is very urgently required

Action field	Climate impact
Biodiversity	Spread of invasive species
	Damage to water-bound habitats and wetlands
	Damage to forests
Soil	Soil erosion by water
	Lack of water in the soil
	Wind erosion
	Production function
Agriculture	Abiotic stress (plants)
	Loss of yields
Forestry	Heat and drought stress
	Pest/disease stress
	Forest fire risk
	Utility: Timber yield
Fisheries	Distribution of fish species in rivers
Coastal and marine protection	Water quality and groundwater salinization
	Natural spatial changes on coasts
	Damage or destruction of settlements and infrastructure on the coast
	Overloading of drainage facilities in areas at risk of flooding
Water balance, water management	Water temperature and ice cover and biological water quality
	Overloading or failure of flood protection systems
	Flash floods (failure of drainage facilities and flood protection systems)
	Groundwater level and groundwater quality
Construction	Damage to buildings due to river flooding
	Vegetation in settlements
	Urban climate/heat islands
	Indoor climate
Transport, transport infrastructure	Navigability of inland waterways (low water)
Industry and commerce	Impairment of the movement of goods via waterways (inland)
Human health	Heat stress
	Allergic reactions due to aeroallergens of plant origin
	UV-related damage to health (especially skin cancer)

Source: Authors' own description, adelphi

From a combination of a) duration of adaptation and b) climate risks, 31 climate impacts were identified that call for very urgent action (see table above). These very urgently needed actions have high priority for future adaptation strategies. They were assigned to the following four central challenges:

1. Heat-related risks for health, especially in urban areas, such as areas along the Rhine and Spree rivers.
2. Risks due to drought and low water levels (often in combination with heat), for all systems that use and depend on water. These risks especially apply to rural areas, primarily in the dry regions in eastern Germany and in the west-central part of the country.

3. Risks from heavy rainfall, flash floods and floods, for infrastructures and buildings. Communities in narrow valleys of low mountain ranges have considerably higher risks.
4. Risks due to gradual temperature increases, such as the consequences that sea-level rises will have for natural and nature-using systems. These apply especially along the coasts, in waters, in rural areas and in mountain regions.

The key message of the KWRA 2021 in this regard is that, basically, Germany (still) has many adaptation options available to it. If climate change is very pronounced, the measures already adopted will have to be followed by increasing numbers of additional adaptation measures, some of which will be far-reaching. Some climate risks can be prevented only through strong climate action, however. Many high climate risks of the future can be reduced only through immediate action now. Many adaptation measures will need several decades to take effect.

From the KWRA 2021, the Interministerial Working Group on Adaptation to Climate Change (IMAA) has derived conclusions for all adaptation actors in Germany.

According to the IMAA, depending on the extent to which climate risks can be reduced through measures (see Table 17), the challenges should be through via the following three approaches:

a) Implement known and adopted measures, if the measures can adequately reduce the foreseeable climate risks. Examples include the impacts of low water levels on inland navigation, or of floods on flood protection.

b) Carry out research for the development and scaling up of more extensive measures, in cases in which only additional measures can be expected to provide substantial risk reduction. This is the case, for example, in connection with the health impacts of heat; the impacts of drought on many water-using and water-dependent systems; or the impacts of gradual temperature increases and sea-level rises on many natural and nature-using systems.

c) Carry out applied research in preparation for far-reaching adaptation as part of a socio-ecological transformation, if the known measures and additional measures cannot adequately reduce the foreseeable climate risks. Examples include the impacts of drought and heat on agriculture and forestry; of heavy rainfall and flash floods on soils, urban areas and drainage systems; or of gradual temperature increases on species compositions and ecosystems.

To reduce climate risks to an acceptable level, all actors and stakeholders in Germany should apply the following principles to their adaptation efforts:

1. Promote ambitious climate change mitigation, which is the central basis for successful climate change adaptation. The more successful climate change mitigation is, worldwide, the more successful climate change adaptation can be. In planning and implementing individual climate mitigation and adaptation measures, take account of conflicts of objectives, synergies and interactions between such measures, to ensure they do not negatively affect each other (example: photovoltaic systems on green roofs).
2. In natural systems and resources, clean up anthropogenic pollution and end overuse, in order to strengthen their adaptation capacities (example: reduce pollutant discharges into waters and soils). Protection of natural systems can help prevent negative domino effects and facilitate sustainable forms of use.
3. Take climate risks into account in connection with forward-looking decisions. The impacts of climate change are becoming ever clearer – they now affect almost all areas of life. For successful precaution, therefore, climate risks, such as those identified in the KWRA 2021, need to be taken into account in all relevant planning and decision-making processes at the

Federal, Länder and municipal levels. Examples include processes related to the maintenance and expansion of infrastructures.

4. View adaptation to climate change as an opportunity to increase sustainability, and strengthen resilience. This means that when implementing measures, focus especially on measures that benefit natural systems and are socially equitable. For example, use organic-farming practices such as humus management and other forms of sustainable soil management. In addition, prepare additional adaptation measures, including far-reaching measures.
5. In light of the growing and still-increasing urgency, intensify and speed up implementation of adaptation measures, in order to prevent or reduce risks, especially for future generations. Here it must be remembered that some measures can take very long to implement (over 50 years, in some cases). To this end, a reliable financial and legal framework should be created, on all levels, and suitable capacities should be provided.

In general, advance climate change adaptation in keeping with the action urgency set forth in the KWRA 2021. The KWRA identified 31 climate impacts with very urgent needs for action and 23 with urgent needs for action. Action is urgently required especially in areas in which many cascading effects could be triggered, where high climate risks already exist, or where high climate risks are expected but adaptation will take a very long time to take effect.

3.C.2 Challenges, gaps and obstacles to adaptation

The strategy process and implementation of the DAS are evaluated on a regular basis. The first external evaluation was conducted in 2018. The findings of the evaluation warrant the conclusion that there should be stronger institutionalisation of climate change adaptation within the ministries, plus deeper cross-ministerial collaboration (horizontal integration). In addition to this requirement for deeper cross-ministerial cooperation, the evaluation identified a need for improved cooperation between the Federation and the Länder, with a stronger strategic focus (vertical integration). For climate change adaptation to be embedded within society, governmental and non-governmental actors have a key role to play. It was noted in the evaluation that participatory processes were conducted in the ministries, but these are not comprehensively and systematically embedded in the implementation and further development of the DAS. Success factors during implementation include the availability of previous outcomes, e.g. from a previous project, practical relevance or needs-based orientation of the measures, stakeholder networking, involvement of stakeholders with relevant skills/responsibilities, public acceptance/consensus, availability of resources, and good communication among participants. Reasons for delays in implementation or non-performance were: lack of human capacities, poor communication/coordination, and inadequate data. In addition, some measures were postponed or not implemented due to changes in priorities. The analysis of APA II implementation status also shows that climate change adaptation measures must more systematically address those climate impacts where there is a substantial need for action.

3.D Adaptation strategies, policies, plans, goals and actions to integrate adaptation into national policies and strategies

3.D.1 Implementation of adaptation in accordance with the global goal on adaptation

Through its activities in the field of climate adaptation, the Federal Government intends to help achieve the global goal on adaptation. In doing so, it will be guided by the UAE Framework for Global Climate Resilience.

3.D.1.1 Adaptation activities – the Federal Adaptation Action Plan

3.D.1.1.1 Federal policy instruments for reducing Germany's vulnerability to climate change

The three policy emphases referred to above are enframed by the Federation's concrete measures to reduce Germany's vulnerability to climate change. These measures are set out in the third Adaptation Action Plan (APA III, 2020), which is described below.

The activities covered by the Adaptation Action Plan III are assigned to the clusters "water," "infrastructure," "land," "human health," "economy," and "spatial planning and civil protection." Activities of a cross-cutting nature, such as provision of data and information services, or funding of adaptation to climate change, are grouped within the cluster "cross-cutting."

The key measures for each of the clusters, which are briefly described below, are implemented within the scope of the available budget and planned resources.

3.D.1.1.2 Mechanisms and actions in the water cluster

The **National Flood Protection Programme** will be carried forward to tackle the growing risks of flood events in a coordinated manner across all Länder. The "Preventive flood protection" special framework plan of the Federal/Länder Joint Task for the Improvement of Agricultural Structures and Coastal Protection provides federal funding for this purpose, co-financed from Land resources. In addition, the responsible Länder, in keeping with the division of competences set forth in the Basic Law (Grundgesetz; Art. 83 GG), will update the **flood hazard and risk maps**[75]**,** in the maps' 3rd cycle, by 22 December 2025. In this context, they will also further harmonise the relevant scenarios, hydrological parameters, and methods. The **restoration of watercourses** that are managed as waterways and are federally owned, together with their floodplains, through **Germany's Blue Belt programme**, also contributes to flood protection. This also fosters the attainment of "good ecological status" and "good ecological potential"[76] of watercourses. Particularly where inland shipping on waterways undergoes change, opportunities arise to improve the hydromorphology of water bodies and their ecological continuity, and to improve the status of floodplain areas.

Climate change may lead to lengthy dry periods (as experienced in 2018 and 2019). Problems then arises in terms of water resource shortages, which lead to competition over use of the available resources (for drinking water, agricultural irrigation, water storage for fire extinguishing, inland shipping, etc.). To **resolve such conflicts of use in future droughts**, proposals will be made which define human drinking water requirements that may have priority, in order to determine a potential hierarchy of water uses where conflicts arise. There is also a need to analyse across the Länder the risks posed by more low-flow events,

[75] See Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA), Empfehlungen zur Aufstellung von Hochwassergefahrenkarten und Hochwasserrisikokarten (Recommendations on the compilation of flooding danger maps and flooding risk maps), available at: https://www.lawa.de/documents/lawa-empfehlungen_aufstellung_hw-gefahrenkarten_und_hw-risikokarten_2_1552298996.pdf .

[76] In keeping with the provisions and definition of Directive 2000/60/EC (Water Framework Directive)

and **develop a foundation for systematic and structured management of low-flow and drought issues by the Federation and Länder administrations**.

Numerous measures are already in place at the Länder level for addressing floods, low-water situations and impacts of sea level rise. The Federal Government will continue to expand its cooperation with the Länder in these areas, within the scope of its competence.

As the risks of heavy rainfall events increase, flood hazards grow. Municipalities are responsible for preparedness in this area. The APA III calls for the development of **guidelines for the preparation of hazard and risk maps for local heavy rainfall events**. Building on the LAWA strategy for effective heavy rain risk management, the guidelines should define minimum standards for the preparation of hazard and risk maps. Moreover, the **potential for decentralised rainwater management in residential areas and industrial zones should be reviewed.** This can help to maintain a natural water regime and avoid having to install larger sewage pipes that may become necessary in the course of climate change.

Furthermore, **extreme events and damages need to be recorded systematically**. To be able to better quantify the extent and frequency of extreme meteorological and hydrological events and the damage and environmental impacts they cause, Germany will set up a database documenting (past) events, modelled on those already established in other countries.

3.D.1.1.3 Mechanisms and actions in the infrastructure cluster

In thematic area 1, **Adapting transport and infrastructure to climate change and extreme weather events**, the BMDV Network of Experts is preparing a climate impact assessment for roads, railways and waterways. The purpose of this analysis is to gain an understanding of the potential effects of climatic impacts and natural hazards on federal transport infrastructure.

Besides damage caused by extreme weather events, climate change leads to increasingly frequent heat waves, which can cause indoor temperatures in buildings to rise. APA III therefore provides for **integrating aspects of climate-resilient construction (for both new builds and retrofitting) into funding programmes**. This aims to achieve building designs that are able to counter higher interior temperatures in climate-friendly ways. During periods of summer heat these can include shading and evaporative cooling, for example.

Furthermore, the **climate-smart building construction** mechanism ensures that available findings and knowledge on extreme weather events are incorporated into technical rules and standards governing the maintenance and repair of existing buildings and the construction of new ones. In the context of funding programmes this can help to identify major potential hazards early on and minimise damage events substantially. The tools envisaged include assessment guidance and regional safe load tables.

Within the sphere of competence of the Federal Waterways and Shipping Administration (WSV), concrete steps are being taken to systematically integrate aspects of climate change into planning procedures. This WSV climate-proofing involves integrating data services, guidelines and training programmes.

3.D.1.1.4 Mechanisms and actions in the land cluster

Providing appropriate nutrition for a growing global population on a sustainable basis continues to be a core task of agriculture. However, farming and forestry are particularly hard hit by climate impacts, as are fisheries and aquaculture (as experienced in 2018 and 2019). In response, in the autumn of 2018 the Federal Ministry of Food and Agriculture (BMEL) began formulating an adaptation agenda for agriculture, forestry, fisheries and

aquaculture. This process involved the Länder administrations, the BMUV and departmental research resources. The agenda is based on the DAS guidelines and is therefore expected to be incorporated into them.

The agenda for adaptation of the agriculture and forestry sectors, and fisheries and aquaculture operations, was adopted by the Conference of Ministers of Agriculture in April 2019. In addition, a programme of measures was finalised that comprises both a) measures for short-term response to extreme weather events, and b) measures for long-term adaptation of agriculture and forestry to changing climate conditions. A total of 5 fields of action were defined, and expert groups then prepared lists of measures for each area: crops (arable and speciality crops), forests, livestock, fisheries and aquaculture, and cross-cutting themes. The cross-cutting areas include research into adapting crops and varieties through breeding activities, actions to preserve and utilise genetic resources, and ways to bring about climate-smart and site-appropriate crop rotations and variety selection.

Climate change can also endanger the survival of native species. APA III therefore calls for the **development of a nationwide, functioning biotope network,** designed to assure the survival of species and habitats and to enable organisms to adapt geographically to climatic changes. One approach here is to **optimise the habitats of climate-sensitive and/or endangered species to improve their resilience and adaptive capacity** – for example, by setting aside adequately sized areas with habitat protection functions. The **Federal Programme for Biological Diversity** is implementing the National Strategy for Biological Diversity, whose "ecosystem services" funding area is expressly designed to ensure adaptability to climate change.

To gain a better understanding of ecosystem changes and the rapid decline of species diversity, in 2019 the BMBF launched the **Research Initiative for the Conservation of Biodiversity (FEdA)**. This will substantially advance biodiversity research, pool relevant research activities, and make a sustained contribution to countering the ongoing loss of biological diversity.

The **Programme for Protection and Rewetting of Moors and Peatlands** is designed to address peatland protection by carrying out a number of individual, federally-funded pilot projects in this area. Also, the Climate Action Plan includes measures for development of peat substitutes, and for a peatland-protection programme for agricultural land, funded with KTF/EKF resources.

Furthermore, a **climate impact and soil monitoring network is to be set up and established on a long-term basis**. It will be tasked to perform nationwide surveying, monitoring and documentation of the current condition of soils in Germany, including the changes resulting from climate change. The network will provide researchers and administrators with convenient access to soil-related measurement data. It will also coordinate and link the activities of measurement site operators and users, and integrate various levels of measurement intensity.

Creating climate-resilient forests in federally owned stands calls for the stable, structurally rich and site-appropriate development of mixed forests. This is based on the latest research findings. The Forest Climate Fund was used to finance research, development, modelling and communication activities on forests' services for climate action and their ability to adapt to climate change. It placed special emphasis on practically oriented projects and the transfer of findings into actual practice. As part of the cuts to the Climate and Transformation Fund in January 2024, the Forest Climate Fund was phased out.

3.D.1.1.5 Mechanisms and actions in the health cluster

Due to climate change, Germany has been experiencing more extreme weather events such as frequent heat waves. The heat exposure that such events entail is currently one of the largest impacts on human health. This area is therefore receiving particular attention, and appropriate measures are being taken. These include **information for the public and for health professionals**, and the development of **outreach to especially vulnerable population groups** (such as seniors, people with pre-existing medical conditions and children).

To manage heat waves more effectively, it is essential to study how the instruments used actually work, and use the findings to develop further measures. To this end a **survey, analysis and evaluation of existing heat action plans** is being carried out.

The existing provisions and relevant **state occupational health and safety regulations** concerning heat and UV radiation are being reviewed, and any needed adjustments are being determined. This applies to the Technical Rules for Workplaces, for example. Furthermore, the **Ordinance on Preventive Occupational Health Care** is being evaluated with regard to its provisions on optional care for outdoor occupations involving intense burdens due to natural UV radiation.

This cluster also includes a study of pathogenic **mechanisms of newly occurring pollen allergens**, as exemplified by Ambrosia artemisiifolia. In addition, **trend analyses for imported vector-borne infectious diseases in Germany** are being carried out. To this end, the Robert Koch Institute (RKI) continually evaluates the surveillance data on imported vector-borne infectious diseases at the national level, and publishes key findings.

Steps are also under way to **improve the integration of health and environmental monitoring**, so that existing structures can be used as part of an integrated surveillance system at federal level to monitor health-related environmental factors and assign them to health problems.

Information and early warning systems are being adapted and expanded, and the channels of information and communication are being adjusted so as to reach all target groups. This instrument also includes establishing and refining warning systems for medical and nursing facilities, and for relevant groups. The early warning systems in question also integrate heat, UV and contaminated air detection.

3.D.1.1.6 Mechanisms and actions in the economy cluster

To ensure the safety of technical and industrial facilities safety during extreme events, APA III provides for **review by the Commission on Process Safety of the Technical Rules on Plant Safety 310 (Precipitation and floods) and 320 (Wind, snow and ice loads), including requirements for updates to reflect recent findings on climate change.**

Climate change is also impacting Germany's tourism sector. APA III therefore includes the **provision of guidelines on how to implement adaptation actions, e.g. for the elaboration of emergency preparedness plans for responding to various kinds of extreme weather events**. Sudden weather events in particular can cause hazardous situations affecting the tourism sector and tourists themselves. For instance, in the winter of 2018/19 heavy snowfall trapped holidaymakers in their destinations and accommodations. Local crisis plans should therefore take account of these target groups.

3.D.1.1.7 Mechanisms and actions in the spatial planning and civil protection cluster

Given the local and regional manifestations of climate change, urban and spatial planning have a key role to play in adapting to climate change. **Urban development promotion programmes**

therefore now **accord higher priority to climate adaptation.** Since 2020, climate change mitigation and adaptation measures have been a mandatory prerequisite for funding in all programmes, also as cross-cutting measures. This includes, for example, measures to improve green infrastructure, the energy-efficient retrofitting of buildings and climate-friendly mobility. This year's administrative agreement on urban development promotion also tightened up requirements. As of 2022, new or revised integrated urban development strategies must address climate change mitigation and adaptation. They must also specify concrete targets and measures

Numerous activities in connection with implementation of the White Paper on Urban Greening support climate change mitigation and adaptation. A central role here is played by the funding of urban green space projects, notably as part of: the aforementioned urban development promotion programmes; the federal programme on Adapting Urban Spaces to Climate Change; the KfW programme Energy-efficient Urban Redevelopment; the national urban development projects (federal programme); the National Climate Initiative; and the funding programme Measures for Adaptation to the Impacts of Climate Change. A further focus involves the communication of information on relevant tools and good practices for climate-resilient urban development, and research on climate-resilient construction and climate-smart urban development. Actions are guided by the vision of developing an urban blue-green infrastructure that protects the quality of life in cities, binds carbon and mitigates the effects of heavy rainfall, heat and drought. To this end the Federation is conducting research projects, notably on climate-smart construction, climate-resilient urban redevelopment, water-sensitive urban development and ways to enhance urban nature. One key foundation for these activities is the detailed recording and monitoring of the scope and quality of urban green spaces. This work is increasingly being carried out using remote sensing techniques (laserscan data, aerial photos, and drone and satellite imagery).

As part of the National Water Strategy, the vision of the "water-sensitive city" is being further elaborated, with a view to promoting sustainable water use in cities. Building on that, **approaches for decentral irrigation of urban green spaces as a precaution against drought** are being further developed and a **generic recommendation** is being prepared. Research projects are exploring water types, water quantities and water quality, in order to preclude adverse effects on human health or the environment.

Besides spatial planning, civil protection also faces challenges that need to be addressed in the context of APA III. The measure for **further development of risk communication on storm-related hazards to the public** is improving existing information services, e.g. on heat (here there are links to the health cluster) and heavy rain. Such services will be integrated in comprehensive risk communication strategies. Furthermore, **recommendations on cooperation between spontaneous responders and volunteer responders in the context of extreme weather events** are being expanded, and supplemented with a compilation of good practice examples. This includes the evaluation of experience with citizens' involvement during storms, and a review of ISO standard 22319:2017 in Germany. In recent years, the UN's Sendai Framework for Disaster Risk Reduction (SFDRR) has provided important impetus. A strategic foundation for implementation of the framework is currently being elaborated. Major synergies are anticipated between disaster resilience enhancement and adaptation to climate change. These will be harnessed to provide added value for the implementation of both strategy processes.

3.D.1.1.8 Cross-cutting mechanisms and actions

The draft APA III envisages with regard to data and information services that the **KLiVO** German Climate Preparedness Portal and the **KlimAdapt system of adaptation services** will be

continued and expanded. KlimAdapt is a module of KLiVO which assembles, processes and provides products, services and assessments for the identification and implementation of adaptation actions and for the further development of the German Adaptation Strategy (DAS).

The **DAS "Climate and water" open service** provides climatological, oceanographic and hydrological data and advisory inputs for the individual action fields of the German Adaptation Strategy. The service will provide decision-makers and planners with comprehensive, up-to-date, uniform and quality-assured data for adaptation measures in Germany. The German Adaptation Strategy also lists numerous research activities that will build the knowledge base on climate change and will advance climate modelling at various scales. These include **publicly funded programmes on the economics of climate change** and on **climate resilience through urban and regional actions** that aim to build actionable knowledge on climate change mitigation and adaptation.

In many instances, the climatic determinants in the specific fields stated above are still insufficiently researched. A particular need for further research remains as regards the robustness of modelled extremes in terms of their modelability, characteristics and probability of occurrence. In the next few years, inter alia programmes funded by the German Research Ministry (BMBF), such as ClimXtreme and RegIKlim, will deliver initial findings on the analysis of rare events and refined regional and global climate modelling.

A further action is **local climate and environmental models for cities and regions of the future**, a **pilot initiative** comprised of several components. The first component involves the development of an urban climate model capable of capturing all relevant urban climate processes. Two further components will lay the groundwork for the next generation of climate information services and will compile and link data on a broad range of local environmental issues.

Existing technical rules and standards need to take systematic account of climate change impacts. An action on **climate-proofing existing rules and technical standards** encompasses specific departmental research, active involvement in relevant bodies, enshrinement in statutory provisions, and incorporation into tendering procedures of the Federation. Furthermore, the **need to integrate climate adaptation into specialised laws, and the practicability of doing so**, are to be reviewed. This is important because implementing the DAS, particularly at municipal level, can be made more robust if it is integrated into a prescribed statutory system with mandatory procedural requirements. The first step is therefore to examine which specialised laws are relevant and what regulations should be included.

The permanent establishment of the **federal authority climate adaptation network** mandated by the Interministerial Working Group on Adaptation to Climate Change promotes DAS implementation. One ministerial research network that is relevant to DAS implementation is the **BMDV Network of Experts** of the Federal Ministry for Digital and Transport. This network is tasked to provide scientific findings of practical relevance to challenges cutting across all modes of transport, such as climate change, environmental protection and ageing infrastructure.

Various funding programmes aim to create a financial framework for adaptation actions. Under the European Union's new multiannual financial framework for 2021–2027, an increased percentage of all funding is to be deployed for climate-relevant actions.

The **Blue Compass award** scheme, through which the German Environment Agency regularly showcases local and regional lighthouse projects for managing climate change impacts, is to be continued on a permanent basis, budgetary resources permitting.

Furthermore, a **system to analyse the effectiveness of actions and mechanisms** is to be established. This will improve the targeted selection of DAS actions and policy mechanisms, and will facilitate coordination between specialised strategies.

3.D.1.2 Nature-based solutions for biodiversity and climate

The synopsis of APA III actions shows that many climate change adaptation activities are nature-based and utilise ecosystem processes. Positive examples of adaptation options using nature-based solutions (NbS)[77] that contribute effectively and sustainably to attaining biodiversity and climate goals, generate synergies between these two and other development goals, and rely on natural ecosystems, include:

- Restoring wetlands and river courses (preventing damage by improving high-water runoff regulation)
- Implementing blue and green infrastructures such as parks, roof greening, lakes and small water bodies in urban areas (reducing the heat island effect of cities and thus reducing human health impacts during heat waves, improving air quality and making a generally positive contribution to human health and well-being, enhancing environmental quality and human quality of life, improving flood management according to the "sponge city" principle)
- In forestry, converting forests to climate-resilient mixed stands with site-appropriate and mostly native tree species helps to ensure that forests can perform their ecosystem functions over the long term.
- In agriculture, low-impact and conservation tillage helps to preserve natural soil functions (such as water storage capacity) and reduces erosion and compaction.
- Conserving and restoring natural ecosystems (e.g. increasing resilience to climate change impacts).

Climate change adaptation should rely more strongly on nature-based solutions, as these are associated with environmental, economic, social and cultural benefits (see e.g. the studies on Germany's natural capital). Numerous studies demonstrate a positive cost-benefit ratio[78]. Nature-based solutions also help to build the resilience of ecosystems[79].

The predominantly long-term benefits of nature-based solutions, their positive cost-benefit ratio and their contribution to achieving sustainability goals are recognised at many levels. This also applies at EU level, where the EU Biodiversity Strategy[80] and Adaptation Strategy[81] give priority to such solutions. In Germany the benefits of nature-based solutions are gradually being

[77] UNEA 5.2. Resolution 5 "Nature-based solutions for supporting sustainable development" defines nature-based solutions as "actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services, resilience and biodiversity benefits''.

[78] https://www.ufz.de/teebde/index.php?en=43767

[79] See e.g.: Seddon N, Chausson A, Berry P, Girardin CAJ, Smith A, Turner B (2020) Understanding the value and limits of nature-based solutions to climate change and other global challenges. In: Philos. Trans. R. Soc. B Biol. Sci. 375. doi:10.1098/rstb.2019.0120; Faivre N, Fritz M, Freitas T, de Boissezon B, Vandewoestijne S (2017) Nature-Based Solutions in the EU: Innovating with nature to address social, economic and environmental challenges. In: Environ. Res. 159, 509–518. doi:10.1016/J.ENVRES.2017.08.032.

[80] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/actions-being-taken-eu/eu-biodiversity-strategy-2030_de

[81] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12381-EU-Strategy-on-Adaptation-to-Climate-Change/public-consultation

recognised[82], as reflected by the Urban Nature Master Plan[83], for instance. The Action Plan on Nature-based Solutions for Climate and Biodiversity[84] also includes numerous measures that contribute to climate adaptation.

3.D.1.3 The EU and the international context

The climate adaptation policy process in Germany is being carried out in the context of European and international strategy processes for climate adaptation. Germany contributes actively to the work at the international and European levels, and it is represented in various bodies (including implementation of the European Adaptation Strategy).

The EU Climate Law addresses both climate change mitigation and adaptation. It calls for the relevant EU institutions and the Member States to make continual progress in improving their adaptability, strengthening their resilience and reducing their vulnerability to climate change. To this end, the Member States are called on to develop and implement national adaptation strategies and plans. Reports on the progress made by the EU as a whole, and on the national progress made by the Member States, are to be regularly submitted to and evaluated by the European Commission.

In February 2020, COM presented a revised draft of an "Implementing Act – Reporting on national adaptation action," and opened the relevant public consultation process. The draft legislation fulfils the provisions on reporting in the Governance Regulation and the United Nations Framework Convention on Climate Change UNFCCC. According to these provisions, the key topics covered by such reports include: the main purposes and goals, and the institutional framework, for adaptation measures; projections for climate change, adaptation capacities, adaptation plans and strategies; the monitoring and assessment framework; and progress made in implementation.

In the Paris Agreement, climate change adaptation and mitigation are treated as equally important pillars of international climate policy. Through its global adaptation goal, the Paris Agreement aims to drive improvements in adaptation capacities; improvements in resilience; and reductions in vulnerability to climate changes. The Second DAS Progress Report discusses Germany's international responsibility within the framework of international climate policy.

At the same time, additional multilateral framework agreements of the United Nations are of relevance to the issue of adaptation to climate change. In 2015, the Sendai Framework for Disaster Risk Reduction (SFDRR) and the Sustainable Development Goals (SDGs) were adopted. Both agreements underscore the importance of climate change adaptation. In addition, climate change adaptation has also grown in importance in the framework of other international organisations and multilateral agreements, such as the Organisation for Economic Co-operation and Development (OECD) and the G7 and G20 meetings.

[82] https://www.bmi.bund.de/DE/themen/bauen-wohnen/stadt-wohnen/stadtentwicklung/gruene-stadt/gruene-stadt-node.html

[83] https://www.bmu.de/fileadmin/Daten_BMU/Pools/Broschueren/masterplan_stadtnatur_bf.pdf

[84] https://www.bmuv.de/fileadmin/Daten_BMU/Pools/Broschueren/ank_publikation_en_bf.pdf

3.E Progress made on implementing adaptation[85]

3.E.1 APA II implementation status

Three quarters of the 147 measures described in APA II have already been or are currently being implemented[86]. A quarter of them are in preparation or are not yet being implemented. In the survey conducted as part of the evaluation, a third of the measures were described as still in progress. Slightly less than a quarter of the actions were described as ongoing tasks; this reflects the fact that APA II and the DAS progress report of 2015 mark a transition from project-based, limited-term measures to established longer-term tasks.

According to the survey conducted as part of the evaluation, the factors enabling successful implementation[87] include: the availability of previous outcomes, e.g. from a previous project, practical relevance or needs-based orientation of the actions, stakeholder networking, involvement of relevant/competent stakeholders, public acceptance/consensus, availability of resources, and good communication among participants. The reasons given for delays in implementation or non-performance were[88]: staffing shortages, poor communication and coordination, and inadequate data. Furthermore, some measures were postponed, or not implemented at all, due to changes in priorities. The analysis of the APA II implementation status also shows that climate adaptation measures need to address more systematically those climate impacts where there is a substantial need for action.[89]

3.E.1.1 Preparation of APA III: methodology

The Adaptation Action Plan III (APA III) was developed in a stepwise and collaborative process by the Federal Ministries represented in the Interministerial Working Group on Adaptation to Climate Change (IMAA). APA III covers activities to be carried out by the Federation within its own sphere of competence, as well as policy instruments to create appropriate frameworks for climate change adaptation in Germany. The Federation focuses these measures on the climate impacts and needs for action identified as priorities in its vulnerability analysis. The actions identified should be developed and implemented within the time period covered by APA III.

APA III includes a range of technical proposals which the higher federal authorities participating in the federal authority climate adaptation network[90] developed within their respective spheres of responsibility and expertise. The proposals are based on an intensive, stepwise process of analysis and evaluation. The evaluation criteria were: effectiveness, flexibility, efficiency,

[85] Source: 2020 Progress Report, pp. 30-31 et seq.)

[86] The APA II implementation status reported here was determined through the DAS evaluation (see Section B.5 and Bundesregierung 2015, p. 8). In terms of methodology, this was achieved using the "APA status tool" (see evaluation report, pp. 69-72). The findings were then supplemented with information on success factors and obstacles encountered when implementing climate adaptation measures. This information was obtained from interviews with the persons responsible for the APA II actions. The findings reported here reflect the status as of May 2018.

[87] Concerning the implementation status of the APA II measures, the APA status tool also enquired about the success factors for their implementation. Information on success factors in implementation was provided for a total of 39 actions.

[88] In a total of 29 cases, there were delays in implementing APA II measures, or the measures were not performed at all. In many instances, the reasons for these delays were stated in the APA status tool.

[89] The evaluation report provides a detailed description of which APA II measures and instruments directly and systematically address climate impacts with a substantial need for action, and which do not.

[90] The network was set up in 2017 as a permanent network of federal authorities and institutions tasked with supporting the IMAA in implementing the German Adaptation Strategy (DAS). The UBA leads the network's activities and organises its regular meetings. At present, 28 federal authorities and institutions are represented in the network. Further federal institutions are invited to participate as and when additional technical expertise is required. The network provides the IMAA with support for the technical development and coordination of scientific content and proposals to improve the DAS, drawing on the results of completed and ongoing research projects. The specific content of the cooperation is regularly agreed by the network partners on the basis of work and resource planning and is submitted to the IMAA for approval.

coherence with other federal strategies, and potential to create synergies with other federal objectives and fields of action. A stepwise approach was adopted; this means that the climate change adaptation measures and policy instruments underwent ex ante assessment, involving an expert appraisal by the authorities' representatives. Selected topic areas were discussed within the network.

Other proposals were put forward by the Federal Ministries and their subordinate authorities. The final decision on which measures and instruments should be included in the APA III was taken jointly by the Federal Ministries.

3.F Monitoring and evaluation of adaptation measures and processes

In 2023 the Federal Government published the Third Monitoring Report on the German Strategy for Adaptation to Climate Change. The report describes the impacts of climate change on the basis of solid scientific data, at the same time as providing the public as well as decision-makers in all sectors of society with information on tangible impacts of climate change. The risks associated with climatic changes affect all sectors of society and all ecosystems which make up the foundations of our life in all aspects of its diverse structures and services. Consequently, the organisation of risk provisioning and adaptation capacities is a task that concerns society as a whole. Curbing global warming and its impacts is a core political challenge for the 21st century worldwide. Meeting this challenge is an essential prerequisite for achieving the objectives set by the 2030 UN Agenda with its focus on sustainable development[91].

In this light, the Federal Government, as early as 2008, under the auspices of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), submitted the first **German Strategy for Adaptation to Climate Change (DAS)**. This strategy has been continuously developing it ever since. The overarching objective of DAS is to mitigate the vulnerability of ecosystems and society to the impacts of climate change, while increasing the resilience and adaptability of these systems. The work on DAS has been carried out within the Federal Government under the auspices of the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) via the Interministerial Working Group for Adaptation to Climate Change (IMAA), with the cooperation of all Federal Ministries and their scientific authorities linked to this Working Group. Furthermore, all work within the DAS framework is carried out in close cooperation with the Länder and municipalities.

Since 2021, the Federal Government has been strengthening the political control of climate adaptation by undertaking the following: a federal law which establishes a binding legal framework for the adaptation to climate change; a precautionary climate adaptation strategy with measurable targets; and safeguarding the joint funding of precautionary climate change mitigation and adaptation measures at Federal and Länder level.

Since 2008, work has been ongoing to develop a **DAS reporting system** consisting of various components. Every four years, the **DAS Monitoring Report** provides updates on climate impacts and adaptation based on measured data. Every six years, a **Climate Impact and Risk Assessment (KWRA)** is carried out to analyse future climate risks. **Evaluations of the DAS** are carried out at regular intervals. These are the foundations for further developing the adaptation strategy covered in the **DAS Progress Report** and underpinned by an **Adaptation Action Plan (APA)**. In 2015[92] and 2020[93] the Federal Government presented progress reports in conjunction with the 2015 and 2020 Action Plans

Using scientific **indicators for climate impacts and adaptation**, the 2023 Monitoring Report provides information on the 16 action fields of the DAS (see pages 4–6[94]). The 2021 Climate Impact and Risk Assessment (KWRA) was used to determine the 31 foremost and most urgent

[91] United Nations General Assembly Resolution dated 25th September 2015 "Transforming our world: the 2030 UN-Agenda for Sustainable Development" (https://undocs.org.en/A/RES/70/1). Goal 13 stipulates to "Take urgent action to combat climate change and its impacts", and to "Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries".

[92] Die Bundesregierung (eds.) 2015: Adaptation to Climate Change. Initial Progress Report by the Federal Government. Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety. 275 pages. https://www.bmuv.de/fileadmin/Daten_BMU/Pools/Broschueren/fortschrittsbericht_anpassung_klimawandel_en_bf.pdf

[93] Die Bundesregierung (eds.) 2020: Second Progress Report on the German Strategy for Adaptation to Climate Change (DAS). 64 pages plus annexes. https://www.bmuv.de/fileadmin/Daten_BMU/Download_PDF/Klimaschutz/klimawandel_das_2_fortschrittsbericht_en_bf.pdf

[94] 2023 Monitoring Report on the German Strategy for Adaptation to Climate Change | German Environment Agency

requirements for action in Germany.[95] The 2023 Monitoring Report presents new indicators for some of the most urgent requirements for action, thus enabling the observation of trends based on measured data. Compared to the first two monitoring reports, the structure has been developed further. Each action field is now preceded by an overview of what has been happening with regard to climate change, and what has already been done. Furthermore, links to the KWRA assessment are established, and important gaps in respect of data and knowledge are highlighted. The technical foundations of the Monitoring Report are reinforced by cooperation with more than fifty authorities at Federal and Länder level, as well as universities and professional organisations, whose expertise contributes to the technical quality of the indicators and the reliability of the evaluation.

The DAS Monitoring Indicators convey a comprehensive overview of the kind of changes that can be attributed to climate change in Germany, and what kind of adaptation measures have already been implemented. The 2023 Monitoring Report also documents precautionary efforts that have been made at federal level in view of the increasing risks. At the same time, the close mutual dependence of achievements in climate change mitigation and progress with climate adaptation is also highlighted. The only way to limit and control the impacts of global warming is to step up climate action. At the same time, the precautionary measures taken to adapt to climate change are both important and urgent, in order to counteract the impacts which have already become inevitable, and to find ways of mitigating any associated environmental, social and economic damage with maximum efficiency.

3.F.1 Where and how are climate changes manifested in Germany?

The previous DAS Monitoring Report was published in 2019. Since then, Germany has repeatedly faced heat waves, droughts, flash floods and other flooding events. Even more so than in 2019, the impacts of global warming are reflected in the measured data contained in the 2023 Monitoring Report. Air, water and soil temperatures have continued to rise, thus also increasing the impacts on humans, the environment, the economy and infrastructures.

Above all, the extreme events are ingrained in the collective memory. From 12 to 15 July 2021, the low-pressure front Bernd caused extreme downpours in various parts of Western Europe. In the region around the rivers Ahr and Erft in Rhineland-Palatinate and North Rhine-Westphalia, flash flooding events resulted in disastrous damages and losses, including the loss of more than 180 lives in Germany – most of them in the Ahr valley. All in all, this caused insured material damage to residential property, household effects and business premises totalling €8.1 billion (see indicator BAU-I-5, page 226[96]). To date, this was the highest ever expenditure on claims for property insurance involving damage caused by natural hazards. World Weather Attribution (WWA), an international alliance of individuals involved in research, studied the extent to which the occurrence of such extreme weather events is related to climate change. They reached the conclusion that the probability of such extreme rainfall events being due to climate change has increased by a factor of between 1.2 and 9[97].

[95] UBA – Umweltbundesamt (eds.) 2022: Die Risiken des Klimawandels für Deutschland – Ergebnisse der Klimawirkungs- und Risikoanalyse 2021 sowie Schlussfolgerungen der Interministeriellen Arbeitsgruppe „Anpassung an den Klimawandel“. Dessau-Roßlau, 19 pages https://www.umweltbundesamt.de/sites/default/files/

[96] 2023 Monitoring Report on the German Strategy for Adaptation to Climate Change | Umweltbundesamt

[97] Tradowsky J. S., Philip S. Y., Kreienkamp F., Kew S. F., Lorenz P., Arrighi J., Bettmann T., Caluwaerts S., Chan S. C., Cruz L. de, Vries H. de, Demuth N., Ferrone A., Fischer E. M., Fowler H. J., Goergen K., Heinrich D., Henrichs Y., Kaspar F., Lenderink G., Nilson E., Otto F. E., Ragone F., Seneviratne S. I., Singh R. K., Skålevåg A., Termonia P., Thalheimer L., van Aalst M., van den Bergh J., van de Vyver H., Vannitsem S., van Oldenborgh G. J., van Schaeybroeck B., Vautard R., Vonk D., Wanders N. 2023: Attribution of the heavy rainfall events leading to severe flooding in Western Europe during July 2021. Climatic Change, 176 (7): 1-38.

The Monitoring Report shows that apart from heavy rain and flooding, there are other extreme events such as heat and drought that descended on Germany with all their measurable impacts. Summers with major heat waves and highest recorded air temperatures to date have been occurring more frequently. For instance, in July 2022, for the first time ever north of the 53rd parallel, a temperature in excess of 40°C was measured at the Hamburg-Neuwiedenthal measuring station[98]. In 2018, 2019, 2020 and more recently in 2022, **heat waves** caused stress to city-dwellers in particular. In Berlin, Frankfurt am Main and Munich, daily peak temperatures of at least 30°C and tropical nights with temperatures never dropping below 20°C occurred significantly more often than the national average. Between 2018 and 2020, some 19,300 individuals died as a result of the effects of heat in Germany (see indicator GE-I-2, page 42[99]).

Heat waves and droughts also constrained the functionality of infrastructures and waterways. For example, **technical obstructions** occurred in goods and passenger transport. In some areas massive disruption to electricity generation in nuclear and coal-fired power plants also occurred in Germany and other member countries of the Trans-European Networks for Energy. Due to the high temperature of water sources there were shortages of **coolant water**. Coal supplies were also restricted by the low water levels in waterways used by inland shipping.

The aforementioned years, which had remarkably hot summers, were also characterised by low precipitation levels which **led to severe droughts in some regions**. Regarding the water balance, massive losses were incurred between 2018 and 2020. Ever since the turn of the millennium, Germany has been losing 2.5 gigatonnes or cubic kilometres of water per year (see indicator WW-I-1, page 70[100]). In the period 2019 to 2021, groundwater levels at many measuring stations fell to record lows. The effects of the years of drought years had not yet been offset even as of 2023. Poor soil water availability led to **crop yield losses in agriculture**. Due to drought stress and related beetle infestations, a significant increase in crown defoliation occurred. From 2019 onwards, it became obvious that **tree dieback rates** had been skyrocketing for all tree species. The extremely dry weather pattern was also reflected in the occurrence of forest fires. There were considerably more forest fires and – in the north-eastern Länder – **large-scale forest fires.**

Despite the drought, especially during the summer of recent years some regions experienced **flooding events** – some of them extreme. On these occasions the multi-annual mean flood discharge values were exceeded by several multiples at some gauges. In fact, the apparent contradiction between drought and extreme flooding represents a genuine example of cause and effect: On the one hand, warmer air absorbs more moisture, thus increasing the risk of **heavy rain;** on the other, it increases the frequency of periods of drought. To name just one of the impacts, desiccated soils are unable to absorb or store the water that accumulates during heavy rainfall. The rainwater then runs off the surface, as a result of which river levels rise rapidly and rivers burst their banks.

[98] DWD – Deutscher Wetterdienst (Hg.) 2022: Klimatologischer Rückblick Sommer 2022. https://www.dwd.de/DE/leistungen/besondereereignisse/temperatur/20220921_bericht_sommer2022.pdf

[99] 2023 Monitoring Report on the German Strategy for Adaptation to Climate Change | German Environment Agency

[100] 2023 Monitoring Report on the German Strategy for Adaptation to Climate Change | German Environment Agency

3.F.2 The DAS Monitoring Indicator System

3.F.2.1 Indicators

For the 2023 (third) Monitoring Report, the indicator system dating back to 2019 was reviewed and further refined. Since that update, the DAS Monitoring Indicator System has comprised117 monitoring indicators in total. 67 indicators describe the impacts of climate change (impact indicators), 45 describe adaptation measures or activities and conditions supporting the adaptation process (response indicators); a further 5 are cross-sectional monitoring indicators.

64 Indicators stemming from the 2019 Monitoring Report were updated based on the same methodology. 25 indicators were revised on the basis of new scientific findings and/or changed baseline data. They are therefore included in an altered form, although most of these appear under the same indicator title as before. 15 Indicators were deleted from the set, either because the relevant data sources no longer existed or because it was possible to replace those indicators with others, or because it is no longer possible from today's perspective to shed sufficient light on the subject matter using the data available. Most of the deletions (5 indicators each) previously appeared appear in the action fields "energy industry" and "tourism industry" respectively. In those cases, there were question marks concerning the previously suggested close links between the circumstances involved and climate change. 4 indicators were assigned a dormant status, as it was still not possible to update the indicators relative to their status in the 2015 report, and/or because methodical reviews are imminent. It is expected that these indicators will reappear in the 2027 Monitoring Report (possibly in a modified form). 28 indicators were newly created and make their first appearance in the 2023 Monitoring Report. Nearly all the action fields include innovations. The new indicators either replace indicators that were removed from the set, or they address new themes which had not been examined previously within the monitoring system. These indicators broaden the thematic width and enhance the quality of the monitoring system.

As far as the "water balance and water management" action field is concerned, the work on the review and development of new indicators was carried out in close cooperation with experts of the Subgroup on Climate Indicators, which is part of the German Working Group on Water Issues of the Federal States and the Federation (LAWA). This group – appointed by the Standing Committee on Climate Change (LAWA-AK) – was tasked with bringing about a cross-Länder agreement on indicators that would enable description of the effects of climate change on the water sector. As part of a research project (DASIF) commissioned by the German Environment Agency (UBA), satellite data were used to develop three new indicators to replace previous case-study indicators (see below). As a result, these can now be used to generate nationwide information. As part of another UBA project, one new indicator for the action field "soil" was developed and incorporated in the DAS indicator set.

In principle, all monitoring indicators are designed to capture nationwide trends through time series. For thematic aspects that are not yet sufficiently underpinned by nationwide data to allow the creation of indicators, it was possible in some cases to develop case studies. In the 2023 Monitoring Report, 13 such case studies demonstrate using spatially limited data sets what findings might be generated at the nationwide level if the relevant data were available. For the 2023 Monitoring Report, several indicators used in the 2019 Monitoring Report as case-study indicators were successfully developed into indicators of nationwide validity.

The nationwide Monitoring Report does not normally disaggregate the indicator findings by region. In some cases, however, findings based on national mean values are difficult to interpret. Using time series for large areas (such as "north" or "south"), it may be possible to generate more specific findings, subject to the availability of relevant data. Maps have now been

integrated into the 2023 Monitoring Report as a new feature. These maps supplement the time series graphs with region-specific data for a current time period.

The deadline for updating the time series in the current, i.e. third, Monitoring Report was 30 September 2022. This means that 2021is the last date referred to in the indicator graphs. Wherever this seemed either meaningful or necessary, the text of the report provides a look ahead to developments in 2022.

3.F.2.2 Dealing with uncertainties

It is not possible to capture all relevant climate impacts and adaptation activities using quantitative monitoring indicators. Several data collection processes are still in their initial stages. Longer time series will be required before it is possible to interpret trends. The inevitable constraints on data availability also mean that the number of monitoring indicators current used in the action fields – fifteen – does not necessarily reflect their significance.

With many monitoring indicators, it is possible to provide a qualitative description of causal relationships between observable changes in the environment, society or the economy on the one hand, and climate change on the other. However, it is much more difficult to determine their significance, as ecological and societal systems are influenced by multiple factors. When assessing damage to forests, for instance, besides any impacts of climate change such as more frequent seasonal periods of heat of drought, or severe storms, it is also necessary to take into account other complex causal factors unrelated to climate change that may impact the health of trees. Examples include nutrient inputs, acidification and high ozone concentrations. During the (ongoing) development of the DAS Monitoring Indicator System, intensive discussions have taken place (and are likely to continue) regarding cause-and-effect relationships. Similarly, the indicators have been (and will continue to be) aligned with to the latest state of the art.

Fuzzy interpretations may also result with respect to adaptation measures. Numerous measures such as the operation of the heat warning service provided by DWD, were taken specifically in the interest of climate adaptation. Other measures also contribute to adaptation but that is not their only purpose. For example, nature-based measures such as forest transformation or the greening of buildings have multiple positive effects, which are primarily why they are planned and implemented in the first place. In any case, these measures also support an effective adaptation process.

Given the inevitable uncertainties and a degree of fuzziness as discussed above, the intention is to continue reviewing and redeveloping the Monitoring Indicator System in the course of future updating cycles.

3.F.3 Assessing the trends

The DAS Monitoring Indicators are designed to enable an assessment of observed trends. The benchmark is the DAS goal of reducing vulnerability to the consequences of climate change, and maintaining and boosting the adaptability of natural and social systems to the unavoidable climate impacts. The intention is that the policy goals outlined in the various action fields can be achieved even under changing climatic conditions.

The adaptation targets are currently the subject of a wide-ranging process of discussions. The aim is to develop quantified targets, the achievement of which should be concretely verifiable using suitable indicators, some of which may need to be newly developed. The future development of the DAS Monitoring Indicator System will include the integration of these new indicators. As far as the current monitoring indicators are concerned, no quantified targets have

been set so far that would enable an assessment of the time series. The assessment is limited to the outcomes of a statistical trend analysis, and an appraisal of whether the trend basically aligns with the DAS goals. However, a negative or positive value judgement of trends does not seem meaningful in all cases, as the consequences of the changes observed are not always fully known. For example, an earlier flowering of winter rapeseed as a consequence of climate change does indicate that climate change impacts agricultural cultivation. However, the earlier flowering is not in itself necessarily a positive or negative phenomenon as it is part of ecological relationships and dependences. In cases of this kind, the finding is restricted purely to the outcome of the trend analysis, and is not subjected to a value judgement.

In the statistical trend analysis, the time series were classified in terms of the trends they bring to light. Each trend analysis was carried out using the same statistical process for all indicators. The methodology underlying the 2019 Monitoring Report was further developed. The analysis was applied to both linear (upward and downward) trends, and to trends with trend reversal (square trends) respectively. Trend reversal is useful – especially when observing extended time series – for describing trends that started out as negative but, owing to successful adaptation measures, have recently become positive, or vice versa. The analysis of linear trends is carried out for all-time series from 7 data points onwards, whilst for square trends, it is carried out from 13 data points onwards. In the process of trend analysis, all data points of the available time series are included. Any data series with too few data points or which are based on data collection procedures that are irregular or too far apart in time are eliminated from the analysis. In addition, a statistical change point analysis is now carried out additionally for data series with at least 30 data points. This type of analysis examines time series for any significant discontinuities or changes in the trend. Basically, all data points of a time series are always included in the trend analysis. In cases where indicators generate time series of different lengths, it follows that a comparison of the trends obtained is limited by this fact. For details on the methodology of trend analysis, please consult the "Organisation Manual for DAS Monitoring".

3.G Information related to averting, minimising and addressing losses and damage associated with climate change impacts

Averting, minimising and addressing loss and damage associated with climate change impacts requires a comprehensive approach that includes complementary activities such as reducing greenhouse gas emissions, comprehensive risk prevention and strengthening resilience and adaptive capacities, including such for managing losses and damages that occur.

Germany's activities to reduce greenhouse gas emissions and adapt to the consequences of climate change as part of a precautionary climate change adaptation strategy also target issues such as averting, minimising and addressing with loss and damage associated with climate change impacts. Information on these topics is already covered in the previous sections.

3.H Collaboration, best practices, experiences and lessons learned[101]

The DAS is evidence of the Federal Government's commitment to active management of adaptation to the impacts of climate change. It provides the strategic framework for the Federal Government's policy instruments and measures and helps to mainstream adaptation in all realms of society and among the relevant stakeholders. The DAS thereby makes a key contribution to fulfilment of Germany's commitments under the UN Paris Agreement (COP 21, 2015) and to implementation of the 2030 Agenda for Sustainable Development.

The DAS has also succeeded in combining and focusing the activities and capabilities of the Federal Government's ministries and other stakeholders in the public and private sectors. This has enabled integrated consideration of climate change adaptation, with the DAS becoming a key element in various policy fields and action areas. This is also due to the constructive collaboration between the Federal Ministries and their subordinate agencies within the Interministerial Working Group on Adaptation to Climate Change (IMAA) and the federal authority climate adaptation network, as well as the relevant joint federal/Länder bodies.

Consequently, in this 20th legislative term, alongside ambitious climate change mitigation the Federal Government has taken up adaptation to the impacts of climate change as a central challenge. It has created a new, binding basis for this in the Federal Climate Adaptation Act, which entered into force on 1 July 2024. This Act obligates the Federation, Länder and municipalities nationwide to address the consequences of climate change and to identify adaptation measures. With the new, precautionary climate adaptation strategy currently under discussion, the Federal Government is therefore presenting for the first time a climate adaptation strategy with measurable targets – pursuant to Section 3 of the Federal Climate Adaptation Act – in its sphere of responsibility.

The DAS has become established on a permanent footing. Adaptation processes at all levels are being implemented continuously, while a need for strategic work remains. These activities need to be consolidated and expanded at a high level, and the capacities of stakeholders responsible for implementing adaptation measures need to be strengthened further.

3.H.1 Vision and goals of the DAS process

3.H.1.1 Specify vision and goals

Clear visions and verifiable goals facilitate efficient implementation of policy processes in society, politics and business. The aim of the DAS is to reduce the vulnerability of society, the economy and the environment to climate change impacts and to maintain and enhance their adaptive capacity. As part of the vision for a climate-resilient Germany, specific, transparent and verifiable climate adaptation targets for Germany will be stated for the individual action areas. The IMAA will identify the conditions under which these targets are achievable.

3.H.2 The enabling environment

Adaptation to climate change impacts requires an enabling environment so that the goals pursued by the DAS can be achieved. The key requirements include continuity of horizontal and vertical cooperation and coordination, identification of appropriate measures and appropriate provision of human and financial resources, while utilising synergies and avoiding duplication of structures and remaining within the bounds of the resources available within the individual ministry budget items. Efficient organisational structures must ensure the optimal use of these

[101] Source: 2020 Progress Report, pp. 44-51 et seq.

resources and involve the relevant stakeholders. The German Strategy for Adaptation to Climate Change has shown that coordinated action by the Federation, the Länder and the municipalities, each in their own spheres of responsibility, is the right approach to implement adaptation policies. This approach should be continued and intensified.

3.H.2.1 Continue to strengthen the legal basis for adaptation to climate change

Reviewing the legislation relevant to their areas of responsibility is one of the permanent core tasks of all government ministries. Much technical legislation – including that on land use, construction planning and urban development – already covers aspects of adaptation to climate change. In the next reporting cycle, the IMAA will highlight how adaptation aspects can be specified in more detail in other areas of legislation, which will have the effect of giving such aspects greater weight. Within the bounds of their individual responsibility, the ministries involved in the IMAA will also determine the scope for secondary legislation. Moreover, they will strengthen enforcement, in part by incorporating further precautionary aspects into the setting of standards. Moreover, the Federation and the Länder will continue to discuss how the framework for municipal adaptation can be strengthened so that precautions against climate risks are taken on the necessary scale in all parts of Germany.

3.H.2.2 Ensure that collaboration and networking is strategically oriented

At the following levels the Federation will further expand the existing structures for cooperation with the Länder, municipalities and other societal actors on the implementation of adaptation strategies and action plans:

Further develop cooperation between the Federal Government and the Länder: The Federation and the Länder are stepping up their already good cooperation in the field of adaptation and paying more attention to conflicts of use that arise from climate change impacts, for example in connection with water use and land use. To put Germany in a climate-resilient position with regard to sea level rise over the long term, the Federation and the Länder will draw up, in close consultation, a strategy for dealing with sea-level rise; in this strategy they will also consider the consequences for the inland parts of the country. In the light of this they will evaluate the special framework plan of the Federal/Länder Joint Task for the Improvement of Agricultural Structures and Coastal Protection: coastal protection measures in response to climate change (2009 – 2025); the subject of floods in inland areas also continues to need detailed collaboration with the Länder in the context of the National Flood Protection Programme (NHWSP).

Activate key adaptation actors and expand networks: As part of their usual administrative activities, the central DAS bodies – the IMAA and the federal authority climate adaptation network – assist key actors in devising and implementing networking activities in order to mainstream future adaptation to climate change in the regions and increase consideration of it across society. The Standing Committee on Adaptation to the Consequences of Climate Change (StA AFK) – a Federal/Länder body – makes an important contribution in this area. The IMAA is examining the extent to which – in the light of the availability of financial resources within the ceiling of individual budget items and in consultation with the Länder – collaboration with other actors can be stepped up, for example by setting up an annual municipal conference for the purpose of dialogue with the municipalities or a national climate preparedness congress for cross-disciplinary communication between policy-makers, administrations and the specialist community.

Advisory council on climate preparedness: The establishment of a council as an advisory body has already proved invaluable in other areas and has helped improve the involvement of civil society. The IMAA will therefore consider setting up an advisory council on climate

preparedness whose members could, for example, comprise representatives of municipal umbrella organisations, the academic community, associations and civil society (including voluntary positions). The advisory council's tasks will include regularly drawing up suggestions for the further development of adaptation policy on the basis of societal needs and scientific findings, and identifying relevant areas in which further research is needed.

Research and operational data services: Efficient, consistent and appropriate development and implementation of adaptation actions depends on robust knowledge of climate impacts, vulnerabilities, action options and the impact of adaptation measures. Closing knowledge gaps and ensuring up-to-date information on advancing climate change calls for further research, for example through research and development projects. Also required are operational data services such as the DAS "Climate and water" open service and the Climate Preparedness Portal KliVO. Research and operational data services need to be implemented, expanded and continued. The "Climate and water" open service is still in the establishment phase and has not yet reached its full potential. Building on research results and other available knowledge, the service will at operational level provide a permanent source of predictive and projection data and user-friendly services for the adaptation actions needed in Germany.

DAS reporting system and products: The IMAA will monitor the timing and interlinking of the German Adaptation Strategy's reporting system (monitoring report, vulnerability analysis, progress report). As part of this, the following will be considered: the steps in the climate adaptation policy cycle, and the opportunities to make greater use of the findings of the monitoring and evaluation processes, both in future action plans and in future DAS progress reports. The IMAA and the DAS monitoring coordination office at the German Environment Agency will draw up and implement a proposal for the future DAS reporting system.

3.H.3 Selecting measures

As the state of knowledge on risks and vulnerabilities improves, the impacts of climate change become increasingly evident and the allocation of resources becomes increasingly targeted, implementation of the DAS through concrete measures will move ever further into the spotlight. In this connection, the Federation has set a special priority.

3.H.3.1 Taking account of disparate social situations

The IMAA now gives greater consideration to the disparate adaptive capacities of different sections of society (differentiated according to low-income and affluent households, gender, age, etc.) and aligns the DAS instruments and measures in a more strategically targeted manner with the concrete adaptation needs of specific groups. This contributes to social equity and environmental sustainability.

3.H.3.2 The Federal Government's assessment of climate impacts and effectiveness

Within the scope of its constitutional competencies and available budgetary funds, the Federation will fulfil its leading role by doing more to implement necessary adaptation actions within its own sphere of responsibility. The ministries of the IMAA will strive to ensure that new strategies, measures and programmes and ones that are due for revision are examined to determine whether there are synergies in relation to adaptation, whether there are possibly conflicting objectives and how they can if necessary incorporate corresponding requirements.

The measures in the Adaptation Action Plan will in future be compiled in a more transparent and easily understood way by providing an estimate of the impact of measures wherever possible. As part of this approach, the measures to be drawn up through the federal authority climate adaptation network will be appraised on the basis of the urgent climate impacts and

requirements for action that arise from the climate impact and vulnerability analysis and of a criteria-based individual assessment that is to be drawn up. Wherever possible, these measures will be assessed in terms of their effectiveness and harmonised with other sustainability goals. The IMAA will coordinate a procedure for this.

To improve assessment of the overall impact of the DAS, the evaluation methodology will also be refined. This aspect will become increasingly important as implementation of the DAS proceeds. The IMAA will create the necessary prerequisites in early 2021 – in good time before the start of the next evaluation.

3.H.3.3 Measures by other actors

In order to enhance the effectiveness of the Federation's action planning, the instruments and measures of the Länder and other actors in Germany will in future be included in the Federation's action plans for information purposes; this will occur as necessary and in close consultation with the actors concerned. In order to make it easier for actors who have not yet addressed adaptation to climate change in any detail to make a start in this area, the possibility of including recommendations for municipalities will be considered in the DAS in close consultation with the municipal umbrella organisations.

3.H.4 Communication and participation

Responsibility for implementing measures in the field of adaptation to climate change does not lie solely with the Federation; the Länder and municipalities, the general public and businesses must also play their part in this task, which is for the whole of society. Active participation of all actors is necessary in order to address the appropriate (responsible) level in a given case and enable that level to identify the risks arising from climate change, assess their impact and take action where necessary.

3.H.4.1 Expanding participation and boosting private provision

In the context of the DAS process, the IMAA persistently seeks the participation of stakeholders on a broad basis. Through discursive participatory procedures and dialogue formats it will involve other stakeholder groups, such as organised civil society and business and industry, even more closely in order to align the Federation's activities with their needs and to trial and demonstrate examples of good practice at regional and local level.

One important aspect of adaptation is effective strengthening of private provision by citizens and businesses in areas outside the responsibility of the state. Private actors must therefore be informed about possible risks and enabled to take steps towards adaptation themselves. Many strategies and measures for adapting to climate change that lie within the decision-making scope of private households and businesses and are also in their own interest can usefully supplement – but not replace – state action to reduce the risks that arise from the impacts of climate change. Examples include implementing structural preventive measures against extreme weather events and natural hazards in buildings and commercial infrastructure, and taking out insurance against natural hazards. This requires the development of schemes tailored to specific target groups that address the particular factors determining private provision in these target groups and also take account of their economic situation.

The ministries represented in the IMAA will to this end expand their activities in the field of press and awareness-raising work. In addition, the German Environment Agency provides instruments that can be employed to systematically assess and review the effectiveness of the participatory procedures and formats used.

3.H.4.2 Specifically addressing decision-makers

A further factor determining the success of adaptation to climate change is the involvement of decision-makers and multipliers in areas such as public administration, agriculture and forestry, the fire service, associations and the private sector who frequently have to deal with climate change impacts. As a key basis for the implementation of adaptation measures, the ministries represented in the IMAA will accord high priority, within the scope of their competencies, to the communication of knowledge and appropriate training schemes for decision-makers. Regional events, competitions and sponsorship schemes that enable municipalities to offer mutual advice and support can create a targeted means of address and additional incentives for the municipalities.

The ministries represented in the IMAA will review the permanent funding of the German Climate Preparedness Portal (KliVO) to the end of 2022 and work closely with the subordinate agencies on adding to the content of KliVO.

Another communication instrument in the context of the DAS is the Blue Compass competition (www.umweltbundesamt.de/blauerkompass), which grants awards to outstanding climate adaptation projects, thus highlighting and upscaling concrete solutions. The IMAA aims to continue the competition on a two-yearly cycle and is exploring opportunities for permanent funding, primarily through the Federal Environment Ministry's departmental budget.

3.H.4.3 Permanent continuation of consultation

Consultation with the Länder, municipal umbrella organisations, economic, environmental and social associations and other civil society organisations on the progress reports will be established as a fixed component of the DAS process and in particular of the progress report.

3.H.5 Germany's support to developing countries[102]

Germany is strongly committed to supporting implementation of the 2030 Agenda for Sustainable Development in developing countries and emerging economies. German development cooperation has traditionally focused on environmental issues. Within the BMZ 2030 reform process launched in 2020, Germany further sharpened its commitment to tackle climate change and promote environmental protection. "Forging ahead with the Just Transition" is one of four priority areas of Germany's development policy (BMZ, 2023[120]). In terms of geographic focus, the BMZ recently reduced the number of partner countries from 85 to 65, while maintaining a strong focus on Africa and Asia (OECD, 2022 [121][103]).

Germany recognises that the 2030 Agenda and the Paris Agreement are intrinsically linked. In response, with other members of the OECD Development Assistance Committee (DAC), it committed to coordinate development approaches with international climate and environment objectives through a member-driven process. In line with the OECD-DAC Declaration of 2021, Germany aims to align its Official Development Assistance (ODA) with the goals of the Paris Agreement (OECD, 2021[122][104]). It supports developing countries' efforts to fight climate

102 The text of this sub-chapter is taken from the latest OECD Environmental Performance Review: Germany 2023, pp.142-145. For further details please refer to https://www.oecd.org/en/publications/oecd-environmental-performance-reviews-germany-2023_f26da7da-en.html

103 OECD (2022), *Development Co-operation Profiles: Germany*, https://doi.org/10.1787/0079f636-en (accessed on 14 March 2023).

104 OECD (2021), OECD DAC Declaration on a new approach to align development cooperation with the goals of the Paris Agreement on Climate Change.

change, biodiversity loss and environmental degradation by channelling a substantial part of its ODA to these purposes (OECD, 2021[105]).

With total ODA (US$32.2 billion, preliminary data) representing 0.74% of gross national income, Germany is the second largest bilateral provider of ODA (OECD, 2022[121])[106]. This reflects a large increase in ODA, more than double the amount spent a decade ago (US$12.7 billion in 2010) (OECD, 2012[123][107]). It also makes Germany the largest provider of environment- and biodiversity-focused ODA globally (Figure 2.12). According to the Rio Markers, about 37% of Germany's bilateral ODA had an environmental focus in 2019-2020, with about 16.8% spent on climate mitigation; 13.1% on climate change adaptation; and 10.8% on biodiversity (OECD, 2022[121][108]). Germany has also been the largest donor of the Adaptation Fund, a key multilateral instrument for climate adaptation financing. The OECD provides a comprehensive development co-operation profile of Germany, which is updated annually (OECD, 2022[121][109]).

The Federal Government aims to scale up its international climate finance to reach €6 billion annually by 2025, helping to meet the collective US$100 billion goal. This target was reached early in 2022 with the provision of €6.28 billion (US$6.61 billion). The country is also working towards increasing the amount of finance committed to nature: Germany has pledged to reach €1.5 billion annually for international biodiversity conservation, beginning in 2025. This commitment, made on the sidelines of the 77th General Assembly of the United Nations in September 2022, would amplify the upward trend for biodiversity funding. It would more than double the average amount provided between 2016 and 2021 (Figure 2.13). Apart from budgetary sources, Germany also mobilises capital market funds and private climate finance. Germany's total contribution of climate finance is estimated at about €8.1 billion in 2021 (Federal Foreign Office, 2022[124][110]), the amount for 2022 at €9.97 billion.

While the BMZ develops strategic orientations of Germany's development cooperation policy and oversees ODA reporting, two specialised agencies manage implementation of bilateral ODA. GIZ oversees Financial Cooperation and KfW (comprising KfW Development Bank and the DEG, the development finance institution) manage financial cooperation (OECD, 2022[121][111]). Together, the two institutions deliver most of the bilateral cooperation projects in collaboration with partner countries' governments and other key stakeholders. In addition, Germany's International Climate Initiative (IKI) (Box 2.6) plays a key role in funding international climate action and biodiversity conservation. To a lesser extent, other ministries, including BMUV or BMEL, also contribute to adaptation action in other countries through a mainstreaming approach (Bundesregierung, 2020[40][112]). Engaging with local partners and beneficiaries is also a key factor in many GIZ projects to ensure alignment and sustainability. Moreover, Germany

[105] OECD (2021), Integrating Environmental and Climate Action into Development Co-operation: Reporting on DAC Members' High-Level Meeting Commitments, OECD Publishing, Paris, http://dx.doi.org/10.1787/285905b2-en

[106] OECD (2022), Development Co-operation Profiles: Germany, https://doi.org/10.1787/0079f636-en (accessed on 14 March 2023).

[107] OECD (2012), OECD Environmental Performance Reviews: Germany 2012, OECD Publishing, Paris, https://www.oecd-ilibrary.org/environment/oecd-environmental-performance-reviews-germany-2012_9789264169302-en

[108] OECD (2022), Development Co-operation Profiles: Germany, https://doi.org/10.1787/0079f636-en (accessed on 14 March 2023)

[109] [109] OECD (2022), *Development Co-operation Profiles: Germany*, *https://doi.org/10.1787/0079f636-en* (accessed on 14 March 2023)

[110] Federal Foreign Office (2022), *Where does the world stand on climate finance?*, https://www.auswaertiges-amt.de/en/aussenpolitik/themen/climate-finance-deliveryplan/2560814#:~:text=Germany%20is%20making%20its%20contribution,to%20adapt%20to%20climate%20change. (accessed on 7 April 2023)

[111] OECD (2022), *Development Co-operation Profiles: Germany*, https://doi.org/10.1787/0079f636-en (accessed on 14 March 2023)

[112] OECD (2021), "Key findings from the update of the OECD Green Recovery Database", OECD Policy Responses to Coronavirus (COVID-19), 30. September, OECD Publishing, Paris, http://dx.doi.org/10.1787/55b8abba-en

supports a large number of multilateral organisations and initiatives, including the work of various OECD bodies (e.g. DAC, OECD Development Centre).

3.H.5.1 Germany's International Climate Initiative

Germany's International Climate Initiative (IKI) is a key instrument of the Federal Government for funding international climate action and biodiversity conservation. Since 2008, it has supported developing countries in formulating and implementing their respective Nationally Determined Contributions under the Paris Agreement. The IKI has four major funding areas:

- Mitigation of greenhouse gas emissions
- Adaptation to the impacts of climate change
- Conservation of natural carbon sinks with a focus on reducing emissions from deforestation and forest degradation (REDD+)
- Conservation of biological diversity.

IKI uses idea competitions to select innovative projects. The process is open to non-governmental implementing organisations, which can apply for funds. IKI approved €5 billion for more than 950 climate and biodiversity projects in over 150 countries between 2008 and 2021. Overall, Germany's assistance through IKI has been well targeted to countries most vulnerable to climate risks. As of 2022, three different ministries (BMUV, BMWK and the Federal Foreign Office) co-manage IKI. It will therefore be important to align priorities, ensure policy coherence and avoid increased administrative costs.[113]

For many years until now, Germany has contributed to the implementation of the Paris Agreement by supporting partner countries in formulating and implementing Nationally Determined Contributions (NDCs), long-term strategies, resilience plans and National Adaptation Plans (NAPs) under the umbrella of the NDC Partnership. It has supported the NAP Global Network for nearly one decade, and continues to do so. Germany also collaborates with the Vulnerable Twenty Group of countries (V20) and the Africa Adaptation Initiative. In addition, it is a member of the Coalition for Disaster Resilient Infrastructure and the Adaptation Action Coalition. Many other projects and policy dialogue platforms contribute to advancing Germany's global climate agenda, including the International Climate Club, which was initiated by Germany within its G7 presidency.

Germany is committed to promoting a just energy transition and supports several long-term Just Energy Transition Partnerships to support the decarbonisation efforts of emerging economies (e.g. Indonesia, South Africa). Germany is also working closely with partners to establish a complementary, coherent and coordinated support system to better manage losses and damages caused by climate change. Besides the COP27 Loss and Damage Fund, this also includes the Santiago Network for Technical Assistance, for which Germany pledged €10 million in 2021, as well as other initiatives outside the climate negotiations that are already successfully supporting climate risk hedging and preparedness, and the expansion of early warning systems. One example is the Global Shield against Climate Risks, launched in partnership with the V20.

In the area of NbS, the BMZ allocates funding through bilateral projects and supports international initiatives such as the Legacy Landscapes Fund, the Blue Action Fund, the Global Fund for Coral Reefs, the African Forest Landscape Restoration Initiative (AFR100) and the Alliance for Development and Climate. In 2002 it also launched a new initiative on "Restoration of Ecosystems and Nature-based Solutions".

[113] Source: IKI: www.international-climate-initiative.com

4 Financial support and technology cooperation

4.A National circumstances and institutional arrangements

Climate, energy and supporting just transitions are core aspects of Germany's development and climate cooperation. Therein, climate and environmental safeguard checks are commonly used instruments to ensure that climate aspects are considered and addressed throughout project implementation and to identify additional climate potential of projects.

There are different systems for the classification of countries as "developing countries". Under UNFCCC, contributions to non-Annex I Parties are reportable as climate finance, while under the EU Governance Regulation, contributions to all ODA-eligible countries, including Annex-I-Parties, can be reported as climate finance. The German climate finance is reported accordingly under the respective regimes. Germany has been a strong advocate and supporter of concrete bilateral and multilateral measures of aligning public finance institutions with the goals of the Paris Agreement. For example, together with like-minded shareholders, Germany critically assesses MDBs' efforts towards their Paris alignment and requests that MDBs set ambitious climate finance targets. Through its voting behaviour on projects and strategies and through political dialogue with MDBs, Germany seeks to increase support for the long-term goals of the Paris Agreement

The climate targets of the Paris Agreement cannot be achieved through public investments alone. Against this backdrop, it is important to systematically mobilise private sector investment. However, macroeconomic, political and regulatory risks often make private investment in climate change mitigation and adaptation in developing countries and emerging economies structurally unattractive. Innovative Development Finance Mechanisms (InnoFins) can help to mitigate these risks and promote private investment in climate change mitigation and adaptation in developing and emerging countries, especially at local level. Policy-based lending (linking development loans to the implementation of reform projects), carbon pricing mechanisms (to internalise the external costs of CO2 emissions, to promote investment in low-carbon technologies, etc.), the issuance of sustainable bonds (e.g. green bonds), debt-for-climate swaps (debt relief in exchange for investments in environmental protection), guarantees (to shift investment risks) or instruments to hedge currency risks (local currency financing) are relevant tried and tested instruments in the context of German development cooperation. However, these cannot replace systemic approaches and structural reforms of the financial sector in and for developing and emerging countries. It is therefore important to make global finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development (in accordance with article 2.1c of the Paris Agreement).

KfW Development Bank as well as KfW subsidiary DEG calculate the private finance mobilised through their interventions in alignment with the methodologies developed by the OECD. Please see Annex 6 of the OECD Converged Statistical Reporting Directives for the Creditor Reporting System (CRS) and the Annual DAC Questionnaire[114] for detailed information regarding individual instruments.

[114] DCD/DAC/STAT(2020)44/ADD1/FINAL: https://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=DCD/DAC/STAT(2020)44/ADD1/FINAL&docLanguage=En

4.B Underlying assumptions, definitions and methods

Annex III Tables III.1, III.2 and III.3 of the 1st Biennial Transparency Report cover climate financing provided in the calendar years 2021 and 2022. All figures are in Euros and US-Dollars. The conversion is based on OECD reference exchange rates for 2021 and 2022. The OECD and the UNFCCC allow for reporting Parties to calculate climate finance according to their own methods aligned with the methodologies laid out by OECD and UNFCCC.[115]

To calculate Germany's climate finance contributions in accordance with Germany's calculation methodology, bilateral amounts are reported as commitments (categorisation as bilateral or multilateral in accordance with DAC "Converged statistical reporting directives for the creditor reporting system (CRS) and the annual DAC questionnaire – 2018"). Multilateral flows are reported as disbursements.

German bilateral development financing uses both grants and different types of concessional loans, all of which qualify as Official Development Assistance (ODA). The ODA requirement states that loans need to be concessional (meaning that they are offered below market rates). Germany calculates the climate-specific amount of its bilateral measures using the OECD's Rio markers for climate change mitigation and climate change adaptation.[116] The OECD DAC Rio Markers for Climate – Handbook serves as a guiding document for applying the Rio Markers.

In Annex III Table III.1, Germany indicates in the column "additional information" if a project targets adaptation/mitigation as a significant or principal goal. Projects that are classified as "cross-cutting" and show the attribute "significant objective" in the column "additional information" are 100% climate relevant because they have a Rio marker score of 1 for both mitigation and adaptation. Regarding multilateral climate finance (Annex III Table III.2), contributions to climate-specific multilateral funds and programmes are considered to be "climate-specific".[117]

In addition, the German methodology on climate finance reporting distinguishes between public climate finance from budgetary sources and mobilised public climate finance. Budgetary funding reported by Germany is provided mainly in the form of grants including interest subsidies for development loans provided by KfW while public mobilised climate finance are mainly concessional loans. In addition, Germany has also provided some equity investments, composite loans as well as direct investments in form of equity or senior debt/ mezzanine and syndicated loans.

Germany provides detailed (project level, as far as possible) information on its bilateral public climate finance. In cases where development loans are subsidised by budgetary sources, those budgetary sources are subtracted from the face value of the loan and reported in total per region, broken down into adaptation, mitigation and cross-cutting in the column "Committed amount". Germany has also calculated the grant equivalent of its bilateral development loans. These grant equivalents are shown as a total per region, broken down into adaptation, mitigation and cross-cutting in the column "Grant equivalent". The reporting of the grant equivalent is an additional item of information. The amounts displayed in the column "Grant equivalent" cannot be added up with the other amounts reported. It is for reasons of banking confidentiality that neither interest subsidies nor grant equivalents can be reported individually on project level.

[115] https://data.oecd.org/conversion/exchange-rates.htm

[116] https://www.oecd.org/dac/environment-development/Revised%20climate%20marker%20handbook_FINAL.pdf

[117] https://www.oecd.org/dac/financing-sustainable-development/development-finance-topics/climate-change.htm

In addition, Germany provides concessional loans and other concessional debt instruments for the implementation of mitigation and adaptation measures via KfW Development Bank and its subsidiary DEG. The German government generally provides these loans on highly concessional terms. Such concessional debt instruments account for around one third of climate finance provided by Germany as a whole. Germany subsidises the interest rates of development loans, meaning that these loans are highly concessional.

Concessional debt instruments are only used for measures that are economically viable – such as the expansion of renewable energies – and therefore the recipient's capacity to repay the loan can be ensured. This is key to avoiding market distortions. The repayment requirements are taken into account when designing the instruments. This shows that Germany bases the decision on the appropriate financial instrument (grant or loan) on sector-specific circumstances and country-specific needs. KfW development and promotional loans are only provided to countries with sustainable debt levels.

Germany provides information on sectors and sub-sectors in accordance with OECD-DAC CRS codes, wherever available. If several (sub)-sectors apply, Germany's current practice is to report up to a maximum of four (sub-)sectors.

To avoid double counting, several measures are taken:

In case of development loans, interest subsidies are deducted from the face value of the loans. Interest subsidies are reported separately and shown as a total per region, broken down into adaptation, mitigation and cross-cutting. Annex III Table III.3 (Information on financial support mobilised through public interventions) includes a column to report on the "amount mobilised" (private finance) as well as on the "amount of resources used to mobilise the support" (public finance). As the latter is also included in Annex III Table III.1, a corresponding comment is included in the column "additional information". Germany does not contribute climate finance that could collide with finance related to Art. 6 of the Paris Agreement.

KfW Development Bank as well as KfW DEG calculate the private finance mobilised through their interventions in alignment with the methodologies developed by the OECD. Please see Annex 6 of the OECD Converged Statistical Reporting Directives for the Creditor Reporting System (CRS) and the Annual DAC Questionnaire[118] for detailed information regarding individual instruments.

Private climate finance mobilised by Germany currently consists of direct investments in companies, syndicated loans, direct investments in companies/Special Purpose Vehicles (SPVs) and co-finance. Germany aims to increasingly mobilise (non-budgetary) public and private climate finance by providing concessional loans and by refinancing local banks in developing countries to help provide climate-relevant financing products, developing structured funds, climate risk finance and insurance schemes, other de-risking instruments, as well as equity participation. Private finance will continue to be mobilised using a two-step approach: Firstly, by directly mobilising private climate finance for mitigation and adaptation measures (e.g. through public co-financing). In this context, we consider it a great obstacle that many efficient innovative financing instruments are not ODA-eligible as well as guarantees – cannot be reported as ODA. This hampers and disincentives private sector financing. Secondly, Germany supports partner countries in designing, implementing and financing enabling environments for private investment in mitigation and adaptation measures, creating capacities that will enable institutions to develop financial products and build a portfolio over the long term.

[118] DCD/DAC/STAT(2020)44/ADD1/FINAL, https://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=DCD/DAC/STAT(2020)44/ADD1/FINAL&docLanguage=En

Germany recognises the principle of common but differentiated responsibilities and respective capabilities, in the light of different national circumstances, acknowledging that developed nations historically contributed more to greenhouse gas emissions and have greater financial capacities. As outlined in Art. 9.3 of the Paris Agreement, as part of a global effort, developed countries should continue to take the lead in mobilising climate finance from a wide variety of sources, instruments and channels, noting the significant role of public funds. Loans, in particular of concessional nature, constitute a relevant instrument for the support provided from developed countries to developing countries.

Germany follows the Standing Committee of Finance's (SCF) definition of climate finance: "Climate finance aims at reducing emissions and enhancing sinks of greenhouse gases and aims at reducing vulnerability of, and maintaining and increasing the resilience of, human and ecological systems to negative climate change impacts." (Standing Committee on Finance (2014): Biennial Assessment and Overview of Climate Finance Flows Report). Germany defines new and additional climate finance as having been newly committed or disbursed (as applicable) in the respective reporting year. In its climate finance reporting, Germany provides information only on resources newly committed or disbursed. Thus, all climate finance reported in the Annex III Tables III.1, III.2 and III.3 is new and additional and reflects only data for the reporting year in question. In accordance with the UNFCCC convention and the context of this report, "developing countries" are defined as non-Annex I countries.[119]

Germany sees multilateral finance as an important pillar to reach the goals of the Paris Agreement. Multilateral finance reported is based on the inflow contribution to multilateral institutions. Contributions to climate-specific multilateral funds and programs are considered to be climate-specific. The climate-specific share of multilateral development banks and the Global Environment Facility (GEF) is calculated using imputed climate relevant shares according to the OECD methodology. Contributions to other multilateral bodies are generally calculated using Rio Markers. Multilateral finance is only reported as core/general for the GEF, the World Bank (IDA), the African Development Fund, the Asian Development Fund, and the International Fund for Agricultural Development (IFAD). However, core/general amounts are not used for the calculation of climate-specific finance. In the above-mentioned cases, the climate-specific shares are instead calculated using the imputed climate relevant shares according to the OECD methodology. As a major provider of climate finance, Germany reports its contributions autonomously. As mentioned above, multilateral finance is reported based on an imputed share of inflow contributions to multilateral institutions. No multilateral climate finance is attributed externally to Germany.

Technology transfer and capacity building are components of virtually all bilateral cooperation projects and cannot be categorised separately. Germany uses a range of international cooperation instruments and institutions to build capacities at the individual, institutional and systemic level in the areas of climate and development. Germany is involved in capacity building through bilateral and multilateral cooperation as well as various partnerships with the private sector, academia, and civil society. Concretely, Germany provides comprehensive capacity building measures in the areas of GHG neutrality, adaptation, technology development and transfer, and access to climate finance, as well as in other specific sectors and cross-cutting aspects such as reporting, to support partner countries in the effective implementation of the UNFCCC and the Paris Agreement. The support measures for capacity building are designed to be context-specific, results-based and consistent with national priorities.

[119] https://unfccc.int/process/parties non party stakeholders/parties convention and observer states?field_national_communications_target_id%5B514%5D=514

With regard to climate technology, the areas low-emission energy services, green hydrogen, climate-smart cities and resilient rural development are of particular relevance in German development cooperation.

4.C Information on financial support provided and mobilised under Article 9 of the Paris Agreement

4.C.1 International climate finance

4.C.1.1 General principles and assumptions

Commitments to climate action go hand-in-hand with commitments to development. With regard to supporting developing, emerging and transition countries in climate-change adaptation and mitigation, Germany considers implementation of the Paris Agreement and the 2030 Agenda to be closely linked. The impacts of increasing climate change are directly affecting the living conditions and development opportunities of all people. It is imperative that growth and development strategies include greenhouse gas neutrality and decarbonisation of the economy.

4.C.1.2 Overview of international climate finance, 2021–2022

The Federal Government continues to be in favour of ambitious financial support for developing, emerging and transition countries, for reduction of GHG emissions, and adaptation to the impacts of climate change, and is working to promote a just transition in these areas.

In 2021, Germany's international climate finance from budgetary resources amounted to about €5.22 billion / US$6.14 billion. The volume of grant equivalents in 2021 amounted to about €583 million / US$687 million. In addition, the public climate finance mobilised by KfW Development Bank and DEG amounted to about €2.59 billion / US$3.05 billion. As a result, public climate finance provided a total sum of about €7.78 billion / US$9.16 billion. The private climate finance mobilised through public-sector funding amounted to about €170 million /US$200 million in 2021.

In 2022, Germany provided budgetary resources amounting to €6.28 billion / US$6.61 billion for international climate finance. The grant equivalents of KfW development loans recorded since 2017 totalled €652 million / US$686 million in 2022. In the same year, in addition to the budgetary resources and grant equivalents provided, a total of €3.09 billion / US$3.25 billion of public climate finance mobilised from capital-market funds was committed through KfW Development Bank and DEG (Deutsche Investitions- und Entwicklungsgesellschaft mbH). The total public climate finance provided amounted to around €9.30 billion / US$9.79 billion. Again, in the same year, private climate finance to the tune of €476 million / US$500 million was mobilised through the use of public funds via KfW and DEG.

In addition, funding of approx. €118 million / US$139 million was provided in 2021 to Annex I countries receiving Official Development Assistance (ODA) – Ukraine, Turkey and Belarus. In 2022, funding for Annex I countries amounted to about €103 million / US$108 million.[120] These amounts are not included in the aggregated climate finance figures given in the report. The total German contribution from all sources thus amounted to around €8.1 billion / US$9.53 billion in 2021 and around €9.96 billion / US$10.48 billion in 2022. Germany is thus contributing a substantial share of around 10% to the existing collective annual US$100 billion target for international climate finance

Since 2005, Germany has increased its financial contribution to international climate finance from budgetary resources more than tenfold. This reflects the ambitious goals being set by the

[120] The total amount includes multi-country projects amounting to some €32 million/US$38 million (2021) and around €67 million/US$71 million (2022), in which one or more of the Annex 1 countries Ukraine, Turkey or Belarus are listed as recipient countries.

ministries allocating funding, as well as the success achieved in bringing climate issues into the mainstream of German development cooperation.

4.C.1.3 Instruments, institutions and initiatives for Germany's international climate finance

Germany's focus for international climate finance is primarily on bilateral cooperation. In 2021-2022, this accounted for over 80% of the budget funds used for international climate finance (including grant equivalents). These funds were implemented in particular by GIZ as part of Technical Cooperation and by KfW as part of Financial Cooperation.

Besides bilateral channels, a large proportion of public climate finance is provided through multilateral cooperation, which is realised through the International Climate Initiative (IKI) and in particular through contributions to multilateral climate funds such as the Green Climate Fund (GCF), the Climate Investment Funds (CIFs), the Adaptation Fund (AF), the Global Environment Facility (GEF), as well as cooperation with multilateral development banks (MDBs) and specialised agencies of the United Nations.

4.C.1.4 Methodology used to measure Germany's international climate finance

Germany attaches great importance to measuring and communicating its climate finance transparently and comprehensively. For this reason, Germany is reporting bilateral climate finance in Annex III Table III.1 on a project-specific basis, in order to describe the individual projects in as much detail as possible. Furthermore, supplementary information on the projects in question is provided on the websites of the responsible ministries BMZ[121], BMUV[122], BMWK, AA and BMBF[123]. The projects of the International Climate Initiative (IKI), which have been implemented since 2022 by the Federal Ministry for Economic Affairs and Climate Action (BMWK), in close cooperation with the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) and the Federal Foreign Office (AA), are presented on the joint IKI website[124].

The calculated climate finance is comprised of new bilateral commitments or funds disbursed to multilateral institutions in the 2021-2022 reporting year. All newly committed funding and newly disbursed funding in the reporting year falls within the category "new and additional". Consequently, all of the climate finance reported in Annex III tables III.1, III.2 and III.3 is new and additional.

Since 2013, Germany has reported on all of its public climate finance, including mobilised public climate finance. Since 2015, mobilised public climate finance has been reported on a by-project basis.

Germany distinguishes between three sub-categories of climate finance:

a) Climate finance from budgetary sources, including grant equivalents of KfW development loans**:** Climate finance provided from the public budget is recorded in this category. Since reporting year 2017, grant equivalents of development loans are also documented and reported. The term "grant equivalent" refers to the difference between the nominal value of a loan and the cash value of the pertinent debt service (repayment and interest payments, discounted at the discount rates defined by the Development Assistance Committee (DAC) of the Organisation for Economic Co-operation and Development (OECD)). A grant equivalent is thus a calculatory value used in quantifying the value of a discount on a concessionary loan. To prevent double-crediting,

[121] https://www.bmz.de/en/development-policy/climate-change-and-development/climate-financing
[122] This ministry was formerly called the "BMU". In the report, its current designation "BMUV" is used, regardless of when initiatives take place. https://www.international-climate-initiative.com/en/search-project/
[123] https://www.fona.de/en/
[124] https://www.international-climate-initiative.com/en/search-project/

grant-equivalents are deducted from foreign loans among KfW's development loans (see category b). Since the interest subsidies coming from budgetary resources used to leverage KfW development loans are given in aggregated form, per region[125] , the subsidies are deducted from the grant equivalents. In addition, since reporting year 2014 multilateral contributions to the climate funds and MDBs are measured with the Imputed Climate Relevant Contributions approach in keeping with the methods developed by the OECD "Joint ENVIRONET and WP-STAT Task Team to Improve Rio Markers, Environment and Development Finance Statistics" (JTT).

b) **Mobilised public finance** is climate-relevant loan financing from KfW Development Bank and DEG. This predominantly comprises finance flows that are eligible as Official Development Assistance (ODA), usually in the form of concessional loans.

c) Private climate finance mobilised through public funding: In 2021 and 2022, the private climate finance mobilised by the Federal Government comprised in particular revolving lines of credit granted to local (development) banks; holdings of structured funds; and public-private partnerships. Germany reports mobilised private climate finance for the areas and financing instruments for which agreed OECD reporting methods are available. Both DEG and KfW Development Bank use such methods in calculating mobilised private finance.

To record climate finance transparently, since reporting year 2011 Germany has used the OECD Rio marker system. This system draws a distinction between climate change mitigation and climate change adaptation. Also, additional information must be provided as to whether climate change mitigation or climate change adaptation is a principal objective (RM score of 2) or a significant objective (RM score of 1) of the measure. If a project has a score of 1, 40% of the project budget is credited; if it has a score of 2, 100% is credited. Budgets of projects that are "cross-cutting" in that they target both climate change mitigation and climate change adaptation, as either a significant objective or a principal objective, are also credited at a level of 100%. To prevent double-counting, when applying the Rio marker system to its project, Germany uses the "sum rule" whereby the sum total of a project's Rio marker scores may not exceed 2.

The Federal Government's bilateral cooperation projects almost always include technology-transfer and capacity-building components, and they often apply a cross-cutting approach. To date, no official markers for capacity building or technology transfer have been defined. Consequently, such aspects of measures cannot be separately listed.

For all climate-relevant bilateral development cooperation projects, the statistical information given in the attached CTF tables Annex III Table III.1, Table III.2 and Table III.3 includes the public-budget funding that was committed in the relevant year. Multilateral contributions to climate finance were included as disbursements. Mobilised public financing, i.e. climate-relevant loan financing from KfW Development Bank and DEG, is also reported as finance commitments.

4.C.1.4.1 Support for Nationally Determined Contributions and the NDC Partnership

Through a range of measures by various ministries, the Federal Government is supporting the implementation of planned Nationally Determined Contributions (NDCs) in the partner countries, which were agreed to by the Parties to the Paris Agreement. In recent commitments in Germany's climate-related development cooperation, NDCs were a central reference point.

In order to quickly and effectively commence the implementation of the NDCs and contribute to raising climate ambition, Germany, in conjunction with the Moroccan COP Presidency, other industrialised countries and developing countries and various international organisations,

[125] Based on the funding regions for the BMZ's bilateral cooperation in Asia, South-Eastern Europe/Caucasus, Latin America and the Caribbean, Middle East and Africa

launched a global partnership to promote the implementation of NDCs at the end of 2016 (the NDC Partnership – NDCP)[126]. The aim of the partnership is to support developing countries in bringing together their NDCs and Sustainable Development Goals (SDGs), and to help in deploying the respective bilateral and multilateral donor programmes in a more coordinated way for implementation. The NDC Partnership[127] is in principle open to all countries and international organisations that support its objectives and principles.

Since the partnership was founded, Germany has been the largest contributing bilateral donor and is also strategically involved in the NDCP as a member of the steering committee. This multilateral partnership continues to develop in a very dynamic way: To date, a total of 129 countries, 57 international organisations and development banks, and 41 associated members have jointed the Partnership.[128]

In the reporting period, in-country implementation in the framework of the NDC Partnership has begun in 79 member countries[129] and in three regional initiatives. The aim of these efforts is to prepare national partnership plans that organise NDC priority activities, and match them with NDC Partnership member support and in-country stakeholders. The plans and their preparation provide an opportunity for improving a) cooperation between in-country stakeholders, for prioritisation of national climate targets, and b) coordination of donors. As of the end of 2022, such partnership plans, which operationalise NDC implementation and address priority requirements of partners, had been prepared in a total of 44 countries.

Between 2019 and 2022, donors and implementation organisations (a total of 40) working via the NDC Partnership's Climate Action Enhancement Package (CAEP), have supported 67 countries in revising their climate targets and making them more ambitious. Such support is provided either directly by the Partnership's members or via a central Technical Assistance Fund (TAF). Germany supported CAEP directly in 26 countries through various implementing organisations, and participated in the TAF.

In June 2020, the NDCP launched the Economic Advisory Initiative, which is aimed at supporting sustainable, climate-friendly recovery and rebuilding in the wake of the COVID-19 pandemic. As of July 2022, the initiative had enabled the short-term deployment of embedded economic advisors in finance and planning ministries in 30 member states and the African Union. The embedded economic advisors supported the creation of climate-sensitive and sustainable economic stimulus packages. Germany is supporting the deployment of advisors in 26 countries.

Besides aligning its International Climate Initiative (IKI) and climate-relevant bilateral development cooperation with the NDC Partnership Plans, the Federal Government has provided financing contributions in direct support of the Partnership. During the reporting period, the BMZ financed the World Bank Climate Support Facility (successor to the NDC Support Facility), GIZ NDC Assist, WRI, the UNDP NDC Support Programme/Climate Promise, and WWF, in order to provide rapid and flexible technical support at country level in the context of the NDCP. To provide organisational support for the Partnership, Germany, in cooperation with other donor countries, is financing a secretariat for the NDC Partnership – the Support Unit.

The NDC Assist project is a concrete contribution by Germany to the NDC Partnership. As part of the "Capacity Building Project" component it builds strategic capacity for the use of Article 6.

[126] https://ndcpartnership.org/

[127] These include: support country-driven processes, promote long-term climate action, enhance efficiency and responsiveness, build in-country capacity, improve coordination, enhance integration into national planning, advance adaptation and mitigation, align development and climate change, support multi-stakeholder engagement, promote gender equality.

[128] http://www.ndcpartnership.org/members - as at August 2024

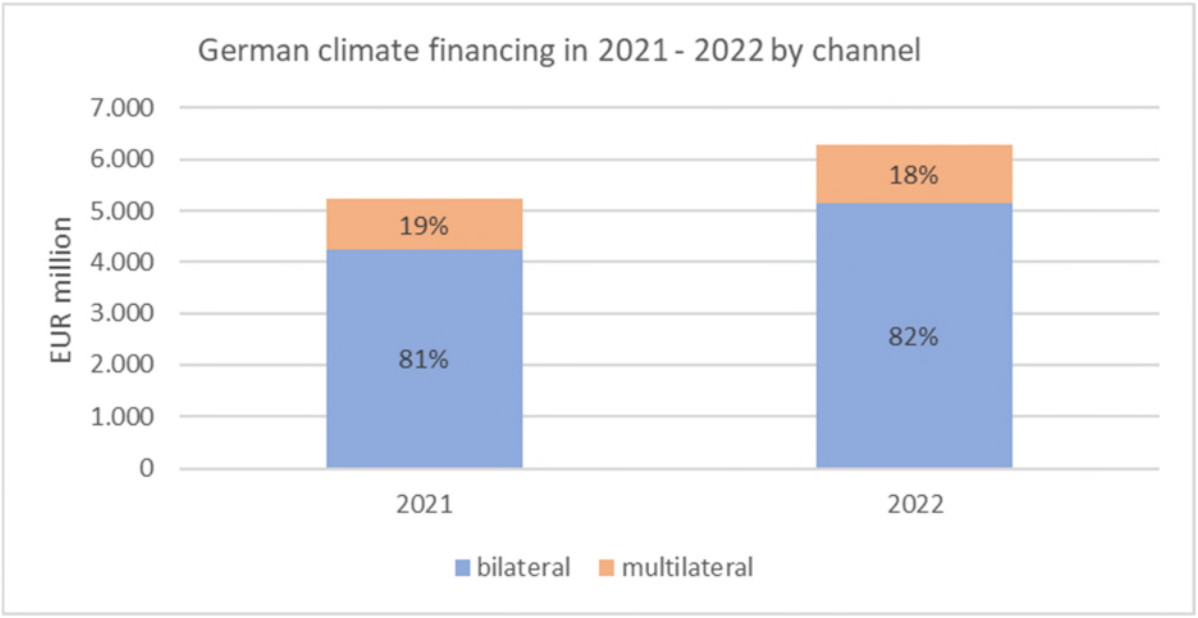
[129] Country Engagement | NDC Partnership

Employees in lead ministries and downstream authorities and institutions receive technical and methodological advice on developing decision-making principles or strategic guidelines to enable fact-based decisions-making on the use of Article 6 in selected sectors or NDC areas. National GIZ staff in three partner countries (Rwanda, South Africa and Peru) are providing policy advice on Article 6 in order to ensure long-term support for local partners. At the same time, cross-regional training measures, workshops and networking events are being organised to support capacity building on Article 6 activities, and to give key stakeholders the opportunity to share information on the latest developments in the carbon market.

4.C.1.5 Channels for delivering German international climate finance

For the years 2021 and 2022, Germany provides a large share of its climate finance contributions – about 80% – in the form of bilateral cooperation (see Figure 28). Germany's commitments in this area build on partner countries' efforts to integrate climate change mitigation and adaptation in their national development strategies. In 2021, in this context, bilateral climate finance (including €584 million / US$687 million of grant equivalents) accounted for a total of €4.25 billion / US$5 billion, while multilateral climate finance accounted for €971 million / US$1.14 million. In 2022 overall, a total of nearly €5.15 billion / US$5.42 billion (including grant equivalents amounting to €652 million / US$686 million) flowed into bilateral climate finance, and €1.14 billion / US$1.20 billion flowed into multilateral climate finance.

Figure 28: Germany's international climate finance contributions, in the years 2021 – 2022, from budgetary resources and grant equivalents, broken down into bilateral and multilateral contributions (in €million and %)



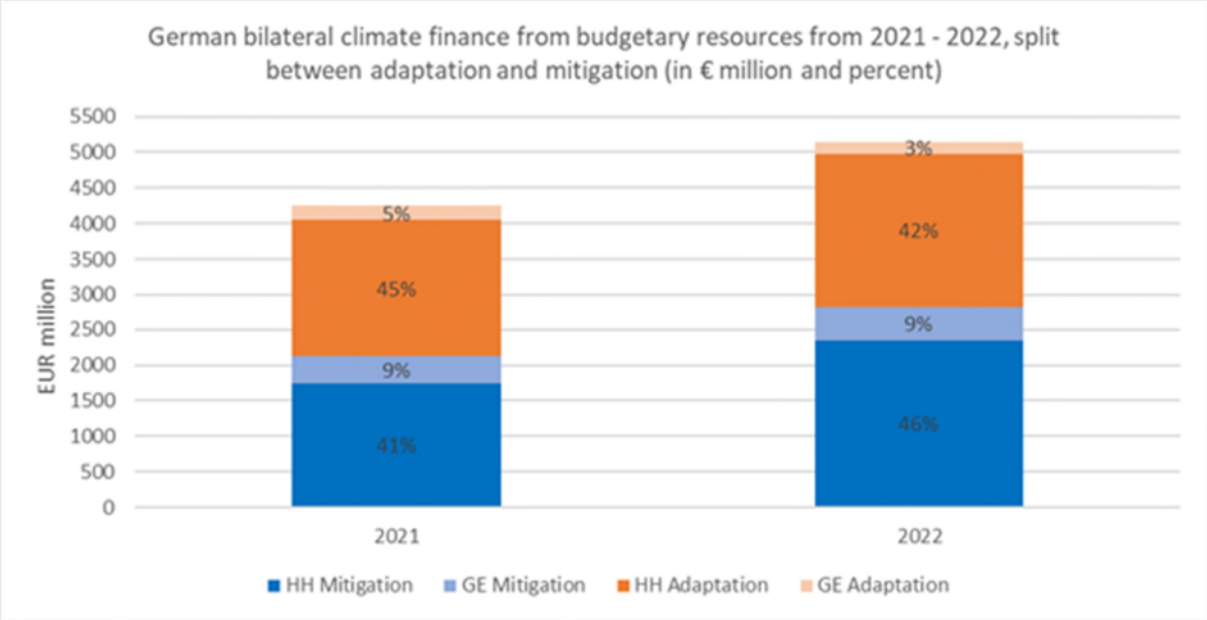
Source: Authors' own graphic, Federal Ministry for Economic Cooperation and Development (BMZ)

4.C.1.5.1 Bilateral cooperation

The Federal Government aims to achieve a suitable balance between its climate finance for emissions reduction projects and its finance for adaptation to climate change (Figure 29). In 2021, about €2.12 billion / US$2.49 billion worth of bilateral budgetary resources, including grant equivalents, were invested in adaptation measures, and about €2.13 billion / UD$ 2.51

billion were invested in emissions reduction measures. In 2022, €2.31 billion / US$2.43 billion of the bilateral funding from the federal budget flowed into adaptation projects, and €2.83 billion / US$2.98 billion went into emissions reduction projects. As a result, in the 2021 – 2022 reporting period, an average of 47% of Germany's bilateral climate finance went towards adaptation and 53% towards greenhouse gas reduction.

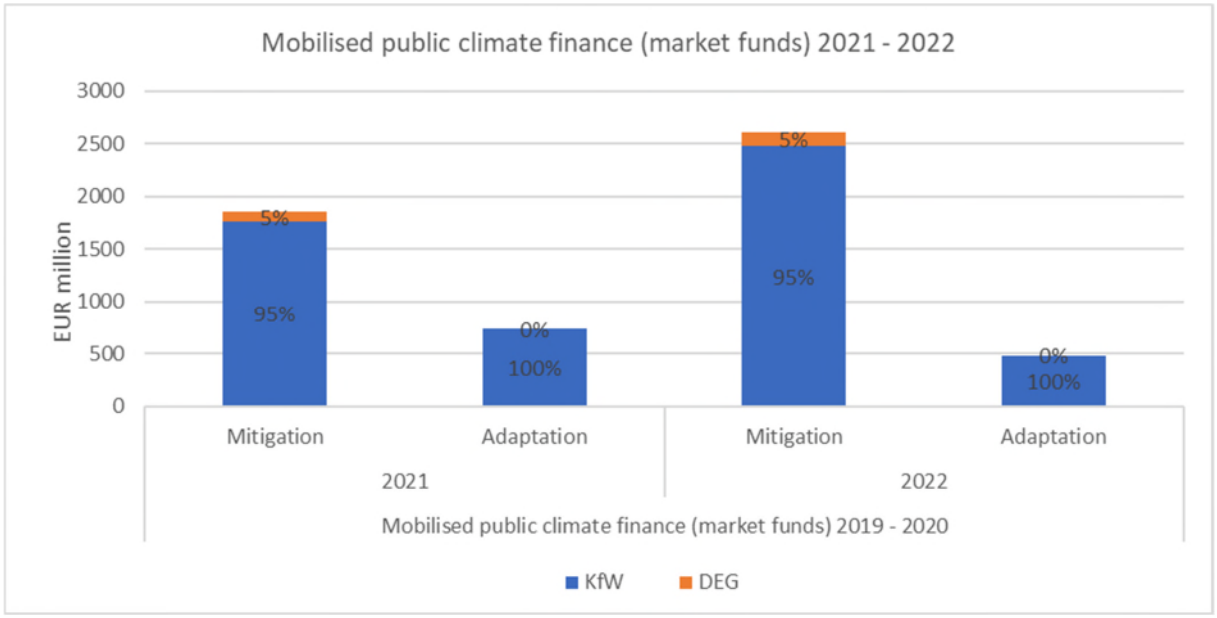
Figure 29: Germany's international climate finance contributions, in the years 2021 – 2022, from budgetary resources and grant equivalents, broken down into bilateral and multilateral contributions (in €million and %)



Source: Authors' own graphic, Federal Ministry for Economic Cooperation and Development (BMZ)

Since 2013, besides reporting on its climate finance from public budgetary resources, Germany has also reported on publicly mobilised climate finance, i.e. on climate-relevant loan financing provided by KfW Development Bank and DEG, using market funds. As Figure 30 shows, in 2021 – and in addition to the budgetary resources provided – an additional total of €2.59 billion / US$3.05 billion were committed by KfW Development Bank and DEG, from capital market funds, for mitigation and adaptation measures. In 2022, the public finance mobilised through KfW Development Bank and DEG amounted to €3.09 billion / US$3.25 billion.

Figure 30: Germany's international finance fed by mobilised public market funds in 2021 and 2022 (in % and €million)

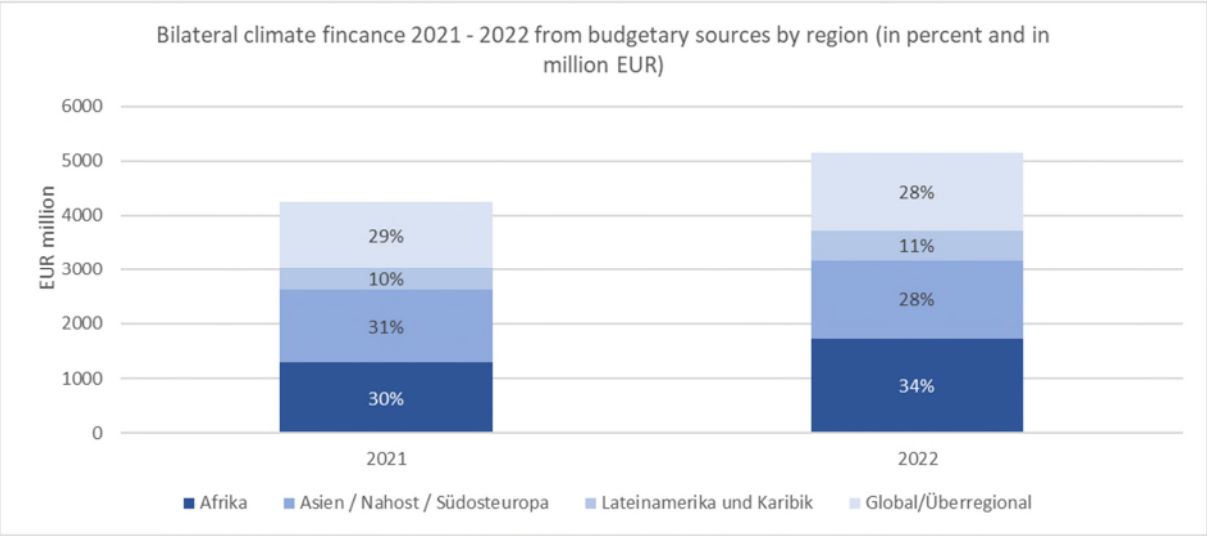


Source: Authors' own graphic, Federal Ministry for Economic Cooperation and Development (BMZ)

By region, the total of €4.25 billion / US$5 billion in bilateral climate finance (budgetary resources including grant equivalents) breaks down as follows in 2021: Germany supported partner governments in Africa by providing €1.30 billion/US$1.52 billion; in Asia, the Middle East and South-East Europe by providing €1.33 billion/US$1.56 billion; in Latin America and the Caribbean by providing €415 million/US$489 million. It also provided €1.21 billion/US$1.43 billion through global projects, see Figure 31).

Of some €5.15 billion/US$5.42 billion in bilateral climate finance (budget funds including grant equivalents) in 2022, Germany spent €1.73 billion/US$1.82 billion on cooperation with African partner governments, €1.45 billion/US$1.52 billion in Asia, the Middle East and South-Eastern Europe, €548 million/US$577 million in Latin America and the Caribbean and €1.42 billion/US$1.49 billion on global projects (see also Figure 31).

Figure 31: Climate finance from budgetary resources in 2021 – 2022, by region (in % and €million)



Source: Authors' own graphic, Federal Ministry for Economic Cooperation and Development (BMZ)

4.C.1.6 Multilateral cooperation

Germany provides part of its climate finance through multilateral institutions by contributing to international climate funds and multilateral organisations. Alongside its role as a donor, Germany is also active in shaping the strategic orientation of the funds and MDBs and the operational implementation of the respective portfolios, in order to optimise its contribution to the effective and efficient management of climate finance. In 2021, Germany provided a total of €971 million/US$1.14 billion through multilateral channels. The figure for 2022 was €1.14 billion/US$1.20 billion.

The funds that were set up directly under the United Nations Framework Convention on Climate Change (and now also operate under the Paris Agreement, and are supported by Germany, include the Green Climate Fund (GCF); the Adaptation Fund (AF); the Global Environment Facility (GEF); the Least Developed Countries Fund (LDCF); and the Special Climate Change Fund (SCCF). As one of the largest donor countries to the climate funds, Germany is strongly in favour of cross-fund cooperation and welcomes the content and direction of the joint declaration of the multilateral climate funds at COP28 to strengthen complementarity and coherence between the funds.[130]

Germany also supports climate funds that exist independently of the Framework Convention on Climate Change. Examples include the Climate Investment Funds (CIFs), the Global Risk Financing Facility and the Sustainable Energy Fund for Africa. Germany also makes regular contributions to the following funds of the Multilateral Development Banks (MDBs): the International Development Association (IDA) of the World Bank; the African Development Fund (AfDF); and the Asian Development Fund (AsDF). These contributions and Germany's contributions to the GEF are included in German climate finance in accordance with the imputed climate relevant shares determined by these institutions. Furthermore, Germany provides annual contributions and special initiatives to support United Nations programmes in implementing the global climate agenda.

[130] https://www.greenclimate.fund/statement/enhancing-access-and-increasing-impact-role-multilateral-climate-funds

In the first replenishment of the Green Climate Fund (GCF) from 2020 to 2023, Germany was the third-largest donor in the replenishment phase. As a member of the Board, Germany is also actively involved in discussing the institutional arrangements and operational implementation of the Fund.

With its pledge for the 8th replenishment period from 2022 to 2026, Germany was the largest donor to the Global Environment Facility (GEF).[131] Ever since the GEF began publishing Germany's imputed climate relevant share (2015), Germany has used this as a basis for calculating its GEF climate contribution. Germany serves as a member of the GEF Council. Within that body, it works to harness synergies between the various fund convention themes in the GEF, and to expand effective impact monitoring at project and programme level.

During the reporting period Germany supported the LDCF financially and provided technical advice on LDCF priorities, including innovative approaches to climate risk management and access for LDCs. It also advised the Fund on project proposals. In this work, Germany is able to draw on its experience at country level to contribute to the strategic orientation and further development of the LDCF.

The Federal Government also provided financial support to the SCCF during the reporting period. Germany focuses its support for the SCCF on adaptation to climate change. It also advises the Fund on project proposals.

In 2021 and 2022, Germany paid into the AF to support adaptation projects worldwide. It has been the largest cumulative donor since the AF was founded in 2007. Germany is also a member of the Board, which is based in Bonn. Through its active participation in Board meetings, Germany supports the strategic orientation and operational implementation of the Fund.

The Federal Government also provided financial support to the CIFs during the reporting period. With a contribution to the Accelerating Coal Transition Investment Programme (ACT), Germany was an important supporter of the CTF. It also supported the Nature People and Climate Programme (NPC) with a grant provided under the Strategic Climate Fund (SCF). Besides providing financial contributions, Germany also actively participated in the work of the CIFs.

4.C.1.6.1 Multilateral finance institutions

Germany cooperates closely with multilateral finance institutions on climate change mitigation and adaptation. Through capital contributions, regular contributions to funds of multilateral financial institutions and climate-specific trust funds, Germany enables the institutions to work intensively on climate issues. It makes regular core funding contributions to the following MDB funds: IDA, AfDF and AsDF. These contributions are included in German climate finance in accordance with the imputed climate relevant shares determined by these institutions.

Germany also promotes close cooperation with the institutions in multilateral initiatives and partnerships, such as the NDC Partnership mentioned above or the Global Risk Financing Facility. In the executive bodies, Germany actively supports climate-related issues and clearly advocates for a climate-oriented agenda and a strong and comprehensive Paris Alignment of the MDBs.

A list of all payments to the climate funds, the MDBs and climate-specific trust funds can be found in CTF Table Annex III, Table III.2.

[131] https://fiftrustee.worldbank.org/en/about/unit/dfi/fiftrustee/fund-detail/gef#1

4.C.1.6.2 Specialised UN organisations

Germany makes annual contributions to designated United Nations programmes to build knowledge and capacity in selected thematic areas. Germany also provides funding for initiatives, fiduciary funds and research centres. A list of the UN programmes it supports is provided in Annex III Table III.2. Through these initiatives, Germany strengthens capacity building in developing countries for the implementation of climate change mitigation and adaptation measures, for increased climate transparency, and for measures to implement the Montreal Protocol. Furthermore, Germany annually supports the activities of the UNFCCC Climate Change Secretariat and climate-related knowledge generation in several institutions. In the period 2021-2022, Germany supported the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC) financially through mandatory and voluntary contributions.

Germany also made voluntary contributions to the trust fund of the Intergovernmental Panel on Climate Change (IPCC) and supported the Technical Support Unit of Working Group II of the IPCC.

4.C.1.7 Approaches to climate adaptation

Climate change is already generating significant costs[132], and jeopardising the development successes achieved in areas such as poverty reduction, drinking water and infrastructure. Germany therefore attaches great importance to supporting developing countries in adapting to climate change. It sees such support as an international responsibility, and has made it one of the four integral pillars of the German Strategy for Adaptation to Climate Change (2008). The Federal Government is striving to improve protection against the impacts of climate change for the world's poorest and most vulnerable population groups; to prevent losses and damages from climate change; and to support households, companies and other countries in managing damages that have occurred. The Federal Government aims to strike an appropriate balance in its support for climate change mitigation and adaptation. In recent years, the support Germany has provided to finance adaptation has increased continuously. In 2021, bilateral climate finance from budget funds, including grant equivalents, for adaptation to climate change totalled €2.12 billion/US$2.49 billion. In 2022, bilateral adaptation finance increased to a total of €2.31 billion/US$2.43 billion. In the group of least developed countries and small island developing states, Germany provides targeted support to the most vulnerable countries in strengthening their adaptive capacities and boosting the resilience of their agricultural production and infrastructure. As part of the Global Shield against Climate Risks (GS) initiative, which was officially launched at COP27 on 14 November 2022, the Federal Government is helping partner countries to protect themselves financially against climate-induced losses and damages, for instance. To this end, the protective shield combines rapid support through pre-arranged finance mechanisms with comprehensive climate risk management. Germany is also supporting **Jordan**, for instance, in adapting to climate change by building a **seawater desalination plant** on the Red Sea in order to improve the water supply for the population, including millions of refugees, in the long term. The huge amount of electricity consumed by the plant will be covered largely by the construction of a **solar photovoltaic system**.

The priority areas of the Federal Government's support are ecosystem-based adaptation (EbA); adaptation of agricultural production, and food and nutrition security; water management and adaptation; and climate risk management. This support is delivered through instruments such as innovative climate risk finance solutions and adaptive social security systems, as well as the

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development and implementation of national adaptation strategies in the context of countries' National Adaptation Plans (NAPs) and NDCs.

Alongside the relevant BMZ projects and programmes, an important component of German climate finance in the area of adaptation is the IKI, for which the BMWK, BMUV and AA are responsible.

4.C.1.7.1 Managing climate risks – Disaster risk reduction and preparedness

As a signatory of the Sendai Framework for Disaster Risk Reduction, as part of its international cooperation Germany supports developing countries in their efforts to analyse fundamental risk factors for their societies with a view to reducing existing risks, preventing the emergence of new risks and managing residual risks. This also includes taking precautions to protect critical infrastructure, such as schools, hospitals and power stations. The Federal Government pursues a comprehensive risk management approach that combines proven and innovative instruments from climate change mitigation and adaptation, disaster risk management, humanitarian disaster preparedness, transitional development assistance and social protection. This addresses the full range of disaster and climate risks systemically and across sectors. The aim is to reduce any increase in humanitarian needs induced by disasters through targeted risk reduction and improved disaster preparedness, and to safeguard development results. To build the capacities needed for risk-informed development in partner countries, Germany launched the Global Initiative on Disaster Risk Management (GIDRM), among other things. Germany's multilateral cooperation in disaster risk management includes its support for the United Nations Office for Disaster Risk Reduction (UNDRR), the World Bank's Global Facility for Disaster Reduction and Recovery (GFDRR) and the International Federation of Red Cross and Red Crescent Societies (IFRC).

4.C.1.7.2 The Global Shield against Climate Risks – Protecting vulnerable people against climate risks

To help deal with extreme weather events, the Vulnerable 20 (V20) group of developing countries and the G7 under the German presidency along with other donor countries launched the Global Shield against Climate Risks (GS) at COP27 in 2022. The Global Shield aims to provide marginalised people and particularly vulnerable countries with financial protection against the consequences of extreme weather events. The focus is on rapid support through pre-arranged finance mechanisms that can make targeted payments at short notice when an extreme weather event occurs. The Global Shield builds on the successes and structures of the InsuResilience Global Partnership (IGP). By the end of 2022, more than 190 million people will have benefited from climate and disaster risk finance and insurance under the InsuResilience Global Partnership.

One key approach in the Federal Government's support to adaptive capacity building is promoting the integration of climate issues into the national development and budget planning of partner countries. The majority (around 80%) of NDCs – the centrepiece of the Paris Agreement and the achievement of its long-term goals – include targets for adaptation. Germany supports partner countries in designing their National Adaptation Plan (NAP) processes – a key vehicle for achieving these adaptation targets. According to a revised and more narrowly defined count, Germany is already supporting 65 partner countries in the planning and implementation of their NAP processes. It is providing support both directly, as bilateral support, and indirectly, via international initiatives such as the NAP Global Network (NAP GN). The NAP GN is a global network for national adaptation planning. It was launched in 2014 by Germany, working in cooperation with a number of countries, to support national and global donor coordination in

the area of climate change adaptation, and provide a forum for networking by experts and government representatives.

Since 2013, Germany has been supporting the development and activities of the African Risk Capacity (ARC) Group, a regional risk pool that offers African countries index-based insurance against drought and cyclone damage with comprehensive technical assistance for disaster preparedness and disaster risk management. The advantage of parametric insurance is that it pays out when predefined parameters (e.g. rainfall, wind speeds in defined areas) are met, often before the actual damage has an economic impact. In the 2021/22 pool, 14 countries opted for this type of insurance. Many people, e.g. in Côte d'Ivoire in 2021 or Zambia in 2022, were saved from economic hardship thanks to rapid aid. In 2021, Germany supported the subsidisation of insurance premiums to reduce the cost of insurance for African countries.

The Global Risk Modelling Alliance (GRMA), which was launched by the V20 and the Insurance Development Forum (IDF), strengthens local capacities and provides local models and data for analysing climate risks. Partner countries can use these to analyse their own climate risk, and on that basis develop strategies for climate risk and disaster finance. One key aspect of German support for the programme in the reporting period is mobilising the private sector and using its expertise to manage the unavoidable impacts of climate change.

4.C.1.7.3 Agriculture

Agriculture is severely affected by the impacts of climate change. Yet at the same time, global agricultural and food systems are responsible for between 21 and 37% of all global greenhouse gas emissions – a key contribution to climate change. Achieving the UN Sustainable Development Goals (SDGs) – especially SDG 2 (Zero Hunger), SDG 13 (Climate Action) and SDG 15 (Life on Land) – will require a transformation to low-emission and climate-resilient agricultural and food systems that guarantee production of sufficient healthy food for a growing world population, in harmony with the planetary boundaries. Germany is therefore working internationally with strategic partners to bring about such a transformation that will promote food and nutrition security, rural development and agriculture. One key partner in this area is the FAO, whose involvement in the Koronivia Joint Work on Agriculture, the UNFCCC work programme on agriculture, was financially supported by the Federal Government. Germany also funded the establishment of the Climate Change Knowledge Hub at the FAO. The hub is a knowledge platform designed to build capacity in the area of agricultural expertise on climate issues. The development of global information systems on the genetic resources of livestock (DAD-IS), fish (AquaGRIS) and trees (SilvaGRIS) at the FAO was also supported. Genetic resources are the foundation for adapting food and forestry production to changing climate and environmental conditions.

As part of the European Cooperative Programme for Plant Genetic Resources (ECPGR), Germany is supporting the development and establishment of evaluation networks (EVA), including such for wheat, barley, for vegetables based on the species pepper, carrot and lettuce, and for maize. In future, these networks will provide publicly available and user-friendly information and materials, e.g. for production and breeding research Furthermore, in 2021-2022 German development cooperation supported the promotion of food and nutrition security, agriculture and rural development, in particular through the special initiative ONE WORLD - No Hunger (EWOH).

As part of the G7 CompensACTION initiative launched in 2022, in that year Germany participated in the Enhanced Adaptation for Smallholder Agriculture Programme (ASAP+) of the International Fund for Agricultural Development (IFAD). The programme enables smallholder farmers in the Global South to access climate and environmental finance through innovative

compensation mechanisms for ecosystem services. It thus promotes living wages and income from climate-resilient and low-emission agricultural practices.

In 2022, Germany supported partner countries in transforming their agricultural and food systems by making them more sustainable and resilient, through the World Bank's Food Systems 2030 Multi-Donor Trust Fund (FS2030). A key lever here is the reallocation of agricultural subsidies that are harmful to the environment and the climate. As part of FS2030, together with the partner countries Ghana, Malawi, Mozambique, Tanzania and Bangladesh, alternative measures to existing support programmes are being implemented. These are designed to create stronger incentives for sustainable, climate-resilient and low-emission agricultural practices and to better manage future food crises.

Germany also helped fund international agricultural research in 2021 and 2022 through the Fund International Agricultural Research project (especially the Centres of the Global Research Partnership for a Food-Secure Future (CGIAR), the World Vegetable Center (WorldVeg) and the International Center for Insect Physiology and Ecology (icipe)). These research centres develop and scale up innovations that strengthen small farmers' resilience against the impacts of climate change and help make food systems more sustainable. In particular, the Federal Government supported the two climate-relevant CGIAR initiatives Livestock and Climate and Climate Resilience. The Federal Government also supports other initiatives such as the Global Research Alliance on Agricultural Greenhouse Gases (GRA) and the "4 per 1000" Initiative.

Numerous bilateral, regional and global projects also supported measures to mitigate climate change, adapt to climate change and promote resilience in agriculture. In 2021-2022, the Federal Government supported the global programme Soil Protection and Rehabilitation for Food Security, which was designed to restore the fertility of damaged soils (2021: 145,582 ha / 2022: 67,504 ha). In seven countries, agroecological approaches for climate-smart soil conservation and rehabilitation, co-financed by the European Union (in Ethiopia, Benin, Kenya and Madagascar under the EU's DeSIRA programme) and the Bill and Melinda Gates Foundation (in the Ethiopian Highlands), are being implemented together with local partners. Here, small farmers are learning how to farm depleted soils sustainably using soil-conservation practices, organic fertilisers, diversified crop rotation and careful use of water, thereby strengthening their resilience. These soil cultivation techniques enabled almost 400,000 tonnes of CO2 equivalents to be stored in the soil in 2022.

Examples of the Federal Government's specific instruments for bilateral cooperation in the agricultural sector include the Bilateral Cooperation Programme of the BMEL, the Bilateral Trust Fund with the FAO, the Innovation and Transformation Dialogue on Agriculture funding programme and international cooperation on world food research.

The Federal Government is also involved in twinning and bilateral administrative partnerships designed to enable selected third countries to move closer to the EU. The common goal of the initiatives in the agricultural sector is to strengthen agroecological, climate-friendly, local, fair and participatory food production worldwide. Through projects, they aim to help realise the right to adequate food, and implementation of the 2030 Agenda, the Paris Climate Agreement and the Kunming-Montreal Global Biodiversity Framework.

Other participatory areas of partnership-based cooperation include knowledge generation (research), education (basic and advanced training), capacity building, innovation promotion and knowledge transfer. Through the Federal Government's international project work, institutions around the world benefit from its advisory expertise in legislation, institution building, and food and agriculture, acquired thanks to its manifold research facilities.

Strengthening resilience to the effects of climate change for land users in Africa plays a special role in capacity building. Land use is an especially important factor in Africa, as local ecosystem services there play an essential role in securing many livelihoods. For this reason, the question of what climate changes African countries must expect, and with what consequences for land and water resources, is becoming increasingly urgent. Together with partners from eleven countries in West Africa and five countries in Southern Africa, Germany has set up two regional competence centres for climate change and adaptive land management (Regional Science Service Centres in West and Southern Africa – RSSCs). These are designed to better enable the countries in the region to make their own informed decisions, for instance on land use and water supply issues. Efforts to promote the training of young scientists and develop local research capacities in these countries play a key role. In the period 2021-2022, the Federal Government provided some €73.8 million for two centres – the West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL), and the Southern African Science Service Centre for Climate Change and Adaptive Land Management (SASSCAL).

Germany is also helping to create a better future in rural areas through the global project Green Innovation Centres for the Agriculture and Food Sector. The project supports innovations in selected rural regions of Africa and South Asia that are designed to increase climate resilience and adaptation in the agricultural and food sector, while at the same time improving regional food supplies and increasing income and employment among smallholder farmers. The project is working with over 150 partner organisations from civil society, associations, science, research and the private sector in order to increase productivity and at the same time ensure a more climate-resilient use of resources.

4.C.1.7.4 Water

Water is the medium through which climate change has the most direct impact on the lives of people and ecosystems, as well as on various economic sectors. Climate change manifests itself in changes to the global water cycle, water availability and water quality, as well as an increase in extreme weather events. Furthermore, unsustainable water and sanitation systems contribute significantly to global greenhouse gas emissions. At the same time, as a cross-sectoral issue, water is a key catalyst for achieving the climate targets and the Sustainable Development Goals (SDGs), especially SDG 6 (Clean Water and Sanitation) and SDG 13 (Climate Action). It can also serve to multiply resilience multiplier for climate change mitigation and adaptation.

Germany is therefore committed to sustainable, recycling-based water supply and sanitation in partner countries. To boost climate resilience in the water sector it promotes integrated, cross-sectoral and ecosystem-based approaches such as Integrated Water Resources Management (IWRM), nature-based solutions (NbS) and the Water-Energy-Food Ecosystem (WEFE) Nexus.

The project Water Sector Governance in Jordan (pledged in 2022, term: 2023 to 2026) aims to improve the lives and climate resilience of the population and the stability of Jordan through safe access to water and sustainable sanitation. Together with Jordanian partners, a new operating structure and a digital tool for the planning, allocation and management of bulk water will be created in order to respond more effectively to climate change.

The project Fostering Climate Resilience through Natural Resource Governance in Tunisia (pledged in 2022, term 2023 to 2026) is supporting the Ministry of Agriculture, Water Resources and Fishery in implementing measures to protect natural resources. The aim is to make better use of rainwater and groundwater, conserve the soil and thus create jobs. The project pursues a systemic approach that links soil and water resource management with Tunisia's climate policy. Key stakeholders, including farmers, receive training as well as

organisational and process extension and consulting services. Networking with the Ministry of the Environment in order to implement climate policy is being promoted.

The project Water Security and Climate Adaptation in Rural India (WASCA-II) (pledged in 2022; term 2022 to 2025) is supporting the Ministry of Rural Development in achieving the goals of the Mahatma Gandhi National Rural Employment Guarantee Act. Among other things, infrastructural and agroecological measures are improving water security for drinking water supply and agricultural production. Furthermore, the theoretical knowledge and practical skills of the experts and managers in the districts and municipalities are being deepened. This will enable them to conduct integrated planning and implementation of government development programmes. The project aims to improve water security and climate adaptation in particular.

Through the FAO project "Knowing Water Better: Towards a more equitable and sustainable access to natural resources to achieve food security (KnoWat)", an integrated approach to mapping water resources and water needs was developed with the participation of three pilot countries (Sri Lanka, Rwanda and Senegal). Based on this, recommendations for water management and allocation options were developed together with water users such as small farmers, herders and fishers. Building on the lessons learned in the pilot countries, the project developed, tested and reviewed methods for the implementation and evaluation of national water legislation.

4.C.1.7.5 Ecosystem-based adaptation

Ecosystem-based adaptation (EbA) utilises biodiversity and the services provided by natural systems as part of a broad strategy to support local populations in adapting to the negative impacts of climate change. EbA is a promising alternative or supplement to traditional technical, "grey" measures. Its primary aims are to protect, restore and sustainably utilise ecosystems on land and in the sea in order to strengthen the resilience of people and nature and mitigate the impacts of climate change. EbA measures are effective in many ways. As well as being cost-efficient and delivering direct adaptation benefits, they also offer people affected by the impacts of climate change numerous additional benefits in the areas of income, key services and well-being.

EbA continues to gain political relevance. According to the IPCC[133], protecting biological diversity and ecosystems is crucial for climate-resilient development in light of climate risks and their role in climate change mitigation and adaptation. This requires the effective and equitable conservation of 30-50% of global ecosystems.

The EbA projects financed by Germany advise partner countries on ways of integrating and implementing the EbA approach in their planning processes. EbA measures are tested in pilot projects, and the results are then systematically analysed and scaled up. Ecosystem-based adaptation measures are used, for example, in the area of flood and coastal protection. Such protection can take the form of retention areas, or may involve the conservation and/or restoration of biologically diverse, resilient vegetation for water storage.

In the NDC Partnership, EbA approaches are funded at the request of partner countries as part of their NDCs. Besides its bilateral portfolio and contributions to the multilateral portfolio, Germany supports various initiatives that include EbA approaches, such as the Legacy Landscapes Fund (pledged in 2021). In 2021, the Federal Government also supported the Blue Action Fund in implementing marine conservation projects that contribute to climate adaptation in marine and coastal regions. Germany is also supporting the important nexus between the

[133] IPCC: Climate Change 2022: Mitigation of Climate Change (ipcc.ch), D.4

ocean and climate change through the MeerWissen initiative, which strengthens partnerships between marine research institutions in Africa and Germany.

Through the International Climate Initiative (IKI), the Federal Government advises partner countries on integrating and implementing the EbA approach in their planning processes. It also supports measures to tackle climate-related impacts such as erosion in coastal areas, water-catchment areas and mountain regions; droughts; and reduced soil fertility. These measures thus also aim to support adaptation in agriculture, animal husbandry, fisheries, aquaculture, water supply, coastal protection and infrastructure. In this way, EbA projects also help to preserve livelihoods and provide 'natural protection' against climate risks.

The focus of the projects has evolved from pilot measures to mainstreaming and upscaling of the approach. The involvement of the private sector and the support of political processes also play an important role in ensuring the sustainability of the projects. In general, the projects' focus has moved from pilot measures to mainstreaming and to broad-based upscaling of useful approaches. Private sector involvement and the support of political processes also play an important role in ensuring that the projects have lasting effects.

The Global EbA Fund (GEBAF), which was established in December 2019 together with UNEP and IUCN, supports innovative approaches to ecosystem-based adaptation (EbA). The Fund improves the understanding, planning and upscaling of EbA processes, as well as access to finance for EbA measures. The GEBAF incentivises new financing mechanisms and investment by the private sector. To extend its reach many times over, the Fund makes use of established partnerships and networks.

4.C.1.8 Approaches to greenhouse gas reduction

The core goals of German development policy include contributing to the global reduction of greenhouse gases. To achieve this goal, Germany is supporting partner countries in establishing low-emission or climate-neutral economic and supply structures, and ensuring a socially just transformation. This includes expanding renewables and phasing out fossil fuels, increasing energy efficiency, and reducing greenhouse gases that are extremely harmful to the climate, such as methane and fluorinated greenhouse gases. Other areas for measures include sustainable urban planning, and the development of climate action strategies for mobility, for industry and for waste management. A further area is the preservation and expansion of natural carbon sinks.

On the initiative of Germany – financed by the International Climate Initiative (IKI) – and the UK Government, the NAMA Facility (since renamed the Mitigation Action Facility) was launched in 2012 as a multi-donor initiative. The NAMA Facility finances innovative and transformative Nationally Appropriate Mitigation Actions (NAMAs) and comparable national initiatives in ambitious developing and emerging countries worldwide that contribute to low-carbon development. During the reporting period, the NAMA Facility supported the special initiative "Ambition Initiative - Round Two", which supports particularly ambitious climate action projects in combination with green economic recovery measures in response to the COVID-19 pandemic. €285 million was leveraged via other public and private actors. At the end of 2022, the NAMA Facility announced it was changing its name to the "Mitigation Action Facility" and would be placing a stronger focus on the energy, industry and transport sectors. By the end of the reporting period, the NAMA Facility had supported a total of 47 climate projects in 33 countries with a funding volume of €668 million. With more than 20 partners and 47 projects, the NAMA Facility reached more than 25 million people between its inception and the end of 2022, mobilising investments from the public and private sectors totalling €1.6 billion.

4.C.1.9 Energy

In 2021, Germany funded the Clean Energy and Energy Inclusion for Africa (CEI Africa) Foundation. CEI Africa is an innovative undertaking designed to reduce energy poverty in sub-Saharan Africa (SSA) and promote the climate-friendly transition to affordable, renewable energy. The programme aims to provide households, municipal institutions and commercial enterprises in sub-Saharan Africa with access to affordable, clean electricity from renewable energy sources, thereby helping to reduce greenhouse gases. This is to be achieved primarily through reliable stand-alone power grids (mini-grids). The CEI Africa Foundation supports projects through two funding windows: "Crowdlending for Energy Inclusion" and the "Smart Outcomes Fund". These measures are implemented together with African partners, public donors and private investors. As part of the programme, 18 megawatts of newly installed capacity and an annual energy output of 24,000 megawatt hours will be generated. In total, 353,000 people will gain new or improved access to energy, and greenhouse gas emissions will be reduced. This will make an effective contribution to enabling a fairer energy transition in Africa.

In 2021 and 2022, the Federal Government supported the Energising Development (EnDev) programme. EnDev is a multi-donor partnership whose goal is to reach around 36 million people with a needs-based, climate-friendly energy supply by 2025. EnDev operates in Africa and Asia, with a focus on sub-Saharan Africa and Least Developed Countries. By improving and increasing access to energy and systematically promoting renewables, the programme aims to reduce poverty, and create a more enabling environment for new jobs and income opportunities in the interests of a just energy transition and climate change mitigation. EnDev promotes access to electricity, for example through solar-powered systems and village power plants. It also scales up clean cooking technologies. The multi-donor partnership pursues a market development approach for decentralised, renewable energy services and products for households, micro, small and medium-sized enterprises (MSMEs), as well as social institutions such as health centres and schools. Until 2025, the strategic focus will be on the "leave no one behind" principle (including poor population groups, refugees and host communities, women and girls), and the promotion of cooking technologies at higher levels of access.

4.C.1.10 Transport

German development cooperation is pursuing the goal of making climate-friendly, safe and affordable mobility options accessible to a growing urban population worldwide. If global climate and development goals are to be achieved, and social and economic participation is to become a universal reality, the global transport sector will need to be transformed.

The Federal Government is supporting its partners in developing and emerging countries in establishing and expanding inclusive and sustainable public transport systems; in introducing regulations and measures for environmentally friendly passenger and freight transport; in modernising vehicle fleets by making them more energy-efficient and environmentally sound; and in improving traffic planning in cities.

To help implement sustainable urban mobility, in 2016 Germany launched the Transformative Urban Mobility Initiative (TUMI) as part of the Habitat III conference. Together with eight international partner institutions (development banks, city networks, think tanks and NGOs) as well as GIZ and KfW, this initiative is supporting cities in developing and emerging countries in making their transport systems more sustainable. One focus is on developing and expanding public transport systems. From 2021 to 2022, KfW financed sustainable mobility projects as part of Financial Cooperation. This includes financing the construction of the metro in the Indian city of Surat through a subsidised loan and a KfW promotional loan. Two lines with 38 stops are to

be built over a distance of around 40 kilometres, which will be served by modern trains. That will reduce CO2 emissions in this fast-growing city by an average of 71,000 tonnes per year. In the medium term, more than 28.6 million people are expected to use the improved transport systems every day.

German development cooperation's mobility portfolio comprises a wide range of Financial and Technical Cooperation projects. In 2022, the Federal Government pledged a grant for sustainable mobility in Dakar, Senegal, through KfW. This project will create an expanded, modern and sustainable bus feeder system that will make urban services and jobs more accessible for the residents of Dakar, thus boosting value creation and social development. The full programme comprises four components, which are being financed and implemented by several donors (AFD, EU and EIB). The programme includes 14 lines of the bus feeder system with midibuses. This will benefit 136 million passengers per year (52% of them men and 48% women; 2026) and save a total of 14.5 million hours of public transport journeys per year. The bus feeder system and the 80 new midibuses will reduce greenhouse gas emissions by 2,757 tonnes of CO2 emissions per year.

One example of Technical Cooperation is the project "Sustainable Urban Mobility in the South Caucasus (Mobility4Cities) – TUMI" (pledged in 2022). To support good governance and capacity building, the project worked with local partners in Tbilisi and Batumi to improve urban mobility in Georgia, reduce greenhouse gas emissions and improve public access to sustainable transport. The project supported both cities in planning and implementing measures to promote sustainable urban mobility. For example, it advised Tbilisi on the development of a transport concept for a sustainable urban mobility corridor, and on the introduction of intelligent transport systems (ITS). The project also supported the first academic programme for the training of transport experts in Georgia.

As part of the WomenMobilizeWomen (WMW) initiative, women working in various areas of the transport sector, including women with disabilities and those in informal employment, are receiving targeted support through representation, visibility and inclusion. Development cooperation is thus contributing to women's employment. As part of the GIZ project "Sustainable Urban Mobility – Air Quality, Climate Action, Accessibility in India", female workers such as bus, rickshaw or taxi drivers are receiving targeted training in traditionally male-dominated professions. Germany supported this project in 2021. The training of female bus drivers increases the proportion of female employees, and makes female passengers feel safer.

The NDC Transport Initiative for Asia is a joint programme of seven organisations that promotes a comprehensive approach to decarbonising transport in China, India and Viet Nam, and in having an impact across Asia. The IKI-funded initiative supports stakeholder processes and the development of climate action measures. In this way, it supports countries in making their sectoral contributions towards increasing their NDCs and raising their ambition for long-term strategies and the 2025 NDCs.

City tolls in Bangkok, investments to shift freight transport to rail in Indonesia, the National Urban Mobility Programme in the Philippines, a scrappage and eco-driving programme for trucks in Peru and a national support programme for electric buses in Colombia are examples of the impact of the IKI project TRANSfer III. This supports its partner countries with concrete mitigation measures and thus the NDCs. The project operated until the end of 2022 as a Mitigation Action Preparation Facility and pursued a multi-donor approach to extend support to other countries. Specially developed toolkits[134] improved and accelerated the process.

[134] The IKI project TRANSfer was funded in 3 phases from 2010-2022. The results and toolkits are available on the project website: https://changing-transport.org/project/transfer/.

International learning processes helped to raise ambitions for climate action in the transport sector. As a result, at least 60 million tonnes of CO2 could potentially be saved over ten years.

4.C.1.11 Biodiversity and forest policy

Along with tackling the climate crisis, preserving our natural resources is a key issue of survival for humankind, and is therefore a core concern of German development cooperation. Climate and biodiversity are inextricably linked. Ecosystems and their services safeguard livelihoods worldwide and play a central role in combating the climate crisis – for climate action, for adapting to the impacts of climate change and for mitigating climate risks. The 1.5-degree target from the Paris Agreement can therefore only be achieved by successfully pursuing the three-pronged approach of conserving the biodiversity of terrestrial, freshwater, coastal and marine ecosystems; managing natural resources sustainably; and restoring ecosystems. This is very important for development cooperation in the field of biodiversity. At the same time, climate change is one of the five main drivers of advancing biodiversity loss. Up to 18% of species in terrestrial ecosystems are threatened with extinction if global warming reaches two degrees Celsius.

Accordingly, the Federal Government has made it a priority to interlink climate change mitigation and adaptation even more closely with the protection, restoration and sustainable use of resources and ecosystems, thereby leveraging mutual synergy potential and positive side effects. Nature-based solutions such as the protection and restoration of mangroves, forest landscapes and peatlands, ecosystem-based adaptation, the expansion and networking of green and blue areas in cities and densely populated areas, and integrated approaches to resource management, play an important role here. This is because they combine the conservation of biodiversity, climate change mitigation and adaptation, and achievement of the Sustainable Development Goals. For the most part, the biodiversity portfolio of German development cooperation is also climate-relevant: 82.5% of all ongoing BMZ measures as at 31 December 2022 that contributed to the conservation, sustainable use and restoration of biodiversity, also contributed to climate change mitigation or adaptation.

In the area of ecosystem-based adaptation, for example, Germany is supporting the adaptation of people and ecosystems in the Peruvian Andes to climate change through the project "Resilient Puna: Ecosystem-based adaptation for sustainable High Andean communities and ecosystems in Peru". In particular, the measure promotes sustainable forms of farming and value chains and supports ecosystem-based adaptation in the area of water supply and agriculture through the restoration of wetlands and pastures (pledged in 2022, term 2023-2027).

Peatlands and mangroves play a crucial role in preserving both the climate and biodiversity worldwide. With the "ProMangrovPeat" project, the Federal Government is supporting the protection and sustainable management of peatland ecosystems in Indonesia. These provide important ecosystem services for both local communities and the global community, for example as carbon sinks or natural coastal protection (pledged in 2022, term 2024-2026).

To support the sustainable use and conservation of biodiversity for food and agriculture, the Federal Government/BMEL is implementing projects in cooperation with the FAO to compile global status reports such as the Biodiversity Report. The resulting Framework for Action on Biodiversity for Food and Agriculture is designed to serve the member states as a guideline for implementing practices to promote biodiversity in agriculture and food in countries.

In the area of forests, Germany supported the "REDD Early Movers" (REM) programme from 2021-2022. This programme has been providing results-based payments for the reduction of deforestation (REDD+) and the achievement of political milestones in forest conservation since

2012. It supports indigenous peoples, small farmers and traditional communities in preserving the rainforest and promotes government measures for deforestation control and forest monitoring. As 2022 drew to a close, 90 million tonnes of CO2 emissions had been saved in Colombia, Brazil and Ecuador.

In addition to promoting projects in partner countries, Germany supports the international exchange of forestry expertise through the Forest Expert Programme run by the German Forest Association. Through this programme, forest experts, particularly from German international cooperation projects, gain practical experience at private or public forest enterprises and other forestry institutions in Germany. Through the targeted training of multipliers, knowledge and experience from sustainable forest management in Germany is made available to the partner countries.

At the multilateral level, Germany is contributing to the protection, restoration and sustainable management of carbon-rich forest resources in the Congo Basin, for instance by supporting the Central African Forest Initiative (CAFI).

4.C.1.12 Waste

The waste management sector contributes significantly to global greenhouse gases. Landfilling and open burning of waste in particular cause around a fifth of global methane gas emissions. Germany supports its partner countries in reducing greenhouse gas emissions in the waste sector and in the transformation to a sustainable and climate-friendly circular economy. The aim is to avoid waste and its impacts on the climate and environment as early as possible when it is generated, and to preserve the value of products, materials and resources for as long as possible. A comprehensive circular economy could reduce global greenhouse gas emissions by up to 39% and increase resilience to the fluctuating availability of raw materials and other resources.

With the Go Circular project (pledged in 2022, term: 2022-24), Germany is promoting knowledge sharing on the circular economy at a global level and the implementation of pilot projects, e.g. on low-carbon organic waste management in Ethiopia in the PREVENT Waste Alliance. The global Go Circular project is also developing guidelines and tools such as a greenhouse gas emissions calculator for the waste sector, and guidance on integrating circular economy activities in national climate plans.

Germany is providing support for a sustainable circular waste economy in Rwanda (pledged in 2021 and 2022, term 2022-26). This support is designed to facilitate the introduction of an enabling institutional and financial framework for inclusive and climate-sensitive approaches to the circular economy in Rwanda. Around three quarters of waste in Rwanda is biowaste, which is especially harmful to the climate if not treated properly. The project is advising the Rwandan Ministry of Environment on the implementation of circular economy approaches together with the private sector. The project is also expanding private companies' access to financially viable business models, and piloting national strategies and plans for the circular economy in the waste sector in three cities in Rwanda.

The Circular City Labs project (pledged in 2022, term 2023-25) supports the development of reuse systems to save resources and greenhouse gases in partner cities in Albania, Georgia and Colombia. To this end, baseline studies are first conducted to determine the local conditions for reuse solutions, opportunities for the advancement of women and cooperation with the private sector and municipalities. Following a test phase, the project offers training programmes on topics such as the circular economy and reuse solutions, and promotes the scaling up of the reuse approach in an international and national context.

Through these and other measures, German development cooperation is actively helping partner countries to achieve their climate targets in the waste sector and thus make an important contribution to global climate action.

4.C.1.13 Urban development

The Federal Government sees cities as key players in efforts to achieve the global sustainability agenda (2030 Agenda) and the global climate agenda (Paris Agreement). German development cooperation promotes sustainable urban development in partner countries as a dedicated area of intervention of the core area strategy Responsibility for Our Planet – Climate and Energy, which was adopted in 2021. In this context, Germany aims to promote not only a more climate-sensitive and low-emission form of urban development, but also a socially just urban transformation. Germany pursues integrated approaches to sustainable urban development that strengthen urban resilience to climate impacts and include a focus on disadvantaged groups, in order to reduce poverty and inequalities. The approach focuses on creating the needed prerequisites for sustainable urban development: good governance, integrated planning approaches and access to finance. Housing and construction, mobility, water, waste management and public spaces have been identified as key sectors with leverage effects.

One example of how integrated urban development can contribute to climate change mitigation and improve the social and economic situation of the population is the project "Promoting Climate-friendly Public Transport in Peru's Cities" (*Asignáción tematica transporte urbano*). This project supports the expansion and improvement of public transport, including bus, cycle and pedestrian transport. In the cities of Piura, Arequipa and Trujillo, around 3 million inhabitants are to benefit from faster, safer and cleaner mobility. This will improve their access to services, healthcare, educational facilities and places of work. Reduced greenhouse gas emissions will also improve air quality. This is measured by a newly developed method that measures greenhouse gas emissions in secondary cities. The method is already in use. The first figures on greenhouse gas emissions from public transport in the partner cities are expected in the second half of 2024. The first measurement will record baseline data on greenhouse gas emissions from public transport. This will enable targeted measures to be applied in the future in order to further reduce emissions. In 2022, loan funds were pledged to support the expansion of public transport in secondary cities in Peru through the construction of express bus routes and the purchase of vehicles.

Cities in our partner countries are growing rapidly. In Africa, for example, the urban population will triple in the next 25 years. At the same time, climate-related risks are increasing and threatening the living space of millions of people. Germany is therefore placing a particular focus on building housing and infrastructure that both promotes low-carbon development, and can withstand impacts of climate change. Through the KfW Development Bank, the Federal Government supported the cities on Lake Kivu in Rwanda in 2021 through the Sustainable Urban Development project. This project aims to make infrastructure more resilient to climate risks such as heavy rainfall, floods and droughts. A good 20% of the Rwandan population live here. The topography of the region is very hilly. This means that the cities are susceptible to landslides and flooding resulting from changing weather conditions. These cause major damage to infrastructure and threaten people's livelihoods, including tourism. Using nature-based solutions such as the restoration of water bodies, erosion control through planting, the construction of rainwater retention basins and improved infiltration, e.g. through green spaces along roads and the creation of parks, the quality of life is being improved and the risk reduced. The long-term impact of the measures is ensured by further developing planning guidelines together with the local authorities. Germany is also supporting research projects in rapidly growing cities and urban regions in developing and emerging countries. Research activities of

the Sustainable Development of Urban Regions (SURE) project focus on a) technological solutions designed to improve energy and resource efficiency, reduce CO2 emissions and develop concepts for sustainable new infrastructure systems (energy supply, transport systems, etc.); and b) developing societal innovations to manage resulting changes in living conditions. Following an initial definition phase, 2020 saw the launch of the four-year funding phase for further research and development of solutions in eleven projects in the Southeast Asian countries of Viet Nam, Cambodia, Laos, Thailand, the Philippines, Indonesia and China (with a funding volume of around €10.1 million during the reporting period).

As cities still often do not receive sufficient funding for climate-friendly infrastructure projects, the Federal Government supports them throughout the entire cycle of preparing projects for funding applications. The City Climate Finance Gap Fund, created jointly with the Government of Luxembourg, supports cities in developing and emerging countries in realising their climate targets by translating low-carbon and climate-resilient approaches into strategies and financeable projects. The Federal Government supported the City Climate Finance Gap Fund in 2022. The Gap Fund is now capitalised with a total of €105 million, which is intended to leverage additional investments of €4 billion in urban climate projects. The Gap Fund is supporting projects in 201 cities in 58 countries. These are being implemented by the World Bank and the European Investment Bank (EIB) together with GIZ. For the late phase of project preparation, the C40 Cities Finance Facility (CFF) supports cities in preparing their climate-friendly and resilient infrastructure projects to the point at which they become bankable, i.e., financeable. Since 2015, this has enabled investments totalling €983 million, of which €643 million has already been implemented. These investments will avoid 7.5 million tonnes of CO2-equivalent greenhouse gas emissions by 2050. The support provided in Mbombela, South Africa, is a good example of how the Gap Fund and the CFF work together. With the help of the Gap Fund, a programme was set up here to improve flood preparedness – the Transformative River and Stormwater Management Programme (MTRSMP). Here, the Gap Fund analysed the existing river and stormwater management regime, prepared a cost estimate for improvements and identified potential donors. The work of the CFF is building on this to further develop three selected water catchment areas of the programme into funding-ready projects.

4.C.1.14 Mobilising private investments in climate change mitigation and adaptation measures in developing and emerging countries

Strategies and measures that help make financial flows consistent with climate-friendly development as set out in Article 2.1.c of the Paris Agreement ("shifting the trillions"), and that help mobilise private investment in climate change mitigation and adaptation, are a fundamental component of German climate finance. At the same time, Germany uses Financial Cooperation instruments to mobilise private funding for climate-relevant activities in developing countries.

To align financial flows with Article 2.1c of the Paris Agreement, a holistic approach is needed that can both mobilise significant funding for climate transformation and help bring about lasting, systemic change in financial markets. The public sector has just as important a role to play here as the real economy. Specifically, the state sets the framework for climate-friendly and climate-resilient investments and can incentivise climate-relevant investments inter alia through climate-sensitive fiscal policy. It can also use public funds to help leverage additional resources. The state also has a regulatory role to play in ensuring that the financial sector is appropriately geared towards sustainability. The private sector, on the other hand, is called on to finance the transformation and to make climate awareness a part of its activities. Relevant measures are being carried out inter alia in the areas described below.

4.C.1.15 Capacity building for implementation of Art. 2.1c

The Federal Government supports advisory services to policymakers on the implementation of reform processes for a more sustainable financial system, and the creation of political and regulatory frameworks to enable private climate-relevant investment. As part of sustainable finance, Germany promotes rigorous compliance with ambitious environmental, social and governance (ESG) criteria in investment decisions and in the risk management of local financial market players. Germany is also committed to promoting financial frameworks and standards in partner countries that will enable the long-term mobilisation of capital for the socio-ecological transformation.

In 2022, Germany launched the Green Financial Market Regulation and Green Bonds project, which supports the Brazilian Ministry of Finance in making the Brazilian financial sector more sustainable. The project is also working closely with the Brazilian Central Bank to strengthen the regulation and oversight of the financial sector with regard to sustainability. The project is supporting the development of a classification system (taxonomy) for sustainable economic activities and investments. It is also helping to mainstream climate risk assessment in financial market supervision and is expanding a monitoring system for rural lending, as well as promoting and disseminating sustainable financial approaches with development banks.

In Viet Nam, in 2021 and 2022 Germany supported the coherence of national economic, financial and fiscal policy, and particularly its green components, through the Macroeconomic Reforms/Green Growth programme (overall term 2019 - 2026). Among other things, a financial market reform is strengthening the green banking system and developing the green capital market. In particular, the project is promoting local capacity building in various national ministries and in the Central Institute for Economic Management, and is supporting regulations and policy to promote green bonds and green loans. As at December 2022, the project activities had helped to triple the credit volume for green investments to around US$21.3 billion.

The Federal Government's International Climate Initiative (IKI) is also intensively involved in financial market-related topics. To increase international climate finance, the International Finance Cooperation (IFC) project "30 by 30 Zero Scale up Climate Finance" is supporting the creation of domestic markets in partner countries for financing climate projects. To this end, IFC is implementing measures at policy, market and financial market level. Besides capacity-building in relevant financial institutions, this includes adapting financial sector strategies to the respective NDCs. Furthermore, the figure for climate loans as a share of the total loan portfolio of the participating banks is to be increased significantly by 2030. To complement this, climate investments will be promoted by developing green bonds. The Latin American Climate Asset Disclosure Initiative, a project of the Federal Government's IKI, is also supporting institutional investors in Peru and Mexico by providing training in the area of reporting.

Germany is supporting the financing of NDCs in partner countries with many other IKI projects. In Ethiopia and South Africa, the IKI project “Aligning Financial Flows” of the NGO SouthSouthNorth (SSN) is identifying evidence-based options for making financial flows consistent with the Paris Agreement – and for highlighting the kinds of ambitious mitigation and adaptation measures that could appear in future NDCs and long-term strategies of African countries. One important component of the project is the cooperation with the African Group of Negotiators on Climate Change (AGN), in conjunction with knowledge transfer – new findings from the target countries are to be shared with African countries that are pursuing similar paths.

4.C.1.16 Private-sector mobilisation and innovative financing instruments

Germany intends to step up the involvement of the private sector in development cooperation, and especially in climate and development partnerships. Under the German G7 presidency in 2022, the plurilateral Just Energy Transition Partnerships (JETPs) with Viet Nam and Indonesia were concluded and scaled up. For the financing packages of the JETPs with Indonesia and Viet Nam, the public contributions were doubled by private pledges delivered through GFANZ. As the JETPs continue to be implemented, reforms in the countries' energy and financial sectors are a prerequisite for mobilising private investments and enabling these resources to contribute to the objectives of the partnerships.

Germany has an established bilateral swap programme under which a partner country can exchange part of its debt for a commitment to invest the same amount in socio-ecological transformation. During COP27 in 2022, the Federal Government pledged a significant contribution to the Egyptian country initiative "Nexus Water Food Energy – Energy Pillar" (NWFE-EP). An overall funding package is intended to support the Egyptian Government in achieving its target of 42% renewable energy by 2030.

KfW Development Bank and its subsidiary DEG leverage private funding in connection with their climate-relevant activities in developing and emerging countries. In 2021, KfW Development Bank mobilised private international climate finance of around €81 million/US$96 million, as calculated using the OECD methodology[135]. In 2022, this amount rose to €385 million/US$405 million. In keeping with its mandate, the DEG works exclusively with the private sector. In the process, it accepts risks that commercial banks and investors either will not or cannot accept, or will/can accept only in part. This enables DEG to provide tailored financing packages in which private investors and commercial banks take stakes. The private international climate finance mobilised through DEG loans or stakes is also calculated based on the OECD methodology. As calculated using this method, private funds of around €89 million/US$104 million were mobilised by DEG in 2021 and around €91 million/US$96 million in 2022.

Germany is involved in a large number of green, innovative finance instruments through Financial Cooperation. For example, since 2020 the Federal Government has held a stake in the "Facility for Energy Inclusion – OnGrid (FEI-OnG)" (together with the African Development Bank, the EU and Norfund) through the KfW Development Bank. In so doing it has contributed to Germany's "Green People's Energy for Africa" initiative, and helped mobilise institutional investors for this purpose.

In 2021 and 2022, KfW Development Bank, working on behalf of the Federal Government, and in cooperation with EIB, EU Munich RE and the African Trade Insurance Agency, participated in the African Energy Guarantee Facility. This Facility provides guarantees for sustainable energy investments, thus reducing the investment risks for private investors. It is expected to mobilise around US$1.4 billion of private investment in energy projects in sub-Saharan Africa.

Under the IKI, Germany also promotes various blended finance vehicles and other fund structures which help to minimise risk and leverage private sector finance. For example, the Federal Government acts as one of the anchor investors in the Emerging Market Climate Action Fund (EMCAF). This fund of funds, managed by Allianz Global Investors and advised by the European Investment Bank (EIB), has a direct investment target of up to €600 million, and mobilises a multiple of this in and for the recipient countries. The fund's resources are used to

[135] The OECD is working to develop an international standard for measuring mobilised private funding. For a number of financing instruments, methods have already been developed that are now in use. In order to paint a realistic picture, efforts are under way to identify a conservative definition of causal mobilisation and to attribute successful mobilisation fairly.

support infrastructure and climate funds that in addition to environmental projects also finance new climate change mitigation and adaptation projects in developing countries.

The Federal Government also supports the Climate Finance Partnership (CFP), a structured equity fund managed by Blackrock as fund manager, from the IKI. To mobilise private donors, the public donors invest in the riskiest tranche of the fund (blended finance structure). This risk hedging reduces investment barriers for private financial players in renewables in developing and emerging countries. To date (as at November 2021), the fund has mobilised a total of US$670 million from governments, philanthropists and private investors with an above-average mobilisation factor of 1:4.

Together with the European Union, Norway, the Netherlands, Sweden and Austria, Germany is co-financing the European programme "GET.Invest", which aims to mobilise private investment for decentralised renewable energy projects. GET.Invest supports clean energy project developers in accessing finance, conducts market analyses and works with business associations to organise events and match-making opportunities.

4.D Information on support for technology development and transfer provided under Article 10 of the Paris Agreement

The development and application of climate technologies is an important part of the German economy. Technology transfer is a significant aspect in almost all of the Federal Government's bilateral cooperation arrangements for climate action. Currently, the key topics with regard to climate technologies are climate-neutral energy supply systems; decarbonisation of the building sector; decarbonisation of industrial processes and products such as steel, cement, concrete and other materials; transport; and waste management/the circular economy. These thematic areas are also of particular importance for international cooperation.

Germany promotes the use of climate technologies through bilateral engagement. Currently (as of 2022), it maintains climate, energy and hydrogen partnerships, and energy dialogues, with over 29 countries in which climate technologies play an important role. Energy and climate partnerships support the expansion of renewables, the promotion of energy efficiency and the dissemination of green technologies. At the same time, these activities promote market-based frameworks and export opportunities, and drive the joint development of new climate technologies. Germany is involved in the G7 initiative to establish Just Energy Transition Partnerships. In existence since 2022, this initiative represents multilateral energy partnerships that currently exist with South Africa, Indonesia, Senegal and Viet Nam.

In German development cooperation, a large number of climate action projects are being realised by GIZ and KfW using the latest climate technologies. The International Climate Initiative (IKI), which has supported ambitious climate and biodiversity projects in around 150 partner countries since 2008, is also an important tool of German international cooperation for reducing greenhouse gas emissions in developing and emerging countries, and for adaptation measures. In 2021 and 2022 alone, 179 new projects were launched, with an average of around 400 ongoing projects each year. These include technology-based cooperation arrangements and numerous projects with technology components.

The Federal Government's CLIENT II - International Partnerships for Sustainable Innovations funding programme establishes international partnerships with selected emerging and developing countries in the climate, environment and energy sectors. These are based on demand-driven projects. The aim is to develop and implement innovative and sustainable solutions for specific challenges in the partner country in seven thematic areas (resource efficiency and circular economy, water management, climate action/energy efficiency, adaptation to climate change, land management, sustainable energy systems and natural risks). Since March 2017, bilateral research and development projects have been funded in over 30 countries. In the period 2021-2022, 19 collaborative research projects with a funding volume of around €32 million were launched. The funded projects are designed to help reduce environmental pollution in the partner countries, manage natural resources intelligently and sparingly, supply all sections of the population with safe, clean and affordable energy, and contribute to global climate change mitigation, and adaptation to climate change and natural risks. The regional focus of the cooperation is on China and Viet Nam, Central Asia, South America, parts of Africa and Iran.

In 2022, the Climate Club was founded on Germany's initiative as a high-level forum to promote the decarbonisation of industry. Founded by the G7, the Climate Club works on key decisions for decarbonisation strategies, including technology development and transfer. The joint Terms of Reference were adopted in December 2022. These structure the work of the Climate Club

around three pillars: (i) advancing ambitious and transparent climate change mitigation policies, ii) transforming industries, and iii) boosting international climate cooperation and partnerships).

Germany supports the Technology Mechanism of the UN Framework Convention on Climate Change and its organisations – the Technology Executive Committee (TEC) and the Climate Technology Centre and Network (CTCN) – through financial contributions, joint initiatives and active participation in events (e.g. regional climate weeks, webinars, etc.). Germany has been operating a National Dedicated Entity for the Technology Mechanism (NDE Germany) for several years. Representatives of the Federal Government and NDE Germany hold positions on the Advisory Boards of the TEC and CTCN and actively participate in working groups.

There is further cooperation with CTCN on the topics of emission-free cement, steel and climate-friendly buildings. Concerning the climate negotiations, Germany supports regular dialogue with other NDEs within Europe, with the European Commission and at global level. In 2021-2022, Germany made voluntary contributions to the TEC totalling €0.5 million and to the CTCN totalling €2.5 million.

4.D.1 Support at different stages of the technology cycle

GET.pro is a multi-donor project founded in 2018 that works on the key issues of a just global energy transition: It was funded by Germany in 2021 and 2022. The project aims to improve the environment for investment in a global energy transition as part of a coordinated European approach. To achieve this, it uses scalable instruments: GET.invest mobilises private investment; GET.transform supports public partners in designing and implementing their energy transitions; and the Secretariat of the Africa-EU Energy Partnership (AEEP) promotes strategic political dialogue between Africa and Europe on an equal footing, in order to accelerate a just African energy transition. Implementation of this global programme focuses on Africa and Latin America. With the German support pledged in 2021 and 2022, GET.pro has supported more than 110 investment projects. These are expected to mobilise €1.6 billion in investments, give 7.2 million people access to clean energy and save around 2.75 million tonnes of CO2 per year. Furthermore, Germany's pledges have enabled it to leverage substantial combined financing from other donors (including the EU and EUD Burundi, Mozambique, Eswatini, Lesotho, and most recently Norad and Sida) totalling around €51 million, which will increase the contribution to a just global energy and climate transition.

4.D.2 Support for the development and expansion of endogenous capacities and technologies in developing countries

By supporting the Technology Mechanism under the UNFCCC and its institutions TEC and CTCN, Germany is also promoting the development and expansion of endogenous capacities and technologies in developing countries.

4.D.3 Efforts to promote private sector activities involving technology development and transfer in support of developing countries

With the develoPPP programme, the Federal Government promotes the involvement of the private sector where economic opportunities and development policy needs coincide. It is a key instrument for attracting private capital for transformation projects. Companies contribute funds of at least the same amount to joint projects for development and climate goals. Since the programme began in 1999 some 3,030 development partnerships have been launched. In 2021 and 2022, a total of 717 development projects were supported with a total of €800 million, of which private investors contributed 59% of the funding. Many of these projects are climate-

relevant as they involve investments in renewable energy, energy efficiency, water treatment, recycling / circular economy, biodiversity or forestry.

With the Project Development Programme (PDP) for developing countries and emerging economies, which is an important pillar of the German energy solutions initiative, the Federal Government supports small and medium-sized enterprises (SMEs) that offer climate-friendly energy technologies in gaining entry to especially difficult, often nascent markets. The PDP is currently being implemented in countries in sub-Saharan Africa, South and South-East Asia and the Middle East.

To achieve the best possible link with development cooperation, the Federal Government has commissioned GIZ to implement the measures. In countries/areas where the PDP is not being implemented because the countries have reached a higher development status, the measures of the German Energy Solutions Initiative / Energy Solutions Made in Germany apply.

4.D.4 Generated knowledge

Germany's support for the TEC and CTCN has contributed to the publication of various policy briefs, project reports, etc.

4.E Information on capacity-building support provided under Article 11 of the Paris Agreement

4.E.1 Capacity building

Capacity building is an integral part and core element of virtually all the Federal Government's climate-related cooperation projects. It is therefore not possible to separately report finance flows used exclusively for capacity building.

The Federal Government is involved in capacity building through bilateral and multilateral cooperation, as well as through various collaborations with the private sector, the scientific community and civil society. To support partner countries in effectively implementing the United Nations Framework Convention on Climate Change and the Paris Agreement, it provides extensive capacity-building support for greenhouse gas mitigation, adaptation to climate change, technology development and transfer, and access to international climate finance, as well as other specific sectors and cross-cutting areas such as reporting. The capacity-building support is designed to be context-specific and impact-oriented, in line with national priorities.

The Federal Government deploys its range of instruments and institutions for international cooperation to improve a specific situation on the ground in climate-relevant capacity-building development projects. It achieves this through an appropriate capacity development strategy and the optimal use of experts, financing and/or materials and equipment. Results are not achieved by using as many of these instruments as possible. It is rather a matter of combining them effectively in line with partner needs in order to achieve the objectives.

Climate-relevant capacity building starts at the various levels of the individual, the organisation and society. The focus is on close cooperation between the state, civil society and the private sector. All of the Federal Government's capacity-building projects for climate change mitigation and adaptation support formal and informal workers, their families, low-income households, suppliers, micro-entrepreneurs and local communities that are especially hard hit by the negative impacts of climate change. The Federal Government's engagement places particular emphasis on the equal participation of girls and women, and ensures that human rights are respected.

Capacity-building support includes

- Developing leadership, management, methodological and technical skills among specialists and managers who are change agents and multipliers (such as trainers and consultants), and who can contribute to climate-relevant changes at the organisational and societal level
- Supporting organisations or individual teams or units in the climate sector in improving their communication, cooperation and organisational skills and their networking
- Delivering long-term policy and strategy advisory services to government decision-makers in key positions for climate change mitigation and adaptation in complex reform processes, and expert advice on legislative procedures, taking into account the general political and economic frameworks and existing cooperation systems.

During the reporting period, the Federal Government supported climate-related capacity-building projects in 70 countries, including projects with a special focus on capacity building in over 28 countries.

In 2021, for example, the Federal Government supported the African Group of Negotiators on Climate Change (AGN) in better supporting its member states in international climate

negotiations. For Somalia, Germany pledged a project for sustainable food security and conflict prevention. This is designed to boost the resilience of conflict-affected internally displaced persons and host communities in the country.

In 2022, for example, the Federal Government pledged a capacity-building project designed to reduce poverty in Benin, Burundi, Rwanda and Togo by training small farmers and strengthening their organisations. In India, Germany supported farming communities in northern Tamil Nadu (India) in applying climate-smart agricultural techniques more effectively, thus adapting better to climate change. In 2022, funding was also provided for the Skills for a Green Future programme, under which 44 projects in 41 countries worldwide are being implemented in the areas of education, vocational training and the labour market.

5 Annex 1: Common tabular formats on information necessary to track progress

Description of a Party's nationally determined contribution under Article 4 of the Paris Agreement, including updates[a]

	Description
Target(s) and description, including target type(s), as applicable, c	**Economy-wide net domestic reduction of at least 55% in greenhouse gas emissions by 2030 compared to 1990.** **The term 'domestic' means without the use of international credits.** **Target type: Economy-wide absolute emission reduction.**
Target year(s) or period(s), and whether they are single-year or multi-year target(s), as applicable	**Single year target, 2030.**
Reference point(s), level(s), baseline(s), base year(s) or starting point(s), and their respective value(s), as applicable	**Base year: 1990.** **Net greenhouse gas emissions level in 1990:** **4 699 405 kt CO_2eq.**
Time frame(s) and/or periods for implementation, as applicable	**2021-2030**
Scope and coverage, including, as relevant, sectors, categories, activities, sources and sinks, pools and gases, as applicable	**Geographical scope: EU Member States (Belgium, Bulgaria, Czechia, Denmark, Germany, Estonia, Ireland, Greece, Spain, France, Croatia, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Malta, Netherlands, Austria, Poland, Portugal, Romania, Slovenia, Slovakia, Finland, Sweden) including EU outermost regions (Guadeloupe, French Guiana, Martinique, Mayotte, Reunion, Saint Martin (France), Canary Islands (Spain), Azores and Madeira (Portugal)).** **Sectors covered, as contained in Annex I to decision 5/CMA.3:** **Energy** **Industrial processes and product use** **Agriculture** **Land Use, Land Use Change and Forestry (LULUCF)** **Waste** **International Aviation: Emissions from civil aviation activities as set out for 2030 in Annex I to the EU ETS Directive are included only in respect of CO_2 emissions from flights subject to effective carbon pricing through the EU ETS. With respect to the geographical scope of the NDC these comprise emissions in 2024-26 from flights between the EU Member States and departing flights to Norway, Iceland, Switzerland and United Kingdom.** **International Navigation: Waterborne navigation is included in respect of CO2, methane (CH_4) and nitrous Oxide (N_2O) emissions from maritime transport voyages between the EU Member States.** **Gases:** **Carbon Dioxide (CO_2)** **Methane (CH_4)** **Nitrous Oxide (N_2O)** **Hydrofluorocarbons (HFCs)** **Perfluorocarbons (PFCs)** **Sulphur hexafluoride (SF_6)** **Nitrogen trifluoride (NF_3)** **The included LULUCF categories and pools are as defined in decision 5/CMA.3.**

Intention to use cooperative approaches that involve the use of ITMOs under Article 6 towards NDCs under Article 4 of the Paris Agreement, as applicable	**The EU's at least 55% net reduction target by 2030 is to be achieved through domestic measures only, without contribution from international credits.** **The EU will account and report for its cooperation with other Parties in a manner consistent with the guidance adopted by CMA1 and any further guidance agreed by the CMA.**
Any updates or clarifications of previously reported information, as applicable[d]	**The information on the NDC scope contains clarifications/further details compared to the information provided in the updated NDC of the EU.**

Note: This table is to be used by Parties on a voluntary basis.

[a] Each Party shall provide a description of its NDC under Article 4, against which progress will be tracked. The information provided shall include required information, as applicable, including any updates to information previously provided (para. 64 of the MPGs).

[b] For example: economy-wide absolute emission reduction, emission intensity reduction, emission reduction below a projected baseline, mitigation co-benefits of adaptation actions or economic diversification plans, policies and measures, and other (para. 64(a) of the MPGs).

[c] Parties with both unconditional and conditional targets in their NDC may add a row to the table to describe conditional targets.

[d] For example: recalculation of previously reported inventory data, or greater detail on methodologies or use of cooperative approaches (para. 64(g) of the MPGs).

5.A Common tabular formats on information necessary to track progress

Indicator(s) selected to track progress[a]	*Description*
{Indicator}	**Annual total net GHG emissions consistent with the scope of the NDC in CO_2eq.**
Information for the reference point(s), level(s), baseline(s), base year(s) or starting point(s), as appropriate[b]	**The reference level is total net GHG emissions of the EU in the base year (1990). The reference level value for the EU is 4 699 405 kt CO_2eq.**
Updates in accordance with any recalculation of the GHG inventory, as appropriate	**This is the first time the reference level is reported, hence there are no updates.** **The value of the reference level may be updated in the future due to methodological improvements to the EU GHG inventory and to the determination of international aviation and navigation emissions in the NDC scope.**
Relation to NDC[c]	**The indicator is defined in the same unit and metric as the target of the NDC. Hence it can be used directly for tracking progress in implementing and achieving the NDC target.**

Notes: (1) Pursuant to para. 79 of the MPGs, each Party shall report the information referred to in paras. 65–78 of the MPGs in a narrative and common tabular format, as applicable. (2) A Party may amend the reporting format (e.g. Excel file) to remove specific rows in this table if the information to be provided in those rows is not applicable to the Party's NDC under Article 4 of the Paris Agreement, in accordance with the MPGs. (3) The Party could add rows for each additional selected indicator and related information.

[a] Each Party shall identify the indicator(s) that it has selected to track progress of its NDC (para. 65 of the MPGs).

[b] Each Party shall provide the information for each selected indicator for the reference point(s), level(s), baseline(s), base year(s) or starting point(s) and shall update the information in accordance with any recalculation of the GHG inventory, as appropriate (para. 67 of the MPGs).

[c] Each Party shall describe for each indicator identified how it is related to its NDC (para. 76(a) of the MPGs).

5.B Structured summary: Definitions needed to understand NDC

Definitions[a]	
Definition needed to understand each indicator:	
Annual total net GHG emissions	**Total net GHG emissions correspond to the annual total of emissions and removals reported in CO_2 equivalents in the latest GHG inventory of the EU. The totals comprise all sectors and gases listed in the table entitled 'Reporting format for the description of a Party's nationally determined contribution under Article 4 of the Paris Agreement, including updates.' Indirect CO2 emissions are included from those Member States that report these emissions.**
Any sector or category defined differently than in the national inventory report:	
{Sector} **Not applicable**	
{Category} **Not applicable**	
Definition needed to understand mitigation co-benefits of adaptation actions and/or economic diversification plans:	
{Mitigation co-benefit(s)} **Not applicable**	
Any other relevant definitions:	
Not applicable	

Notes: (1) Pursuant to para. 79 of the MPGs, each Party shall report the information referred to in paras. 65–78 of the MPGs in a narrative and common tabular format, as applicable. (2) A Party may amend the reporting format (e.g. Excel file) to remove specific rows in this table if the information to be provided in those rows is not applicable to the Party's NDC under Article 4 of the Paris Agreement, in accordance with the MPGs. (3) The Party could add rows for each additional sector, category, mitigation co-benefits of adaptation actions and/or economic diversification plans, indicator and any other relevant definitions.

[a] Each Party shall provide any definitions needed to understand its NDC under Article 4, including those related to each indicator identified in para. 65 of the MPGs, those related to any sectors or categories defined differently than in the national inventory report, or the mitigation co-benefits of adaptation actions and/or economic diversification plans (para. 73 of the MPGs).

5.C Structured summary: Methodologies and accounting approaches – consistency with Article 4, paragraphs 13 and 14, of the Paris Agreement and with decision 4/CMA.1

Reporting requirement	*Description or reference to the relevant section of the BTR*
For the first NDC under Article 4:[a]	
Accounting approach, including how it is consistent with Article 4, paragraphs 13–14, of the Paris Agreement (para. 71 of the MPGs)	**Net GHG emissions, calculated from emissions and removals from the GHG inventory of the EU and supplemented with data on international aviation and navigation collected in the Joint Research Centre's Integrated Database of the European Energy System (JRC-IDEES), are used to quantify progress towards implementing and achieving of the NDC in respect of the NDC target. This approach promotes environmental integrity, transparency, accuracy, completeness, comparability and consistency and ensures the avoidance of double counting, as described below. Existing methods and guidance under the Convention are taken into account, as described below.**
For the second and subsequent NDC under Article 4, and optionally for the first NDC under Article 4:[b]	
Information on the accounting approach used is consistent with paragraphs 13–17 and annex II of decision 4/CMA.1 (para. 72 of the MPGs)	**The European Union accounts for anthropogenic emissions and removals corresponding to its NDC consistent with paragraphs 13–17 and annex II of decision 4/CMA.1, as detailed below.**
Explain how the accounting for anthropogenic emissions and removals is in accordance with methodologies and common metrics assessed by the IPCC and in accordance with decision 18/CMA.1 (para. 1(a) of annex II to decision 4/CMA.1)	**The accounting for anthropogenic emissions and removals is based on the data contained in the EU GHG inventory, which is compiled in accordance with the 2006 IPCC Guidelines. The accounting for emissions from international aviation and navigation in the scope of the NDC is based on activity data, emission factors and methods which are in line with the IPCC guidelines. The accounting approach is also in accordance with decision 18/CMA.1 because the EU GHG inventory conforms with the provisions of chapter II of the Annex to decision 18/CMA.1.**
Explain how consistency has been maintained between any GHG data and estimation methodologies used for accounting and the Party's GHG inventory, pursuant to Article 13, paragraph 7(a), of the Paris Agreement, if applicable (para. 2(b) of annex II to decision 4/CMA.1)	**The GHG data used for accounting is based on the GHG inventory of the EU. The methodology used for accounting consists of a balancing of GHG emissions and removals, which is consistent with the methodologies used in the GHG inventory of the EU.**
Explain how overestimation or underestimation has been avoided for any projected emissions and removals used for accounting (para. 2(c) of annex II to decision 4/CMA.1)	**Not applicable. Projected emissions and removals are not used for accounting.**
For each NDC under Article 4:[b]	

Accounting for anthropogenic emissions and removals in accordance with methodologies and common metrics assessed by the IPCC and adopted by the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement:	
Each methodology and/or accounting approach used to assess the implementation and achievement of the target(s), as applicable (para. 74(a) of the MPGs)	**The methodology used to assess the implementation and achievement consists of a comparison of the reduction of net GHG emissions from the GHG inventory national total, including a share of GHG inventory international aviation and navigation emissions in line with the NDC scope, with the NDC target. The EU will account for its cooperation with other Parties in a manner consistent with guidance adopted by the CMA.**
Each methodology and/or accounting approach used for the construction of any baseline, to the extent possible (para. 74(b) of the MPGs)	**Progress is tracked by comparing annual net emissions with net emissions in the base year. No baseline is constructed.**
If the methodology or accounting approach used for the indicator(s) in table 1 differ from those used to assess the implementation and achievement the target, describe each methodology or accounting approach used to generate the information generated for each indicator in table 4 (para. 74(c) of the MPGs)	**Not applicable. The methodology/accounting approach used for the indicator in table 1 is the same as the methodology/accounting approach used to assess the implementation and achievement the target.**
Any conditions and assumptions relevant to the achievement of the NDC under Article 4, as applicable and available (para. 75(i) of the MPGs)	**Not applicable. The NDC is unconditional.**
Key parameters, assumptions, definitions, data sources and models used, as applicable and available (para. 75(a) of the MPGs)	**Net GHG emissions are the key parameter used for tracking progress in implementing and achieving the NDC. The GHG inventory of the EU is the data source used. Details on assumptions, definitions and models used for determining net GHG emissions can be found in the National Inventory Document of the EU.**
IPCC Guidelines used, as applicable and available (para. 75(b) of the MPGs)	**2006 IPCC Guidelines; and 2019 refinement to the 2006 IPCC Guidelines for some source categories.**
Report the metrics used, as applicable and available (para. 75(c) of the MPGs)	**100-year time-horizon global warming potential (GWP) values from the IPCC Fifth Assessment Report.**
For Parties whose NDC cannot be accounted for using methodologies covered by IPCC guidelines, provide information on their own methodology used, including for NDCs, pursuant to Article 4, paragraph 6, of the Paris Agreement, if applicable (para. 1(b) of annex II to decision 4/CMA.1)	**Not applicable.**
Provide information on methodologies used to track progress arising from the implementation of policies and measures, as appropriate (para. 1(d) of annex II to decision 4/CMA.1)	**Progress arising from the implementation of policies and measures is expressed in a reduction of GHG emissions or increase of GHG removals. The methodology used to assess such progress is based on the estimation of GHG emissions and removals in the GHG inventory of the EU and on data on international aviation and navigation monitored in the Joint Research Centre's Integrated Database of the European Energy System (JRC-IDEES).**
Where applicable to its NDC, any sector-, category- or activity-specific assumptions, methodologies and approaches consistent with IPCC guidance, taking into	**Sector-, category- and activity-specific assumptions, methodologies and approaches applicable to the NDC are described in the**

account any relevant decision under the Convention, as applicable (para. 75(d) of the MPGs)	**national inventory document of the EU and are consistent with IPCC guidance.** **Emissions from international aviation and navigation in the scope of the NDC are determined based on activity data from the JRC-IDEES, using emission factors and methodologies consistent with IPCC guidance.**
For Parties that address emissions and subsequent removals from natural disturbances on managed lands, provide detailed information on the approach used and how it is consistent with relevant IPCC guidance, as appropriate, or indicate the relevant section of the national GHG inventory report containing that information (para. 1(e) of annex II to decision 4/CMA.1, para. 75(d)(i) of the MPGs)	**NA**[136]
For Parties that account for emissions and removals from harvested wood products, provide detailed information on which IPCC approach has been used to estimate emissions and removals (para. 1(f) of annex II to decision 4/CMA.1, para. 75(d)(ii) of the MPGs)	**The EU accounts for emissions and removals from harvested wood products as an integral part of net GHG emissions and removals in the scope of the NDC. GHG emissions and removals from harvested wood products are determined in accordance with the production approach, as defined in Annex 12.A.1 to Volume 4 of the 2006 IPCC Guidelines for National GHG Inventories.**
For Parties that address the effects of age-class structure in forests, provide detailed information on the approach used and how this is consistent with relevant IPCC guidance, as appropriate (para. 1(g) of annex II to decision 4/CMA.1, para. 75(d)(iii) of the MPGs)	**The EU does not address the effects of age-class structure in forests in the accounting approach for its NDC.**
How the Party has drawn on existing methods and guidance established under the Convention and its related legal instruments, as appropriate, if applicable (para. 1(c) of annex II to decision 4/CMA.1)	**The EU has drawn on existing methods and guidance established under the Convention by using an NDC target which is an advancement of the quantified economy-wide emission reduction target for 2020, which was communicated and tracked under the Convention.**
Any methodologies used to account for mitigation co-benefits of adaptation actions and/or economic diversification plans (para. 75(e) of the MPGs)	**The NDC does not consist of mitigation co-benefits of adaptation actions and/or economic diversification plans. Hence these co-benefits were not accounted for, and no related methodologies were used.**
Describe how double counting of net GHG emission reductions has been avoided, including in accordance with guidance developed related to Article 6 if relevant (para. 76(d) of the MPGs)	**GHG emissions and removals from the EU's GHG inventory, complemented with JRC-IDEES data for determining the share of emissions form international aviation and navigation in the NDC scope, are used for tracking the net GHG emission reductions. Emissions and removals are reported in line with IPCC guidelines, with the aim of neither over- nor underestimating GHG emissions.** **GHG emissions and removals are reported by the EU and its Member States in their respective GHG inventories. For tracking progress towards implementing and achieving the EU NDC, only those net GHG emission reductions are counted which are reported at EU level.** **For cooperative approaches under Article 6, corresponding adjustments are made in a**

[136] To determine emissions and removals in the scope of the NDC, the EU does not disaggregate emissions and removals on managed land into those considered to result from human activities and those considered to result from natural disturbances.

	manner consistent with guidance adopted by the CMA.
Any other methodologies related to the NDC under Article 4 (para. 75(h) of the MPGs)	**Not applicable.**
Ensuring methodological consistency, including on baselines, between the communication and implementation of NDCs (para. 12(b) of the decision 4/CMA.1):	
Explain how consistency has been maintained in scope and coverage, definitions, data sources, metrics, assumptions and methodological approaches including on baselines, between the communication and implementation of NDCs (para. 2(a) of annex II to decision 4/CMA.1)	**The scope, coverage, definitions, data sources, metrics and approaches are consistent between the communicated NDC and its implementation, as described in the BTR.**
Explain how consistency has been maintained between any GHG data and estimation methodologies used for accounting and the Party's GHG inventory, pursuant to Article 13, paragraph 7(a), of the Paris Agreement, if applicable (para. 2(b) of annex II to decision 4/CMA.1) and explain methodological inconsistencies with the Party's most recent national inventory report, if applicable (para. 76(c) of the MPGs)	**The GHG inventory of the EU is the primary source for the GHG data used for accounting. The share of GHG inventory emissions from international aviation and navigation in the scope of the NDC have been determined separately based on JRC-IDEES data, using emission factors and methodologies consistent with IPCC guidance. There are no methodological inconsistencies with the most recent national inventory report.**
For Parties that apply technical changes to update reference points, reference levels or projections, the changes should reflect either of the following (para. 2(d) of annex II to decision 4/CMA.1):	
Technical changes related to technical corrections to the Party's inventory (para. 2(d)(i) of annex II to decision 4/CMA.1)	**No technical changes related to technical corrections to the GHG inventory were applied to update reference points, reference levels or projections.**
Technical changes related to improvements in accuracy that maintain methodological consistency (para. 2(d)(ii) of annex II to decision 4/CMA.1)	**No technical changes related to improvements in accuracy were applied to update reference points, reference levels or projections.**
Explain how any methodological changes and technical updates made during the implementation of their NDC were transparently reported (para. 2(e) of annex II to decision 4/CMA.1)	**Methodological changes and technical updates are reported in the chapter entitled 'recalculations and improvements' of the National Inventory Document of the EU.** **GHG emissions from international aviation and navigation in the scope of the EU NDC are reported for the first time in this BTR (see Annex 2 to the BTR).**
Striving to include all categories of anthropogenic emissions or removals in the NDC and, once a source, sink or activity is included, continuing to include it (para. 3 of annex II to decision 4/CMA.1):	
Explain how all categories of anthropogenic emissions and removals corresponding to their NDC were accounted for (para. 3(a) of annex II to decision 4/CMA.1)	**The indicator used for tracking progress towards implementing and achieving the NDC target comprises all categories of anthropogenic emissions and removals corresponding to the NDC.**

Explain how Party is striving to include all categories of anthropogenic emissions and removals in its NDC, and, once a source, sink or activity is included, continue to include it (para. 3(b) of annex II to decision 4/CMA.1)	**The scope of the NDC of the EU covers all categories of emissions and removals reported in the GHG inventory, in line with IPCC guidelines. Member States report some specific source categories as 'not estimated' when the estimates would be insignificant as defined in paragraph 32 of the annex to decision 18/CMA.1. Information on these categories is provided in Common Reporting Table 9 of the respective Member States' GHG inventory submission.** **Besides including all sectors listed in decision 18/CMA.1, a share of emissions from international aviation and navigation are also included in the NDC scope.**
Provide an explanation of why any categories of anthropogenic emissions or removals are excluded (para. 4 of annex II to decision 4/CMA.1)	**All categories of anthropogenic emissions and removals contained in the national total of the EU GHG inventory are included in the NDC.**
Each Party that participates in cooperative approaches that involve the use of ITMOs towards an NDC under Article 4, or authorizes the use of mitigation outcomes for international mitigation purposes other than achievement of its NDC	
Provide information on any methodologies associated with any cooperative approaches that involve the use of ITMOs towards an NDC under Article 4 (para. 75(f) of the MPGs)	**The EU will account and report for its cooperation with other Parties in a manner consistent with the guidance adopted by CMA1 and any further guidance agreed by the CMA, when applicable.**
Provide information on how each cooperative approach promotes sustainable development, consistent with decisions adopted by the CMA on Article 6 (para. 77(d)(iv) of the MPGs)	**The EU will account and report for its cooperation with other Parties in a manner consistent with the guidance adopted by CMA1 and any further guidance agreed by the CMA, when applicable.**
Provide information on how each cooperative approach ensures environmental integrity consistent with decisions adopted by the CMA on Article 6 (para. 77(d)(iv) of the MPGs)	**The EU will account and report for its cooperation with other Parties in a manner consistent with the guidance adopted by CMA1 and any further guidance agreed by the CMA, when applicable.**
Provide information on how each cooperative approach ensures transparency, including in governance, consistent with decisions adopted by the CMA on Article 6 (para. 77(d)(iv) of the MPGs)	**The EU will account and report for its cooperation with other Parties in a manner consistent with the guidance adopted by CMA1 and any further guidance agreed by the CMA, when applicable.**
Provide information on how each cooperative approach applies robust accounting to ensure, inter alia, the avoidance of double counting, consistent with decisions adopted by the CMA on Article 6 (para. 77(d)(iv) of the MPGs)	**The EU will account and report for its cooperation with other Parties in a manner consistent with the guidance adopted by CMA1 and any further guidance agreed by the CMA, when applicable, when applicable.**
Any other information consistent with decisions adopted by the CMA on reporting under Article 6 (para. 77(d)(iii) of the MPGs)	**The EU will account and report for its cooperation with other Parties in a manner consistent with the guidance adopted by CMA1 and any further guidance agreed by the CMA, when applicable.**

Notes: (1) Pursuant to para. 79 of the MPGs, each Party shall report the information referred to in paras. 65–78 of the MPGs in a narrative and common tabular format, as applicable. (2) A Party may amend the reporting format (e.g. Excel file) to remove specific rows in this table if the information to be provided in those rows is not applicable to the Party's NDC under Article 4 of the Paris Agreement, in accordance with the MPGs.

[a] For the first NDC under Article 4, each Party shall clearly indicate and report its accounting approach, including how it is consistent with Article 4, paras. 13–14, of the Paris Agreement (para. 71 of the MPGs).

[b] For the second and subsequent NDC under Article 4, each Party shall provide information referred to in chapter III.B and C of the MPGs consistent with decision 4/CMA.1. Each Party shall clearly indicate how its reporting is consistent with decision 4/CMA.1 (para. 72 of the MPGs). Each Party may choose to provide information on accounting of its first NDC consistent with decision 4/CMA.1 (para. 71 of the MPGs).

5.D Structured summary: Tracking progress made in implementing and achieving the NDC under Article 4 of the Paris Agreement[a]

	Unit, as applicable	Reference point(s), level(s), baseline(s), base year(s) or starting point(s), as appropriate (paras. 67 and 77(a)(i) of the MPGs)	Implementation period of the NDC covering information for previous reporting years, as applicable, and the most recent year, including the end year or end of period (paras. 68 and 77(a)(ii–iii) of the MPGs)		Target level[b]	Target year or period	Progress made towards the NDC, as determined by comparing the most recent information for each selected indicator, including for the end year or end of period, with the reference point(s), level(s), baseline(s), base year(s) or starting point(s) (paras. 69–70 of the MPGs)
			2021	2022			
Indicator(s) selected to track progress of the NDC or portion of NDC under Article 4 of the Paris Agreement (paras. 65 and 77(a) of the MPGs):							
Annual total GHG emissions and removals consistent with the scope of the NDC	**kt CO_2eq**[137]	**4 699 405**	**3 272 650**	**3 205 223**	**(at least 55% below base year level)**	**2030**	**The most recent level of the indicator is 31.8 % below the base year level.**
Where applicable, total GHG emissions and removals consistent with the coverage of the NDC (para. 77(b) of the MPGs)	**kt CO_2eq**	**4 699 405**	**3 272 650**	**3 205 223**			
Contribution from the LULUCF sector for each year of the target period or target year, if not included in the inventory time series of total net GHG emissions and removals, as applicable (para. 77(c) of the MPGs)	**NA**		**NA**	**NA**			
Each Party that participates in cooperative approaches that involve the use of ITMOs towards an NDC under Article 4 of the Paris Agreement or authorizes the use of							

[137] Net GHG emissions in the scope of the NDC

mitigation outcomes for international mitigation purposes other than achievement of the NDC, shall provide (para. 77(d) of the MPGs):							
If applicable, an indicative multi-year emissions trajectory, trajectories or budget for its NDC implementation period (para. 7(a)(i), annex to decision 2/CMA.3)	**kt CO_2eq**		**To be reported in subsequent BTR**	**To be reported in subsequent BTR**			
If applicable, multi-year emissions trajectory, trajectories or budget for its NDC implementation period that is consistent with the NDC (para. 7(b), annex to decision 2/CMA.3)	**NA**		**NA**	**NA**			
Annual anthropogenic emissions by sources and removals by sinks covered by its NDC or, where applicable, from the emission or sink categories as identified by the host Party pursuant to paragraph 10 of annex to decision 2/CMA.3 (para. 23(a), annex to decision 2/CMA.3) (as part of para. 77 (d)(i) of the MPGs)	**kt CO_2eq**		**3 272 650**	**3 205 223**			
Annual anthropogenic emissions by sources and removals by sinks covered by its NDC or, where applicable, from the portion of its NDC in accordance with paragraph 10, annex to decision 2/CMA.3 (para. 23(b), annex to decision 2/CMA.3)	**kt CO_2eq**		**3 272 650**	**3 205 223**			
If applicable, annual level of the relevant non-GHG indicator that is being used by the Party to track progress towards the implementation and achievement of its NDC and was selected pursuant to paragraph 65, annex to decision 18/CMA.1 (para. 23(i), annex, decision 2/CMA.3)	**NA**		**NA**	**NA**			
Annual quantity of ITMOs first transferred (para. 23(c), annex to decision 2/CMA.3) (para. 77(d)(ii) of the MPGs)	**kt CO_2eq**		**To be reported in subsequent BTR**	**To be reported in subsequent BTR**			
Annual quantity of mitigation outcomes authorized for use for other international mitigation purposes and entities authorized to use such mitigation outcomes, as	**NA**		**NA**	**NA**			

appropriate (para. 23(d), annex to decision 2/CMA.3) (para. 77(d)(ii) of the MPGs)							
Annual quantity of ITMOs used towards achievement of the NDC (para. 23(e), annex to decision 2/CMA.3) (para. 77(d)(ii) of the MPGs)	**kt CO_2eq**		**To be reported in subsequent BTR**	**To be reported in subsequent BTR**			
Net annual quantity of ITMOs resulting from paras. 23(c)-(e), annex to decision 2/CMA.3 (para. 23(f), annex to decision 2/CMA.3)	**kt CO_2eq**		**To be reported in subsequent BTR**	**To be reported in subsequent BTR**			
If applicable, the cumulative amount of ITMOs, divided by the number of elapsed years in the NDC implementation period (para. 7(a)(ii), annex to decision 2/CMA.3)	**NA**		**NA**	**NA**			
Total quantitative corresponding adjustments used to calculate the emissions balance referred to in para. 23(k)(i), annex to decision 2/CMA.3, in accordance with the Party's method for applying corresponding adjustments consistent with section III.B, annex to decision 2/CMA.3 (Application of corresponding adjustments) (para. 23(g), annex to decision 2/CMA.3)	**kt CO_2eq**		**To be reported in subsequent BTR**	**To be reported in subsequent BTR**			
The cumulative information in respect of the annual information in para. 23(f), annex to decision 2/CMA.3, as applicable (para. 23(h), annex to decision 2/CMA.3)	**kt CO_2eq**		**To be reported in subsequent BTR**	**To be reported in subsequent BTR**			
For metrics in tonnes of CO2 eq. or non-GHG, an annual emissions balance consistent with chapter III.B (Application of corresponding adjustment), annex, decision 2/CMA.3 (para. 23(k)(i), annex to decision 2/CMA.3) (as part of para. 77 (d)(ii) of the MPGs)	**kt CO_2eq**		**To be reported in subsequent BTR**	**To be reported in subsequent BTR**			
For metrics in non-GHG, for each non-GHG metric determined by participating Parties, annual adjustments resulting in an annual adjusted indicator, consistent with para. 9 of chapter III.B (Corresponding adjustments),	**NA**		**NA**	**NA**			

annex to decision 2/CMA.3, and future guidance to be adopted by the CMA (para. 23(k)(ii), annex to decision 2/CMA.3)							
Any other information consistent with decisions adopted by the CMA on reporting under Article 6 (para. 77(d)(iii) of the MPGs)	**The EU will account and report for its cooperation with other Parties in a manner consistent with the guidance adopted by CMA1 and any further guidance agreed by the CMA in a subsequent BTR or initial report, when applicable.**						

Notes: (1) Pursuant to para. 79 of the MPGs, each Party shall report the information referred to in paras. 65–78 of the MPGs in a narrative and common tabular format, as applicable. (2) A Party may amend the reporting format (e.g. Excel file) to remove specific rows in this table if the information to be provided in those rows is not applicable to the Party's NDC under Article 4 of the Paris Agreement, in accordance with the MPGs. (3) The Party could add rows for each additional selected indicator.

[a] This table could be used for each NDC target in case Party's NDC has multiple targets.

[b] Parties may provide information on conditional targets in a documentation box with references to the relevant page in their biennial transparency report.

6 Annex 2: Methodology applied for the identification of GHG emissions from international aviation and navigation in the scope of the EU NDC

The scope of the EU NDC goes beyond national GHG emissions and removals in the scope of the national GHG inventory; it also includes specific emissions from international aviation and navigation. This annex describes the methodology for identifying these emissions.

International aviation and maritime emissions are estimated by using the Joint Research Centre's Integrated Database of the European Energy System (JRC-IDEES).[138] It allows to split the international transport CO2 emissions into intraEU/extraEU and intraEEA/extraEEA and the departing flights from the EU to the UK and Switzerland, categories backwards in time (i.e. 1990) (i.e. for the time period back to 1990).[139]

For international transport, JRC-IDEES applies a decomposition methodology that reconciles the scopes of available primary statistics and harmonises historical data on international aviation and maritime emissions, energy use, and transport activity. The resulting annual dataset covers 1990-2021 and distinguishes domestic, intra-EU/intra-EEA, and extra-EU/extra-EEA activity for each EU Member State, Norway and Iceland.

In aviation, JRC-IDEES distinguishes passenger and freight modes, with three geographical categories of flight origin/destinations for each mode: domestic, intra-EEA + UK, and extra-EEA + UK. Intra-EU, the UK, and EEA[140] categories are also used internally during calibration but aggregated for reporting. For each mode/category combination, JRC-IDEES estimates activity (as passenger-km or tonnes-km), energy use and CO_2 emissions, aircraft stock (expressed as representative aircraft), load factors, and aircraft efficiencies. As country-specific activity statistics are not available, the decomposition first allocates EU-level activity data from the Transport Pocketbook[141] of the European Commission's Directorate-General for Mobility and Transport to each country and flight category.

For passenger modes, this allocation calculates average load factors using Eurostat data on total passengers and flights. These load factors and total flight numbers are combined with average flight distances from EUROCONTROL, the pan-European organisation dedicated to air traffic management, to yield an initial estimate for passenger transport activity. For intra-EU activity, a uniform scaling factor is then applied across Member States to match total EU-level Transport Pocketbook data. Freight activity follows a similar process, using a 'representative flight' concept with a common load factor across all Member States to account for mixed passenger-freight flights.

138 European Commission, Joint Research Centre, Rózsai, M., Jaxa-Rozen, M., Salvucci, R., Sikora, P., Tattini, J. and Neuwahl, F., JRC-IDEES-2021: the Integrated Database of the European Energy System – Data update and technical documentation, Publications Office of the European Union, Luxembourg, 2024, doi:10.2760/614599.

139 The JRC-IDEES analytical database is designed to support energy modelling and policy analysis, by combining primary statistics with technical assumptions to compile detailed energy-economy-emissions historical data for each key energy sector. For aviation, EEA emissions includes emissions related to the UK but not to Switzerland, where total CO_2 emissions for the scope are additionally estimated from EUROCONTROL data.

140 In this annex, EEA stands for European Economic Area, which comprises the 27 EU Member States, Iceland, Liechtenstein and Norway.

141 Statistical pocketbook 2023, https://transport.ec.europa.eu/facts-funding/studies-data/eu-transport-figures-statistical-pocketbook/statistical-pocketbook-2023_en.

Next, the decomposition estimates fuel use from EUROCONTROL data, by deriving a distance-dependent average aircraft efficiency, then applying it to the country-specific ensemble of flights and routes. The final step scales the estimates to meet Eurostat energy balances for total domestic and international consumption back to 1990 values, maintaining intra-EEA/extra-EEA fuel use ratios derived from EUROCONTROL. JRC-IDEES additionally reports resulting differences with submissions by Parties to the UNFCCC. The above process is followed throughout the entire decomposition period (1990-2021). Data gaps are estimated from the existing indicators as follows:

The process iterates backwards towards 1990, starting from the oldest years in which data is available in each Member State.

Average flight distance is kept constant for early years without EUROCONTROL data (generally before 2004).

If the load factor (passengers per flight) cannot be calculated due to a lack of passenger and/or flight data, it is estimated from the trend of the existing time series.

Missing numbers of flights are calculated from the load factor and the passengers carried.

If no passenger data is available, the total mileage is estimated from the energy consumption, and combined with average flight distance to estimate the number of flights. The number of flights is then combined with the load factor to estimate the total passengers carried.

For early years without data, constant values are assumed for the factors used to *i)* scale intra-EU activity to the Transport Pocketbook, *ii)* adjust the estimated fuel use to EUROCONTROL data for specific routes, and *iii)* scale this adjusted fuel use to Eurostat energy balances (e.g. before 1995 for Transport Pocketbook data; before 2004 for EUROCONTROL data).

For international maritime transport, JRC-IDEES estimates data both for intra-EU/extra-EU and intra-EEA/extra-EEA geographical categories. The emission estimates in the GHG inventory already include CO_2, CH_4, and N_2O gases. Transport activity (tonnes-km) is estimated from Eurostat data on gross weight of transported goods, using port-level and country-level data for intra-EU and extra-EU categories, respectively. Intra-EU activities are then scaled to match the Transport Pocketbook totals, accounting for domestic coastal shipping (calibrated separately in JRC-IDEES). Next, transport activity is combined with data reported under the monitoring, reporting and verification system for maritime transport under the EU ETS ('THETIS MRV'[142]), namely EU-level mileage data and country-specific vessel sizes to estimate load factors (tonnes per movement). The load factors and resulting annual mileage (km) are calibrated to meet EU-level THETIS MRV mileage. The annual mileage is in turn combined with THETIS MRV average efficiency to yield a total technical energy consumption, with corresponding emissions derived from default emissions factors. This energy consumption is scaled to Eurostat energy balances so as to minimise discrepancy to total intra-EU THETIS MRV emissions. As with aviation, JRC-IDEES reports corresponding differences to submissions under the UNFCCC. Early years with data gaps are estimated from existing indicators as follows:

The process iterates backwards towards 1990, starting from the oldest years in which data is available in each Member State.

Average distance of voyages is kept constant for early years without Eurostat activity data (generally before 1997-2000).

142 THETIS MRV, https://mrv.emsa.europa.eu/#public/eumrv.

If the load factor (tonnes per movement) cannot be estimated due a lack of activity data, it is kept constant.

If activity data is not available, it is estimated from Eurostat energy consumption.

Missing mileage data is derived from the activity and load factor estimates.

For early years without data, constant values are assumed for the factors used to i) scale intra-EU activity to the Transport Pocketbook, ii) scale estimated mileage to meet EU-level THETIS MRV mileage, and iii) scale domestic and intra-EU CO_2 emissions estimated from energy consumption so as to match total THETIS MRV CO_2 emissions.

Finally, the ratios between the estimated MRV emissions and the CO_2 emissions for the reported transport activity (for intra-EU/EEA and extra-EU/EEA categories) between 2018 and 2021 are used to calculate the MRV compliant estimates back to 1990 levels.

For the year 2022, the international navigation and aviation emissions under the EU NDC scope have been estimated by applying the same share of those emissions on the total international navigation and aviation emissions (as reported in the GHG inventory) as in 2021.

Table 19: Aviation emissions covered by the EU NDC scope

Emissions	Domestic aviation		Intra-EEA aviation			Extra-EEA aviation
	Domestic EU flights (e.g. Palermo Milan)	Domestic "non-EU EEA" flights (e.g. Oslo to Bergen)	Flights between "non-EU EEA" countries (from Oslo to Reykjavik)	Flights within the EEA, departing from EU airports	Flights to/from EU airports to OMRs	Departing flights from EU airports to UK and Switzerland
Current NDC commitment	Yes	No	No	Yes	Yes From Jan 2024	Yes

Table 20: Maritime navigation emissions covered by the EU NDC

Emissions	Domestic maritime navigation		International maritime navigation				International maritime navigation	
	Voyages within a MS (e.g. Valencia - Barcelona)	Voyages within NO/IS (e.g. Oslo – Bergen)	Voyages between two EU MS (e.g. Valencia - Rotterdam))	Voyages between a MS and NO/IS (e.g. Rotterdam - Oslo)	Voyages between an EU MS and a third country	Voyages between NO/IS and a third country (or IS/NO)	Emissions within a port of an EU MS (reported under domestic emissions)	Emissions within a port of NO or IS (or another third country)

Emissions	Domestic maritime navigation		International maritime navigation				International maritime navigation	
Current NDC commitment (CO2; CH4; N2O)	Yes	No	Yes	No	No	No	Yes	No