

TREIBHAUSGAS-PROJEKTIONEN FÜR DEUTSCHLAND

# Greenhouse gas projections 2024 for Germany - Framework data





GREENHOUSE GAS PROJECTIONS FOR GERMANY

KLIFOPLAN of the Federal Ministry for Economic Affairs and  
Climate Protection

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## **2024 greenhouse gas projections for Germany - framework data**

from

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**Short description: Greenhouse gas projections 2024 for Germany - framework data**

This document contains the overarching framework data for the 2024 projections. These include, on the one hand, demographic and overall economic development. On the other hand, energy prices and prices for greenhouse gas emission certificates are derived.

**Abstract: Greenhouse gas projections 2024 for Germany – Modeling data**

This document comprises overarching modeling data for the projections 2024. These include on the one hand data on the demographic and economic development. On the other hand, energy prices as well as prices for GHG emission certificates are derived.

This document is an update and supplement to the publication Mendelevitch et al. (2022). Large parts of the text are taken from this publication. Only where there were updates to the content was the text adapted accordingly. Tables and figures are filled with the new framework data and other data used for the classification, some of which are similar to those from Mendelevitch et al. (2022).

The processing status of the framework data is from the beginning of December 2023.

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## List of abbreviations

abbreviation	Explanation
<b>BBSR</b>	Federal Institute for Building, Urban and Spatial Research
<b>BEHG</b>	Fuel Emissions Trading Act
<b>GDP</b>	gross domestic product
<b>BMDV</b>	Federal Ministry for Digital and Transport
<b>BMWK</b>	Federal Ministry for Economic Affairs and Climate Protection
<small>Federal Constitutional Court</small>	Federal Constitutional Court
<b>CARMEN</b>	Central agricultural raw material marketing and energy network
<b>CDM</b>	Clean Development Mechanism
<b>CO<sub>2</sub></b>	Carbon dioxide
<b>EEG</b>	Renewable Energy Act
<b>EEX</b>	European Energy Exchange
<b>EUA</b>	EU Allowance
<b>EU COM</b>	European Commission
<b>EU ETS</b>	EU emissions trading system
<b>Hu</b>	lower calorific value
<b>JI</b>	Joint Implementation
<b>KTF</b>	Climate and transformation fund
<b>MMS</b>	With-measures scenario
<b>MSR</b>	Market stability reserve
<b>MWMS</b>	With additional measures scenario
<b>VAT</b>	VAT
<b>NECP</b>	National Energy and Climate Plan
<b>nEHS</b>	national emissions trading system
<b>OPEC</b>	Organization of Petroleum Exporting Countries
<b>StBA</b>	Federal Office of Statistics
<b>TFZ</b>	Technology and support center in the competence center for young talent raw materials
<b>WEO</b>	World Energy Outlook
<b>WSF</b>	Economic Stabilization Fund





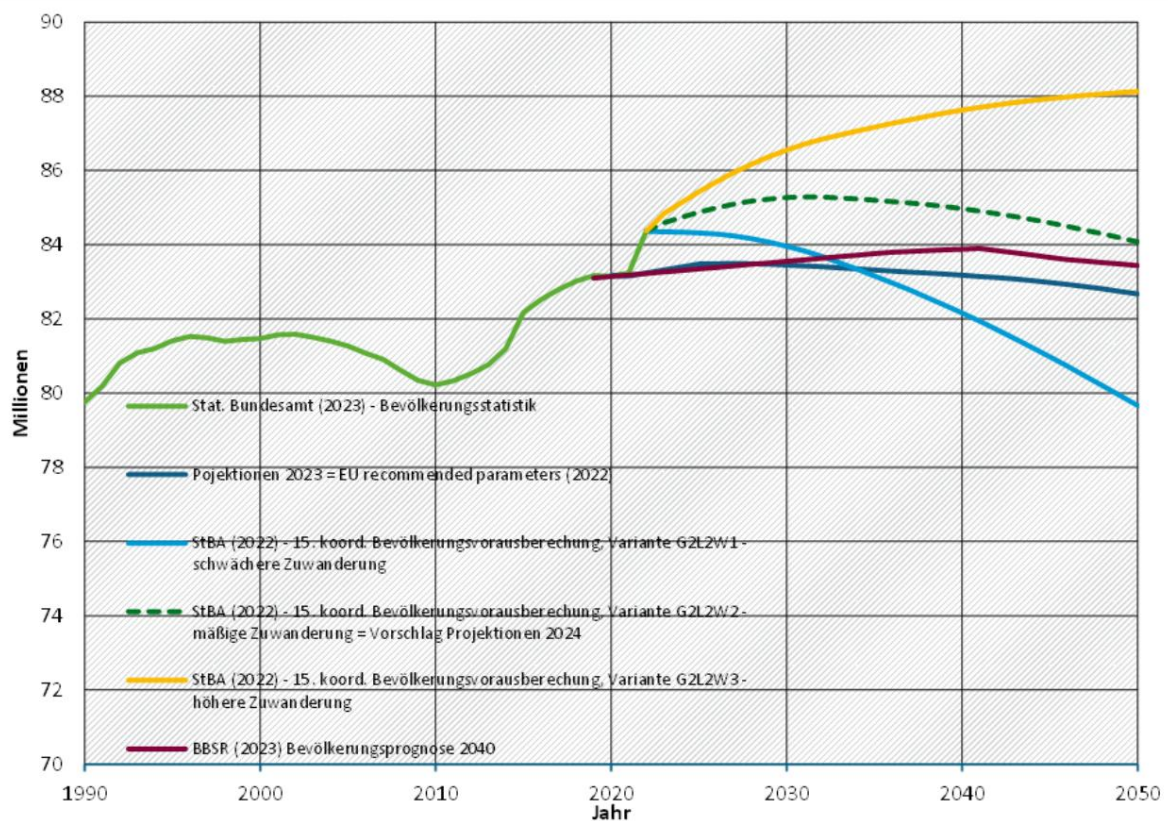
# 1 Demographic and macroeconomic framework data

## 1.1 Demographic development

Demographic development is an important factor for greenhouse gas projections. There is a direct connection between population size and greenhouse gas emissions, e.g. B. through the use of fuels for transport and heating purposes.

As a result, the assumptions about population development play an important role in the estimates of future emissions development. Figure 1 shows a comparative comparison of current population projections from the Federal Statistical Office (Federal Statistical Office 2023a), the Federal Institute for Building, Urban and Spatial Research (BBSR) and the projections for 2023.

**Figure 1: Current population projections in comparison**



Source: Own illustration; Mendelevitch et al. (2022); Federal Statistical Office (2023a); Federal Statistical Office (2023b); European Commission (EC) (2022); Kluth et al. (2023)

After the 2011 census was published, the population figures in the population statistics of the Federal Statistical Office (StBA) were corrected downwards (by 1.6 million people). From 2011 onwards, the 2011 census will form the basis for the StBA's population statistics.

The Federal Statistical Office published the 15th coordinated population forecast in several versions in 2022. It is based on the population level as of December 31, 2021. Its assumptions already show a greater range in the first forecast year (2022) than in previous calculations, as population development is currently characterized by great uncertainty.

On the one hand, it is characterized by the corona pandemic, which is accompanied by a change in the

mortality, fertility and migration, as well as from 2022 onwards by particularly high net immigration to Germany, especially as a result of the Russian war of aggression against Ukraine.

Variants 1 to 3 are shown in Figure 1. They assume an increase and subsequent stabilization of the birth rate at the level of 1.55 children per woman and a moderate increase in life expectancy at birth for boys to 84.6 and for girls to 88.2 years by 2070. The difference in these three variants lies in the migration balance. Variant 1 (net migration W1) assumes an average net immigration of 180,000 people between 2022 and 2070, the net migration in variant 2 (W2) is 290,000 people per year and variant 3 assumes a net migration (W3) of 400,000 people per year.

The values of variants 1 to 3 were scaled to the current population level at the end of 2022, since the Federal Statistical Office's calculations are based on the population level as of December 31, 2021 and different increases in net migration for 2022 were assumed within the variants.

The Federal Ministry for Digital and Transport (BMDV) is currently having a new strategic long-term traffic forecast "Traffic Forecast 2040" (VP 2040) drawn up. As part of this traffic forecast, the Federal Institute for Building, Urban and Spatial Research (BBSR) has developed a spatially and factually differentiated "Population Forecast 2040" for the BMDV (Kluth et al. 2023). The "Population Forecast 2040" also takes into account the long-term demographic effects of migration and the war in Ukraine.

The 2023 projections were based on the "Recommended parameters for reporting on GHG projections in 2023" (European Commission (EC) 2022) on population development provided by the EU Commission every two years. To create the projections, the EU Commission provides assumptions every two years, among other things, on population development in the individual member states of the European Union ("Recommended parameters for reporting on GHG projections in 2023" (European Commission (EC) 2022). The core variables of population modeling come from the Eurostat population projections EUROPOP20191 and include updated values for the historical data (2020-2021) from the recent publication of the Eurostat population dataset2.

**For the 2024 projections, the G2-L2-W2 variant is used due to comparability with previous projections.**

Table 1 provides an overview of population trends for the individual sources.

**Table 1: Population development**

Sources	Population in million					
	2022	2025	2030	2035	2040	2050
StBA (2022) - Population statistics	84.4					

<sup>1</sup>[https://ec.europa.eu/eurostat/cache/metadata/en/proj\\_23n\\_esms.htm](https://ec.europa.eu/eurostat/cache/metadata/en/proj_23n_esms.htm)

<sup>2</sup>[https://ec.europa.eu/eurostat/databrowser/view/proj\\_19np/default/table?lang=en](https://ec.europa.eu/eurostat/databrowser/view/proj_19np/default/table?lang=en)

Sources	Population in million					
StBA (2022) - 15th coord. Population forecast, variant G2L2W1	84.0	84.0	83.6	82.8	81.8	79.4
StBA (2022) - 15th coord. Population forecast, variant G2L2W2	84.2	84.8	85.2	85.1	84.9	84.0
StBA (2022) - 15th coord. Population forecast, variant G2L2W3	84.4	85.8	86.8	87.3	87.7	88.2
Projections 2023 = EU recommended parameters (2022)	83.2	83.5	83.5	83.3	83.2	82.7
BBSR (2023) Population forecast 2040	83.2	83.3	83.6	83.8	83.9	83.4
Projections 20243	84.4	84.9	85.3	85.2	85.0	84.1

Source: Own illustration; Mendelevitch et al. (2022); Federal Statistical Office (2023a); Federal Statistical Office (2023b); European Commission (EC) (2022)

## 1.2 Overall economic development

Gross domestic product (GDP) is an indicator of the value added in the production of goods and services. Depending on the greenhouse gas intensity, these contribute to greenhouse gas emissions to varying degrees. Over time, GDP has become significantly decoupled from the development of greenhouse gas emissions. Nevertheless, GDP and the associated use of fossil energies represent a greenhouse gas driver, especially in the manufacturing sector. This connection is taken into account in the models for projecting greenhouse gas emissions, which is why the growth rate of GDP, ie the change in GDP over time, is an important influencing factor for the development of emissions.

The following forecasts for real GDP for Germany are currently available (October 2023):

ÿ The Federal Government's autumn forecast from October 2023 (Federal Ministry of...

Economy and Climate Protection (BMWK) and Federal Ministry of Finance (BMF) 2023): In the current projection, the federal government expects a weakening of gross domestic product of -0.4% in 2023, triggered, among other things, by the aftereffects of the energy crisis and the necessary fight against inflation the European Central Bank However, the federal government assumes that the economy will recover with growth of 1.3% in 2024 and 1.5% in 2025. The economic upswing in the coming years will be supported by the further decline in inflation, which will allow real incomes to rise again and thus form the basis for a domestic economic recovery. In the years 2026 to 2028, the forecast growth is 0.6%.

ÿ Bundesbank projection 2023 (Deutsche Bundesbank 2021): The current projections of the

According to the German Bundesbank, the German economy is recovering only slowly from the crisis

3 The values of the variant G2-L2-W2 are scaled to the current population level at the end of 2022 for the 2024 projections, since the Federal Statistical Office's calculations are based on the population level as of December 31, 2021 and this variant assumes a migration balance in 2022 of 1, 3 million people (W1 assumes a net migration of 1.1 million people and W3 of 1.5 million people).

Crises of the past three years. High inflation reduces the purchasing power of private households. In 2023, economic development is expected to slowly recover, but due to the decline in the last winter half, gross domestic product is expected to shrink by 0.3%. In the following two years, 2024 and 2025, the economy is expected to grow by 1.2%.

ÿ The projections of the Expert Council for the Assessment of Macroeconomic Development (Council of Experts for the Assessment of Macroeconomic Development 2023) and the Joint Diagnosis Project Group of the Federal Ministry for Economic Affairs and Climate Protection (Joint Diagnosis Project Group 2023) for the years 2024 and 2025 are within the framework of the Federal Government's autumn forecast. For 2023, the project group assumes a stronger downturn of -0.6%.

ÿ The Federal Ministry for Digital and Transport (BMDV) has as part of the In addition to the strategic long-term traffic forecast "Traffic Forecast 2040", a spatially and factually deeply differentiated "Economic Forecast 2040" (Economics Trends Research (ETR) 2022) can be developed. This economic forecast was also included in the moving long-term traffic forecast, which was carried out on behalf of the Federal Ministry for Digital and Transport (Kluth et al. 2023). The economic forecast predicts an increase in the gross domestic product in Germany of 1.35% pa in real terms until 2040 and 1.26% pa thereafter

The 2023 projections for the years 2022 to 2027 are based on the Federal Government's 2022 autumn projection (Federal Ministry for Economic Affairs and Climate Protection (BMWK) and Federal Ministry of Finance (BMF) 2022). Until 2031, it is assumed that growth rates will remain at the level of 2027. From 2032 they will follow the growth rates of the European Commission (EC) (2022) from spring 2022.

For the 2024 projections, it is proposed to follow the growth rates of the Federal Government's autumn projection up to 2028 and for the following years up to 2050 the growth rates of the European Commission (EC) (2022).

A summary of the various sources and their growth rates can be found in Table 2.

**Table 2: Annual growth rates of the gross domestic product for Germany in various projections for the years 2020-2050 in percent**

	2021	2022	2023	2024	2025	2026	2027	2028	2030	2035	2040	2045	2050
History (StBa 2023)	3.2	1.8											
Federal government autumn projection 2023				-0.4	1.3	1.5	0.6	0.6			0.6		
Bundesbank 2023				-0.5	1.2	1.2							
Council of Experts (03-2023)				0.2	1.3								

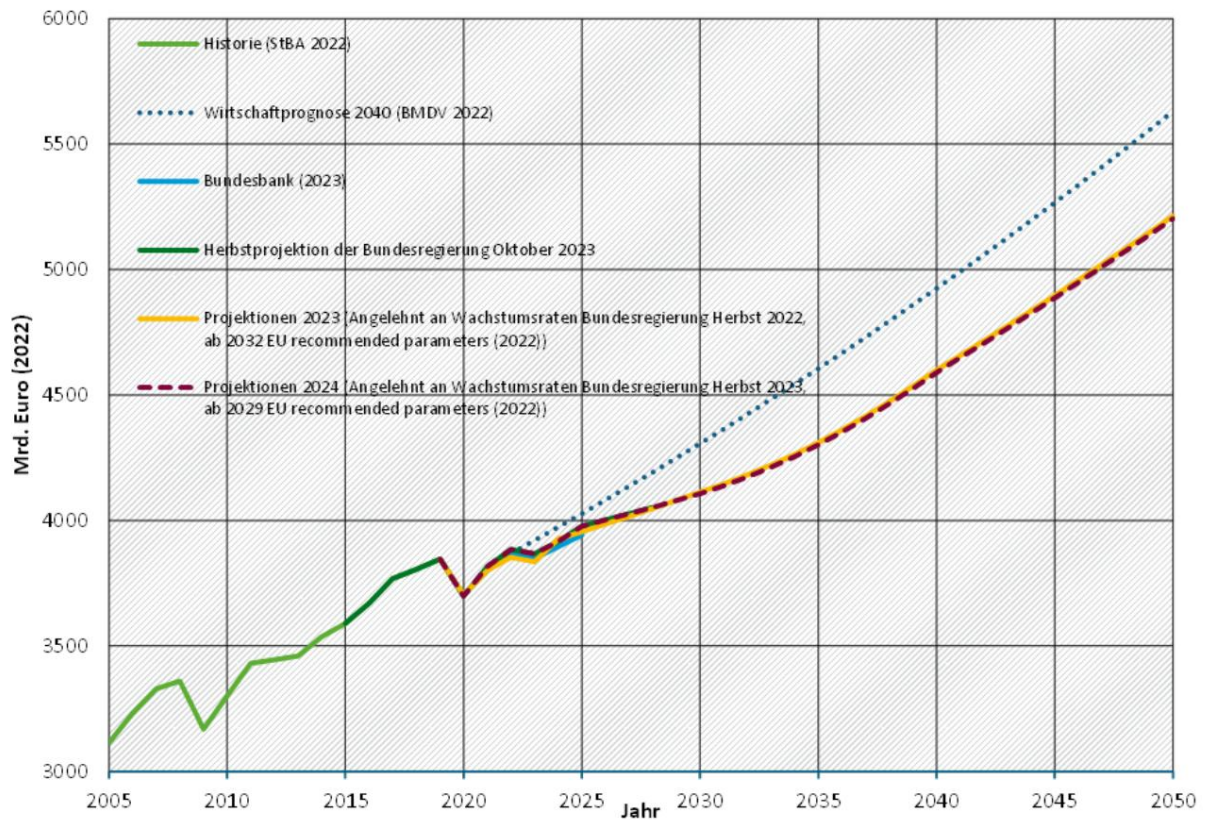


	2021	2022	2023	2024	2025	2026	2027	2028	2030	2035	2040	2045	2050
Community diagnosis (09-2023)				-0.6	1.3	1.5							
economic forecast 2040 (BMDV 2022)	1.35	1.35	1.35	1.35	1.35	1.35	1.35				1.35	1.35	1.26
EU recommended parameters (2022)	2.9	1.6	2.4	1.6	0.9	0.8	0.7	0.7	0.7	0.7	1.1	1.4	1.3
Projections 2023	2.6	1.4	-0.4	2.3	0.8	0.8	0.8	0.8	0.8	0.8	1.1	1.4	1.3
2024 projections	3.2	1.8	-0.4	1.3	1.5	0.6	0.6	0.6	0.6	0.7	1.1	1.4	1.3

Source: Own calculations based on the sources listed above

Figure 2 compares the historical development (black solid line) and current and previous GDP projections. This is for the 2024 projections Proposed GDP is highlighted in dashed red.

**Figure 2: Comparison of different gross domestic product projections**



Source: Own representation based on the Federal Statistical Office (2023c); Deutsche Bundesbank (2021); Mendelevitch et al. (2022); Federal Ministry of Economics and Climate Protection (BMWK) and Federal Ministry of Finance (BMF) (2023); European Commission (EC) (2022); German Bundestag (2019)

## 2 energy price projections

### 2.1 Preliminary remarks

In the run-up to and especially after the outbreak of the Russian Federation's war of aggression against Ukraine on February 24, 2022, the situation on the wholesale fuel markets was extremely confusing. Initially, it was not clear whether and by when a "normalization" of the key indicators on the fuel markets could be expected. However, it seems to be becoming apparent that after a phase of extreme price increases since autumn 2022, a trend reversal has taken place. However, it cannot be ruled out that some price levels will shift compared to the pre-02/24/2022 levels. An orientation based on the price dynamics of the major mainstream projections still appears to make sense.

The recommendations for the framework assumptions used as the basis for the projections Price paths are based on the following basic principles:

- As good a connection as possible to price trends currently observed on the market. This is ensured in particular by providing historical data and using Futures<sup>4</sup> and expert estimates.
- The best possible consistency between the projections of individual price trends for the medium to long term, which is achieved by selecting the same scenario as the basis for the dynamics.
- Plausibility of the projections in the context of current developments on global energy markets and global climate policy ambition levels.
- In order to take into account the high dynamics of the energy, fuel and CO<sub>2</sub> certificate markets, the basic procedure and the selection of orientation parameters are defined within the framework of this coordinated paper.
- The final parameters are based on those currently available at the time of creation Futures and expert estimates as shown in the relevant sections, as well as long-term trends extracted from the World Energy Outlook (WEO) 2023 (International Energy Agency (IEA) 2023).

### 2.2 Summary of the framework data for the 2024 projections proposed primary energy prices

Table 3 summarizes the energy prices chosen as framework data for the projections and provides a comparison with the data used in the 2023 projections. The following texts present the considerations for compiling the projections and explain the approaches used for the projections.

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<sup>4</sup> Really traded futures used for medium-term price forecasts also contain assumptions about the general development of the Inflation (contracts only have to be settled on the due date). Assumptions must therefore be made about the inflation expectations underlying the futures. To do this, it is important to keep inflation estimates consistent with the time periods for which the futures were collected. To ensure consistent treatment of prices as well as taxes and levies, the deflators determined are also used to index levies and taxes, for example in order to reflect real, constant taxes in the modelling.

For the primary, final energy and CO<sub>2</sub> price projections, the GDP deflators were used for the years up to 2022, a value of 5.8% for 2023 and 2.6% for 2024; a decline to the long-term target of 2% was assumed by 2027, and for that This value is assumed to remain at this level until 2050.

**Table 3: Recommendation for 2024 projections and comparison with 2023 projections: Energy price projections for crude oil, natural gas and hard coal at 2022 prices (€/MWh Hu), 2023-2050**

		Unit	2023 <sup>*</sup>	2024	2025	2030	2035	2040	2045	2050	
<b>Recommendation – Projections 2024</b>	crude oil Brent	EUR(2022)/MWh (NCV)	43.4	39.6	36.5	28.6	27.2	25.9	24.5	23.2	
	Hard coal	EUR(2022)/MWh (NCV)	16.0	15.2		14.4	12.2	11.5	10.8	10.2	9.5
	natural gas	EUR(2022)/MWh (NCV)	57.7	56.3		48.0	22.8	21.9	20.9	19.9	19.0
<b>Projections 2023</b>	crude oil Brent	EUR(2022)/MWh (NCV)	54.1	46.9	42.0	32.1	31.6	31.1	30.6	30.1	
	Hard coal	EUR(2022)/MWh (NCV)	33.1	27.0	23.8		12.2	11.7	11.3	10.8	10.4
	natural gas	EUR(2022)/MWh (NCV)	118.0	81.3		58.3	26.7	25.4	24.0	22.7	21.3

Notes: but are \* The reported values for 2023 are not used for modeling the 2024 projections, only listed here for information purposes. The first modeling year is 2024.

Source: own illustration.

Historical data of the respective projections for crude oil and natural gas from the Federal Office of Economics and Export Control (BAFA) (n.d.) and hard coal from the Intercontinental Exchange (ICE) (2023a).

All information is border crossing or northwest European wholesale prices in €/2022/MWh, based on the lower one Calorific value.

## 2.3 Details on price projections for crude oil, hard coal, natural gas and hydrogen

### 2.3.1 Wholesale crude oil prices

Figure 3 first shows the historical development of Brent crude oil prices from 1991 to mid-2022. After a phase of relatively low prices over the course of the 1990s (which was caused, among other things, by the collapse of the Soviet Union and other Eastern and Central European states and the corresponding loss of influence of the OPEC cartel) there were significant price increases after the turn of the millennium, which were followed by a price collapse after the financial and economic crisis and a volatile price situation in the last 5 years. The years 2020 and 2021 were influenced by the special situation of the global Covid-19 pandemic, first by the fall in prices due to reduced demand due to a reduction in economic activity and motorized transport (especially in 2020) and then by an increase in prices (in 2021), which is due, among other things, to economic catch-up effects. From autumn 2021, prices in Europe rose as part of the looming energy crisis and market trends intensified again after the start of the Russian Federation's war of aggression on Ukraine in February 2022.

Since then, the crude oil markets have been characterized by massive turbulence. However, they are Prices remain in a range that was already reached in the years 2011-2013.



Futures<sup>5</sup> for 2023 to 2030 show a clear backwardation trend. There are already signs of a return to the price level that existed before the Covid-19 pandemic in 2019 by 2024. The futures until 2030 point to a further fall in price levels, with market prices that were last observed before the financial crisis. This market trend is not reflected in the recommendations of the European Commission (EC) (2022), which project that the high level of 2022 will remain until 2030.

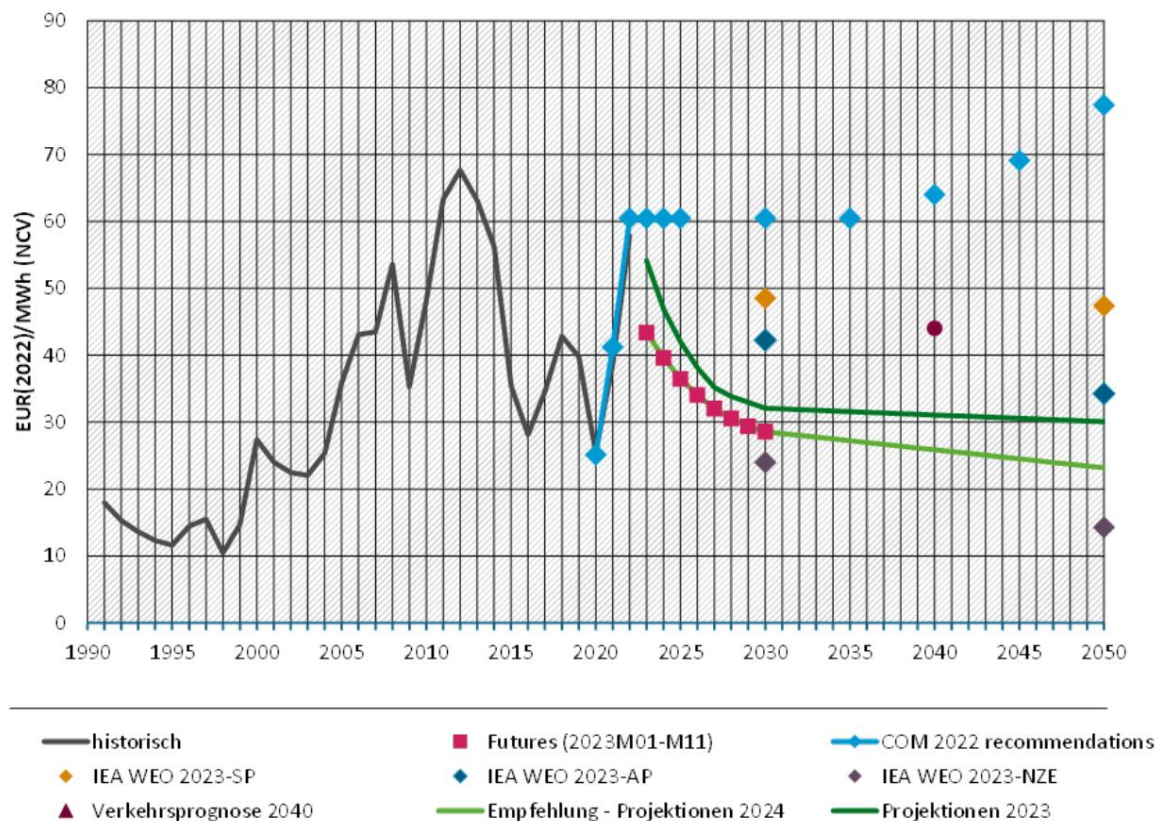
ȳ There is also a divergence between the recommendations of the European Commission (EC) (2022) and the mainstream projections of the World Energy Outlook 2023 (International Energy Agency (IEA) 2023) for the period from 2030 to 2050. All WEO 2023 values are at a significantly lower level. All three scenarios of the WEO 2023 tend to assume a fall in the price of crude oil, while the values for crude oil prices proposed by the EU COM increase from 2035. As part of the "Traffic Forecast 2040", assumptions were also made about the possible development of the crude oil price (Kluth et al. 2023). These trend between the values of the WEO 2023 SP scenario and the WEO 2023 AP scenario.

ȳ From the overview it is derived for the modeling that was carried out at the time of Specification of the framework data for current futures and the current international projection of the WEO 2023 for the development of Brent crude oil prices. To implement the projection, the values corresponding to the current futures will be adopted until 2030. From 2030, the dynamics from the WEO-2023-AP scenario will be adopted.

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5 The underlying assumptions about the development of exchange rates are also a decisive influencing factor, particularly for the conversion of futures that are traded in US dollars (oil and hard coal). In the period 2015-2021, the exchange rates fluctuate in the range of 1.14 USD/EUR, but in the summer of 2022 a parity between USD and EUR was achieved. The average exchange rate for 2022 was 1.05 USD/EUR. The trend reversal continued in the first half of 2023, so that the exchange rate was 1.09 USD/EUR during this period. The futures (<https://www.eurex.com/ex-en/markets/fx/currency-pairs/EUR-USD-Futures-253790>, accessed at the beginning of August 2023) continue to point to a return towards 1.14-1.15 USD/EUR. The following was therefore assumed for the projections: historical values were used until 2022, a value of 1.09 USD/EUR was assumed for 2023, 1.12 USD/EUR was assumed for 2024 and 1.13 USD/EUR was assumed for 2025. It was also assumed that an exchange rate of 1.15 USD/EUR would be achieved again by 2027 and then further remains at this level.

**Figure 3: Prices for crude oil (Brent) in historical trends and for selected projections and recommendation for 2024 projections**



Source: own representation based on: historical prices: Federal Office of Economics and Export Control (BAFA); Futures: Intercontinental Exchange (ICE) (2023b), Projections: European Commission (EC) (2022), International Energy Agency (IEA) (2023).

### 2.3.2 Wholesale natural gas prices

The historical development of natural gas prices (Figure 4) up to 2021 shows a structurally similar picture to that of crude oil prices, even if the volatility is somewhat more pronounced. Furthermore, the situation for 2020 is due to the special situation caused by the crisis and the storage levels of European natural gas storage facilities caused by this and other factors (weather, etc.). As of summer 2021, in the months before the Russian invasion of Ukraine, natural gas deliveries to Central Europe were reduced compared to previous years and natural gas storage facilities were not filled to the same extent as in previous years, leading to an increase in natural gas prices since fall 2021 has. After the start of the Russian Federation's war of aggression against Ukraine in February 2022, these market trends intensified, and further reduced natural gas supply led to an increase in natural gas prices. There was a further increase in prices over the course of 2022. This was driven, among other things, by: the blowing up of North Stream 1 and thus a further physical shortage of delivery quantities, the purchase of additional quantities available on the Central European market to fill the natural gas storage facilities in Germany, and general uncertainty regarding the development of the supply situation. In addition to high spot prices, the latter also resulted in very high prices for future deliveries in the future markets.

By late autumn 2022, but by spring 2023 at the latest, the situation had calmed down significantly: there were no supply bottlenecks and additional ones were being set up

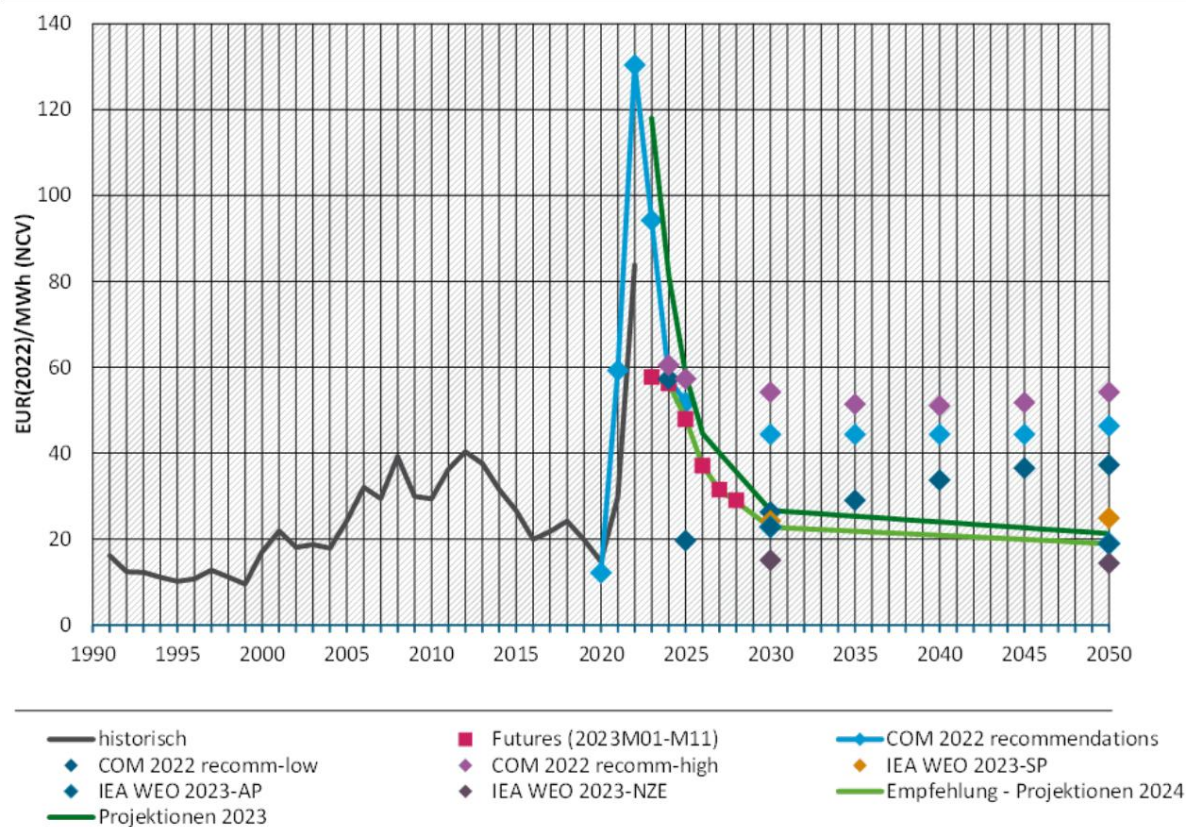
Landing capacities were addressed for the winter of 2023/24 via LNG regasification terminals; storage levels remained at a high level over the winter. Although the prices for 2023 are still at a level that is significantly above the previous price peaks of 2008 and 2012, the futures show a clear backwardation trend, so that the mark of 40 EUR (2022)/MWh will be back by 2026 at the latest

is undercut.

In the synopsis of futures, price projections from the WEO 2023 and recommendations from the European Commission the following characteristics can be derived:

- Both the futures of the European Energy Exchange (EEX) (2023a) for the years 2023 to 2027 and the recommendations of the European Commission (EC) (2022) show a backwardation trend (decreasing trend), although this falls significantly in the futures stronger than in the projections. While the values for 2024 are still relatively close to each other in both cases, the further decline in the futures is much more pronounced than in the Commission recommendation. The low variant, in turn, shows prices for 2025 that are at the price level that prevailed before the Covid-19 pandemic. In contrast, the last available future value for 2027 is still around 50% above this level compared to the level before the Covid-19 pandemic.
  
- The projections for 2030 are for the low version of the recommendation European Commission (EC) (2022) and for the WEO-2023-SP and WEO-2023-AP scenarios closely together. Most projections assume prices will stagnate or fall from 2030 onwards. The exception is the WEO-2023-SP scenario and the low variant of the recommendation of the European Commission (EC) (2022), which projects a slight price increase in the first case and a significant price increase in the second case. While the central projection of the European Commission (EC) (2022) for the years 2030 to 2045 remains consistently slightly below the level of the futures for 2025, the levels projected in the WEO-2023 are significantly lower in all scenarios.
  
- Overall, the recommendations of the European Commission (EC) (2022) appear Predetermined price trajectory after 2025 is not very plausible. In the direction of 2030, price levels well above observed prices before Russia cut natural gas deliveries only appear plausible if a long-term physical shortage of natural gas is expected. Against the background of the measures presented by the Federal Government and the European Commission and the easing of the markets that will begin in late autumn 2022, this does not seem very plausible. The price increase of the low version of the recommendations of the European Commission (EC) (2022) is also not plausible against the background of international efforts for climate protection and the diversification of trading partners in Central Europe and could rather be due to the form of the coupling between oil and gas price developments in the European Commission (EC) projections (2022)  
  
is assumed to be conditional.
  
- For the 2024 projections, a price path that is based on futures up to 2027 is therefore recommended. For the year 2030, the value of the WEO-2023-AP scenario (International Energy Agency (IEA) 2023) is used as a starting point; between 2027 and 2030 the values are interpolated. After 2030, the dynamics from the WEO 2023-AP scenario are adopted.

**Figure 4: Wholesale natural gas prices NWE/THE in the historical trend and for selected Projections and recommendation for 2024 projections**



Source: own representation based on: historical prices: Federal Office of Economics and Export Control (BAFA); Futures: European Energy Exchange (EEX) (2023a), Projections: European Commission (EC) (2022), International Energy Agency (IEA) (2023).

### 2.3.3 Wholesale prices for hard coal

Figure 5 is structurally similar to that of crude oil and natural gas prices. After the loss of operational production due to the Covid-19 pandemic in 2020, the economic recovery in 2021 led to a sharp increase in coal demand, especially in India and China, which are among the largest coal importers on the global market. This led to an increase in coal prices in 2021. After the start of the Russian Federation's war of aggression against Ukraine in February 2022, these market trends intensified, which in Europe is also being driven by additional demand from hard coal-fired power plants to replace generation from natural gas-fired plants. Overall, the situation on the hard coal markets in Europe (similar to natural gas) can be described as very turbulent. But here too, a backwardation trend could be observed from late autumn 2022 at the latest, so that the further price increase expected from the futures for 2023 in summer 2022 did not materialise. In fact, by 2023 the price level will be below the peak values of 2008 and 2011 and only slightly above the value in 2021.

For the years up to 2026, the futures show a clear backwardation trend. Will this one

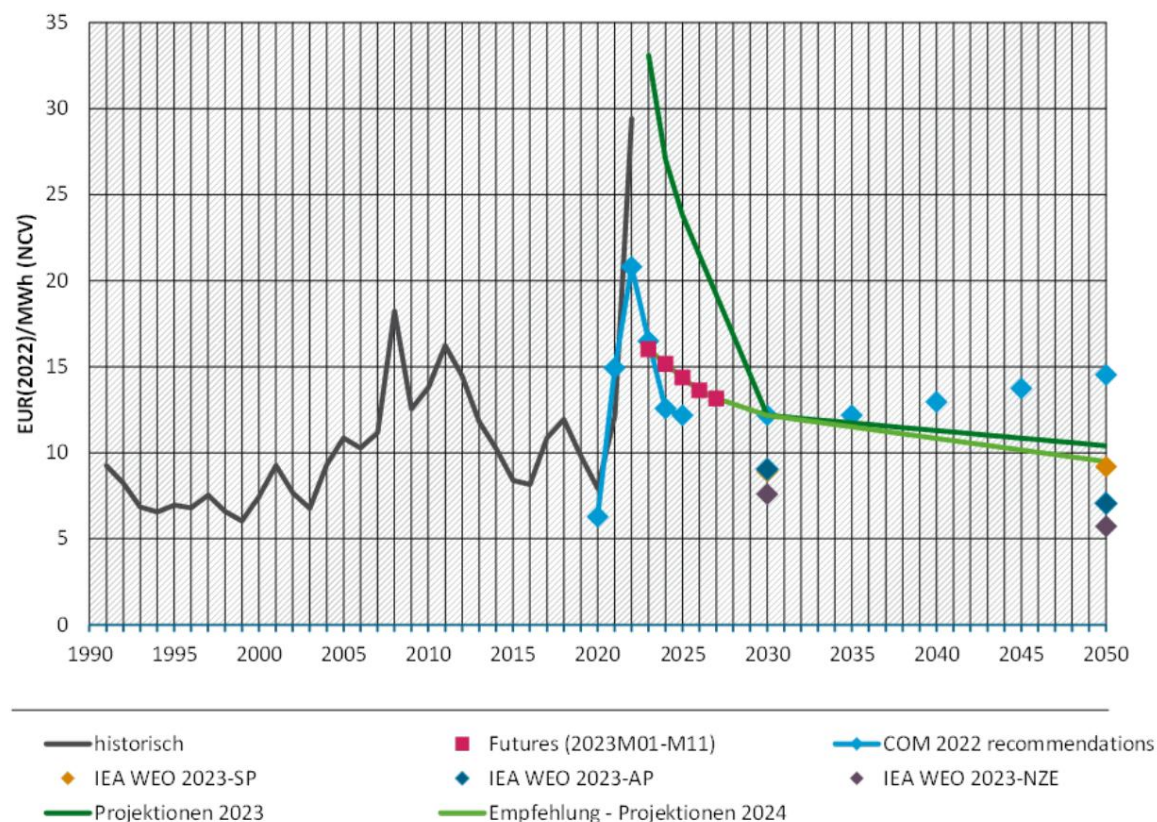
If the trend is continued, the price level will be higher than in the WEO-2023 projections. For the period after 2030, the WEO-2023 projections show a falling price trend, which is consistent with the logic of falling demand for coal in a world with climate policy efforts. Only increases in the WEO-2023-SP scenario



the price of coal. The price projection of the European Commission (EC) recommendations (2022) also shows an upward trend, but this is much more pronounced and does not seem very plausible.

For the 2024 projections, a price path is therefore recommended that takes over the futures until 2026 and continues the existing trend to the value of the recommendations of the European Commission (EC) (2022) until 2030. From 2030, the dynamics of the WEO-2023 AP scenarios adopted for the resulting essay point.

**Figure 5: Wholesale prices for hard coal ARA, historical development and for selected Projections and recommendation for 2024 projections**



Source: own representation based on: historical prices: Federal Office of Economics and Export Control (BAFA) (no Yes) until 2018; from 2019 and Futures own calculations based on Intercontinental Exchange (ICE) (2023a), projections: European Commission (EC) (2022), International Energy Agency (IEA) (2023).

### 2.3.4 Wholesale prices for hydrogen

Due to the technological and regulatory uncertainty and a lack of a liquid market, an estimate of the wholesale prices for hydrogen can only be viewed as a first indicative approximation. To estimate the volume and the resulting prices, production costs at home and abroad as well as transport costs must be taken into account. For long-distance transport, the transport costs (possibly incl.

Conversion/reconversion) plays an important role. A wide range of developments can be assessed as plausible.

Due to the great uncertainty regarding future

Price developments and, on the other hand, the controversially discussed role of hydrogen for the

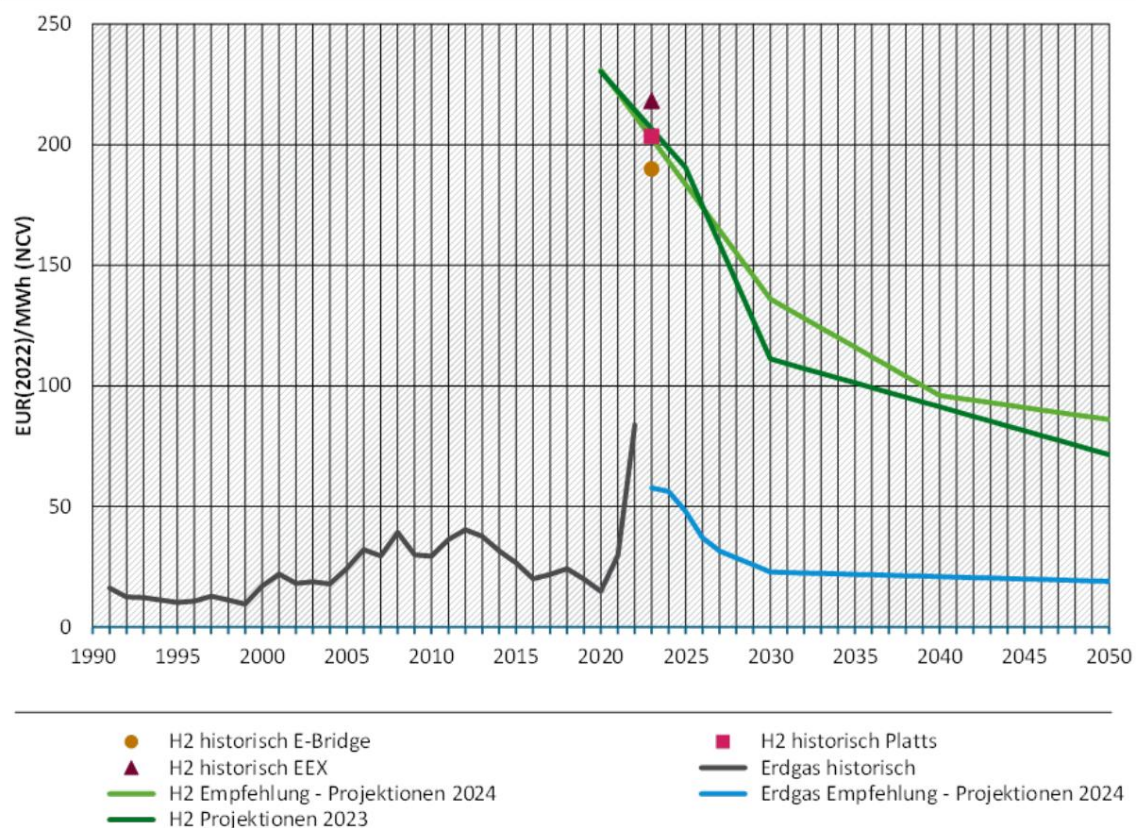
To decarbonize individual sectors, it is recommended to use a price path that is based on a broad consensus between representatives of very different areas

Interest groups in the National Hydrogen Council were developed. The bottom-up study on the decarbonization of the heating sector commissioned by the National Hydrogen Council (Thomsen et al. 2022) provides three agreed price paths, of which only the “Cheap” and “High” paths have been published, the third, middle path is not in the publication contain.

In order to ensure the traceability and robustness of the projection, the average value of the published price paths is used. The prices shown for households include surcharges for the provision of 1.9 ct/kWh Hu. To calculate the wholesale prices, these were deducted from the stated values.

The first market data for the German/Northwest European market is available from the providers E-Bridge, Platts and EEX for 2023. As can be seen in Figure 6, the price information from the three sources shows a significant range. The value for 2023 envisaged for the 2024 projections fits into the range and is roughly in line with Platts' assessment. A liquid market cannot yet be assumed in 2023, so the market prices are only of limited significance. As the hydrogen ramp-up increases, liquid markets will also emerge in the future.

**Figure 6: Wholesale hydrogen prices, current level estimates and projections, as well Recommendation for 2024 projections**



Source: own presentation based on own data and data from Thomsen et al. (2022).

**Table 4: Recommendation for 2024 projections and comparison with 2023 projections: Projection of wholesale hydrogen prices**

	Unit	2023	2024	2025	2030	2035	2040	2045	2050
<b>Recommendation - 2024 projections</b>	EUR(2022)/MWh (NCV)	202.5	193.0	183.5	136.0	116.0			
<b>Projections 2023</b>	EUR(2022)/MWh (NCV)	206.4	198.5	190.6	111.2	101.2			
							96.0	91.0	86.0
							91.3	81.4	71.5

Source: own illustration based on Thomsen et al. (2022) and our own calculations.

## 2.4 Other energy sources

Further energy sources for which assumptions about energy source prices were made are listed below. Beyond this information, prices for other energy sources have not been adjusted for the 2024 projections and are unchanged compared to the 2023 and 2021 projection reports.

### 2.4.1 Biomass

For modeling in the building sector, in addition to the prices for fossil fuels and electricity, end consumer prices for different forms of biomass are also required. The price forecasts are created based on real price information from the base year and, if necessary, beyond. The statistical prices for wood pellets, wood chips and logs come from the Central Agricultural Raw Materials Marketing and Energy Network (CARMEN)

(Central Agricultural Raw Materials Marketing and Energy Network (CARMEN) 2023b, 2023a) as well as the technology and support center in the Competence Center for Renewable Raw Materials (Technology and support center in the Competence Center for Renewable Raw Materials (TFZ) 2023). The price information for biomethane comes from the German Energy Agency (dena) (2023).

The development of prices for individual products is then linked to the development of the price of natural gas.

**Table 5: Development of prices for biomethane, pellets, logs and wood chips**

energy source	Unit	2022	2025	2030	2035	2040	2045
Wood pellets	ct2022/kWh	10.78	7.45	5.55	5.44	5.33	5.22
logs	ct2022/kWh	9.52	9.58	7.15	7.00	6.86	6.72
Wood chips WG 35	ct2022/kWh	3.06	2.77	2.07	2.02	1.98	1.94
Wood chips WG 20	ct2022/kWh	3.90	3.47	2.59	2.53	2.48	2.43
Biomethane	ct2022/kWh	21.60	19.07	14.22	13.93	13.65	13.38

Source: Own calculations

### 2.4.2 District heating

In addition to biomass, district heating is also relevant in the building sector. The end consumer prices for district heating are proportional to the development of the prices for coal, natural gas, biomass and

Power coupled. An increasing share of electricity and biomass is expected by 2045, the share of natural gas is declining, and coal will no longer play a role from 2038.

The basis is the statistical prices from the BMWK energy data (2022a).

**Table 6: Development of prices for district heating**

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Unit	2022	2025	2030	2035	2040	2045
ct2022/kWh	10.82	10.41	9.32	9.25	9.62	9.80

Source: Own calculations



### 3 Development of prices for greenhouse gases

#### Emission certificates in the EU ETS and CO<sub>2</sub> prices for Transport and heat as well as for industrial emissions not covered by the EU ETS

##### 3.1 Development of prices for greenhouse gas emission certificates in the EU ETS

The prices for emission allowances from the European Emissions Trading System for Greenhouse Gases (EU ETS), along with the prices for fuels and other energy sources, are a key determinant of emissions developments in the energy and industrial sectors. The price development in the EU ETS since 2005 is shown in Figure 7. In the years 2012 to 2017, which were characterized by an oversupply of certificates, prices were at a level of less than EUR 10 (2022)/EUA.<sup>6</sup> From 2018 onwards, the measures to reduce the oversupply had an effect, so that prices were again influenced by the fuel switching costs continental European electricity market can be explained. The prices initially moved in a range of 15-30 EUR (2022)/EUA, followed by a sharp increase since autumn 2020 to around 60 EUR (2022)/EUA in autumn 2021. This can be attributed to the resolution on the EU climate law which makes the goal of climate neutrality legally binding for 2050. By fall 2022, the price rose to over 80

EUR(2022)/EUA, which is due to the further measures provided for in the "Fit-for-55" package (Cludius et al. 2022).

The reforms adopted as part of the European Union's Fit For 55 package are crucial for future price developments in the EU ETS. These include, among other things, a tightening of the reduction target to 62% by 2030 (previously it was 43%), a strengthening of the market stability reserve and a reform of free allocation (EU 2023; for an overview of the reforms in detail see also Gores et al. 2023 ). Together with the European Union's Fit For 55 package, the increase in the price of natural gas is an important driving force for the price of the certificates. A shift from natural gas to more carbon-intensive fossil fuels (such as fuel oil for heating and coal for electricity generation) will lead to an increase in demand for allowances in installations covered by the EU ETS, and thus higher prices.

Overall, it should be noted that an assessment of the development of CO<sub>2</sub> prices in the EU ETS is subject to great uncertainty due to the large influence of regulatory interventions, a less liquid market towards 2030 and a lack of markets after 2030. Therefore, where possible, expert estimates or internationally recognized projections are used.

ÿ In this context, the expert estimates from the largest trading houses show a clear contango trend on average for the 2020s (Carbon Pulse 2023). The price will rise to 112 EUR (2022)/EUA by 2026, but after that only slightly to 126 EUR (2022)/EUA. For 2030, the expert value is above the recommendation of the European Commission (EC) (2022) and the WEO 2023 SP scenario, at the level of the WEO 2023

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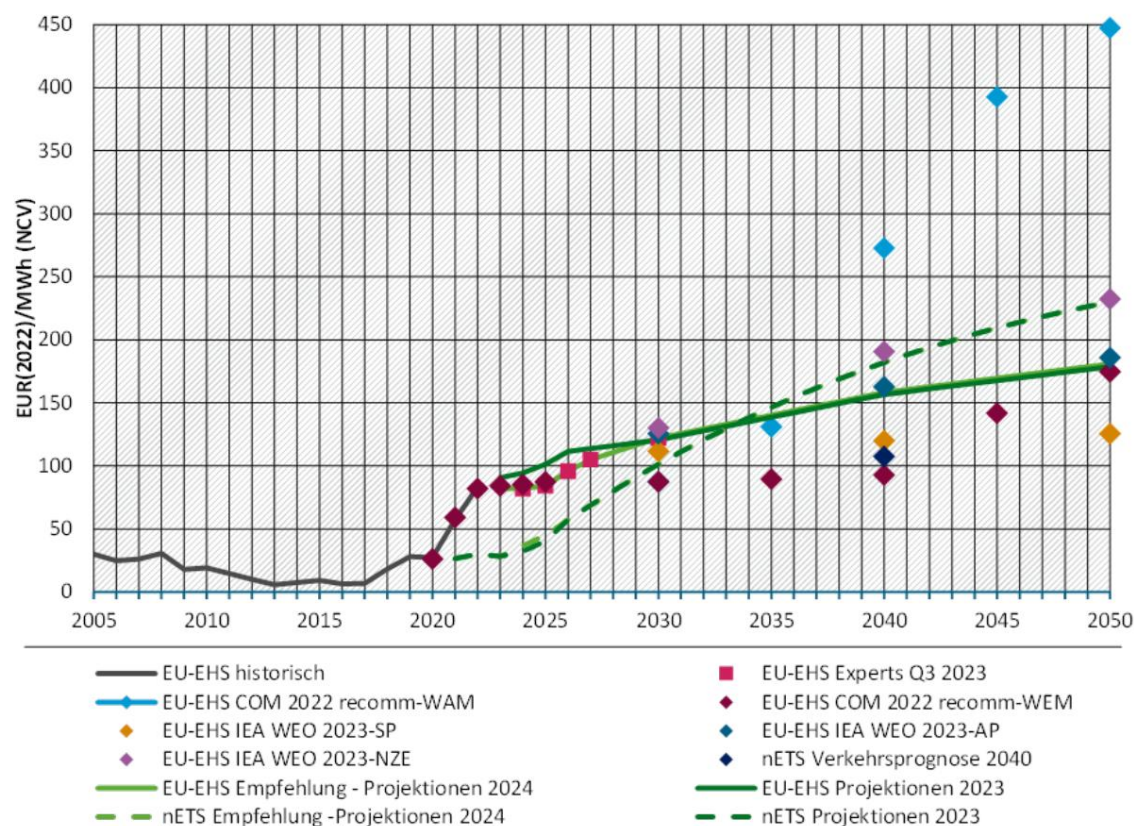
<sup>6</sup> This phase is characterized by an oversupply of certificates, which was caused by several factors: The approval of CDM and JI certificates led to a de facto increase in the emissions budget. At the same time, demand was lower than expected because industrial production declined from 2008 onwards due to the financial and economic crisis (and with it the associated emissions and corresponding demand for certificates) and then slowly recovered. Starting in 2014, supply-side measures were implemented to reduce oversupply. Initially, in the period 2014-

A total of 900 million certificates were withdrawn from the market in 2016 and should initially be returned to the market in 2020. Shortly thereafter, the Market Stability Reserve (MSR), a rules-based mechanism for managing supply, was introduced (Zaklan et al. 2021).

AP (not visible in figure due to overlay), but slightly below the NZE scenario. Remaining at a low level until 2040 in the recommendation of the European Commission (EC) (2022) seems implausible and is not consistent with a continuation of the expert trend. For 2050, the values of the WEO 2023 AP scenario and those of the European Commission (EC) recommendations (2022) are quite close to each other. In contrast, the values of the WAM recommendation of the European Commission (EC) (2022) are not congruent with the strong climate protection scenario WEO-2023-NZE.<sup>7</sup>

ÿ For the 2024 projections, a price path is therefore recommended that adopts the expert recommendation until 2030. From 2030, the dynamics of the WEO 2023 AP scenario are adopted for the resulting entry point. According to the scenario description, this already represents the Fit for 55 package and parts of the REPowerEU plan (International Energy Agency (IEA) (2023)).

**Figure 7: Prices for CO<sub>2</sub> in the EU ETS and under BEHG, historical development and for selected projections and recommendation for 2024 projections**



Source: own representation based on: historical prices: European Energy Exchange (EEX), projection 2024-2030: Carbon Pulse (2023); Projections 2030-2050: European Commission (EC) (2022), International Energy Agency (IEA) (2023).

<sup>7</sup> The latter is probably due to the methodology used and the differences between the WEM and WAM approaches. The accompanying document states: "Table 3 shows the trajectory of the carbon price of the existing ETS in its current scope (power, industry, centralized heat and aviation sectors) up to 2030, corresponding to the legally binding -55% climate target context and considering the central trajectory for international fuel prices. For long-term values beyond 2030, Table 3 shows two trajectories: a trajectory based on the EU Reference Scenario 2020 for the EU ETS carbon price in "WEM" scenarios, and an indicative carbon value trajectory across the economy to reaching the EU climate neutrality for national ("WAM") scenarios. The indicative post-2030 "WAM" trajectory is a modeling driver to achieve the EU 2050 climate neutrality in the FF55 package analysis. It is acknowledged that national analyzes projecting economy-wide GHG emissions compatible with the EU 2050 climate neutrality objective may provide a different carbon value trajectory." The WAM scenario is therefore a target scenario in which no explicitly defined policy mix is modeled and the reported values represent the CO<sub>2</sub> shadow prices.

A distinction between MMS and MWMS CO2 price path is not considered useful. In particular, the greenhouse gas impact of national measures should be reflected in the 2024 projections. With different CO2 price paths, the effects would overlap and could no longer be clearly assigned. This means that only the CO2 price path described above and shown in Table 7 is used in the EU ETS.

**Table 7: Recommendation for 2024 projections and comparison with 2023 projections: Historical development and projection for the price of CO2 in the EU ETS**

		2023 <sup>*</sup>	2024	2025	2030	2035	2040	2045	2050
<b>Recommendation - 2024 projections</b>	EUR(2022)/EUA	82.0	81.9	84.2	122.1	140.2	158.3	169.6	180.9
<b>Projections 2023</b>	EUR(2022)/EUA	90.8	94.3	101.2	120.5	138.6	156.6	167.6	178.6

Notes: but are \* The reported values for 2023 are not used for modeling the 2024 projections, only listed here for information purposes. The first modeling year is 2024.

Source: own representation based on: historical prices and futures: European Energy Exchange (EEX) (2023b), Carbon Pulse (2023), International Energy Agency (IEA) (2023).

### 3.2 Development of CO2 prices for transport and heat as well as for those not Industrial emissions covered by the EU ETS

With the Climate Protection Program 2030, CO2 pricing was introduced in the heating and transport sectors for the first time in 2021. The aim is to create an incentive in these sectors to switch from more emissions-intensive to more climate-friendly technologies, such as the use of heat pumps and electromobility, more energy efficiency and the use of renewable energy sources. Emissions from the combustion of fossil fuels are recorded in a national emissions trading system (nEHS). The nEHS starts at the upstream trading levels, with the companies that place fuels on the market ("upstream ETS"). The legal implementation took place with the adoption of the Fuel Emissions Trading Act (BEHG).

On December 18, 2019, the mediation committee between the Bundestag and the Bundesrat recommended some additions or changes to the 2030 climate protection program, which, among other things, affect the CO2 price in the introductory phase of the nEHS and which were approved by the Bundestag on December 19, 2019 (Deutscher Bundestag 2019). Through an amending law to the BEHG passed by the Bundestag on October 8, 2020, fixed prices will be increased in the introductory phase of the nEHS (2021-2025) after the law comes into force (German Bundestag November 3, 2020). As part of the 3rd relief package, the Federal Council passed an amendment to the BEHG, which temporarily slows down the previously planned increase in the CO2 price (Federal Government 2022b). Specifically, the increases planned for 2023 and 2024 will be postponed to 2024 and 2025. The Budget Financing Act, the draft of which was approved by the Federal Cabinet on August 16, 2023 and which entered into force on September 11, 2023

The Bundestag, in turn, provides for an increase in the fixed prices for the years 2024 and 2025 to 40 €/t and 50 €/t CO2 respectively (Federal Government 2023)<sup>8</sup>. The mechanism planned for 2026 with a price corridor, a minimum price of 55 €/t CO2 and a maximum price of 65 €/t CO2, will be retained.

<sup>8</sup> As of December 1, 2023, the Bundestag had not yet passed a resolution in this regard.

From 2027, the nEHS will transition into a market-based instrument. This means that certificates are auctioned on the market under free pricing with a binding, ambitious cap - in accordance with common practice in EU emissions trading.

In addition, it was agreed in the coalition agreement to transfer the nETS to an existing EU-wide system. This system will represent the EU ETS-2, which has now been approved at EU level and will be introduced from 2027. However, there are no concrete regulatory proposals that would justify consideration within the framework of the MMS or MWMS. One of the issues to be addressed is that the scope of the nETS is broader than that of the EU ETS-2. Furthermore, the cap in the EU ETS-2 is less ambitious than in the nETS, so that a simple transfer would result in the climate protection targets for 2030 being missed. Due to the lack of specifications, we assume for the 2024 projections that the group of obligated parties and the price levels will continue to exist after 2027.

Since it is currently not foreseeable how prices will develop on the market without a price corridor, the same assumptions regarding the price path were made for the projections as for the calculation of the MMS scenario in the "Policy Scenarios X" project (Repenning et al. 2021), These will be adapted to the new resolutions of the Bundestag and the cabinet draft of the Budget Financing Act:

Ÿ Until 2025, the current price path of the Cabinet draft of the Budget Financing Act will be used for the 2024 projections. In 2026 the upper end of the price range (65 €/t) is assumed. From 2027, the CO<sub>2</sub> price will be determined on the market unless maximum or minimum prices are agreed in 2025. From 2027 onwards, it is assumed that the price will increase by €15/t (nominal) annually and will amount to €275/t CO<sub>2</sub> in 2040. This is a significantly higher value than was assumed, for example, in the "Traffic Forecast 2040" with the equivalent of around 162 €/t (nominal) (Kluth et al. 2023).

Ÿ No values are available from the previously used scenario for the period after 2040. A further annual increase in the nominal price of €15 is assumed.

Ÿ The nominal values for the projections are adjusted to real prices due to the unknown regulation for inflation compensation and are shown in Table 8.

Ÿ The price path shown in Table 8 applies to both MMS and MWMS Application.

The scope of application of the nETS overlaps heavily with the EU ETS 2, which will be introduced at the European level from 2027. How the two systems will be connected in Germany or how and whether the nETS will be reformed with the introduction of the EU ETS 2 is at the cutoff point not clarified. Therefore, it is assumed for the modeling that the nEHS with its scope and the estimated price levels will be retained.

**Table 8: Recommendation for 2024 projections and comparison with 2023 projections:  
CO2 prices for transport and heat as well as for those not covered by the EU ETS  
Industry emissions**

Year	CO2 price (nEHS price)			
	Projections 2024 €/t (nominal)	Projections 2023 €/t (nominal)	2024 projections €2022/t (real)	Projections 2023 €2019/t (real)
2021*	25	25	26	24
2022*	30	30	30	27
2023*	30	30	28	27
2024	40	35	37	30
2025	50	45	45	38
2026	65	65	57	54
2027	80	80	69	65
2028	95	95	80	75
2029	110	110	91	85
2030	125	125	101	95
2031	140	140	111	104
2032	155	155	121	113
2033	170	170	130	122
2034	185	185	138	130
2035	200	200	146	137
2036	215	215	154	145
2037	230	230	162	152
2038	245	245	169	158
2039	260	260	176	165
2040	275	275	182	171
2041	290	290	188	176
2042	305	305	194	182
2043	320	320	199	187
2044	335	335	205	192
2045	350	350	209	196
2046	365	365	214	201

## Greenhouse gas projections 2024 for Germany - framework data

Year	CO2 price (nEHS price)			
2047	380	380	218	205
2048	395	395	222	209
2049	410	410	226	212
2050	425	425	230	216

Remarks: \* The reported values for 2021-2023 are not used for modeling the 2024 projections used, but are only listed here for information purposes. The first modeling year is 2024.

Source: Oeko-Institut's own illustration with data for nominal values for the years 2021 to 2023 from the Federal Ministry for Economic Affairs and Climate Protection (BMWK) (2022b) and 2024 and 2025 from the Federal Government (2023).

## 4 Final energy prices: Recommendations for framework data Projections

The measures and interventions taken into account for the projections are briefly listed and specified below. Further changes in the area of taxes and levies will not be taken into account because, if at all, their scope and design are still too vague.

ÿ Elimination of the EEG levy: As part of the first relief package, the EEG levy was abolished  
Abolished on July 1, 2022 (Federal Government 2022a).

ÿ Subsidy for electricity network fees from the EEG account: The increased redispatch, network reserve and control energy costs are offset by a subsidy<sup>9</sup> so that they remain structurally constant (adjusted for inflation).<sup>10</sup>

ÿ Increase in electricity network fees: the 2024 projections assume an overall increase in network usage fees due to the necessary expansion of the network infrastructure. Derived from the TN-45 scenarios of the long-term scenario 3 specifications (Sensfuß et al. 2022), a structural increase in wages of 21% (compared to 2022) by 2030, by 33% by 2035 and by 36% by 2040 and it is assumed that it will remain at this level after 2040.

ÿ For other network fees (e.g. natural gas and mineral oil products) it is assumed that they remain structurally constant.

ÿ Reduction of VAT on natural gas to 7% from October 2022 up to and including February 2024.

It should be noted that many energy and other tax rates are currently defined as fixed surcharges and are therefore subject to high inflation, as is expected for this and the next few years, and without further intervention - for example inflation indexation. actually decrease.

In order to cushion the effects of Russia's war of aggression on Ukraine on final energy prices, the federal government has introduced extensive measures. In particular, the so-called "electricity price brake" and "gas price brake" should be mentioned here. Both instruments expire at the end of 2023. The instruments are designed in such a way that, despite the state intervention and the corresponding relief resulting from the intervention, neither deployment/

Consumption and investment incentives are distorted, but these continue to be based on the existing (uncompensated) price signals. On the revenue side of the "electricity price brake" too, only excess revenue is skimmed off, but there is no intervention in the price formation mechanism itself.

<sup>9</sup> As part of the legislation on electricity, gas and heat price caps, the federal government wants to reduce transmission network fees. The federal government will stabilize the year 2023 at the level of 2022 with a grant of 12.84 billion euros 2022c.

<sup>10</sup> The Federal Constitutional Court (BVerfG) declared the Second Supplementary Budget Act 2021 invalid in its judgment of November 15, 2023 (ref. 2 BvF 1/22). This affects funds from the Climate and Transformation Fund (KTF) and the Economic Stabilization Fund (WSF). The funds finance numerous energy and climate protection measures. The subsidy for network fees, for example, should also be financed from these. As of December 1, 2023, this is not for 2024 secured. The effects of the judgment and any new measures resulting from it or resulting changes to existing or planned measures cannot be taken into account here.

• Special factors such as truck tolls or heat pump tariffs are parameterized in the individual sectors and are not specified centrally.



## 5 Hydrogen imports: Recommendations for bandwidths

The 2024 projections are also essential input into the final updated National Energy and Climate Plan (NECP), which Germany must report to the European Commission in June 2024. In the NECP, renewable energy shares must be reported in accordance with the methodology of the EU Renewable Energy Directive. For this purpose, shares of green hydrogen or its derivatives are accepted for imports of hydrogen. Since hydrogen plays a role in all sectors to be reported, the shares are only calculated if these green import shares are deposited with hydrogen.

The update of the National Hydrogen Strategy was approved by the cabinet at the end of July 2023. The import strategy was still excluded. The overall import share of hydrogen can be derived from the National Hydrogen Strategy, but not how high the share of green hydrogen or derivatives is. This share could be part of the announced hydrogen import strategy.

From the modeling of the 2024 projections, the import shares of hydrogen and hydrogen derivatives per sector will be available. However, the proportion of green hydrogen or its derivatives cannot be determined, nor is it possible to predict to what extent non-green hydrogen will be imported in the period up to 2050.

In order to still be able to reflect the information on renewable energy shares required in the NECP, two extreme variants of the import shares of green hydrogen are created in order to provide information about the entire range of renewable energy shares:

• Once with the assumption of 0% green share of hydrogen and derivatives import the entire period

• Once with the assumption of 100% green content in hydrogen and derivatives imports over the entire period

The two extreme variants only span the theoretical space of possibilities. The actual future share will be within this space.

## 6 List of sources

Federal Office of Economics and Export Control (BAFA) (no yes): Third country coal price (until December 31, 2018). Coal purchases from third countries and average prices free of the German border for hard coal for power plants. Available online at <https://>

[www.bafa.de/DE/Energie/Rohstoffe/Drittlandskohlepreis/drittlandskohlepreis\\_node.html](https://www.bafa.de/DE/Energie/Rohstoffe/Drittlandskohlepreis/drittlandskohlepreis_node.html), last checked on August 15, 2023.

Federal Office of Economics and Export Control (BAFA) (n.d.): Natural gas statistics. Development of border crossing prices since 1999. Available online at <https://>

[www.bafa.de/DE/Energie/Rohstoffe/Erdgas/Statistics/erdgas\\_node.html](https://www.bafa.de/DE/Energie/Rohstoffe/Erdgas/Statistics/erdgas_node.html), last checked on August 15, 2023.

Federal Ministry for Economic Affairs and Climate Protection (BMWK) (2022a): Energy data: Complete edition. Energy data and scenarios. Available online at <https://>

[www.bmwk.de/Redaktion/DE/artikel/Energie/energiedaten-kritik.html](https://www.bmwk.de/Redaktion/DE/artikel/Energie/energiedaten-kritik.html), last checked on August 15, 2023.

Federal Ministry for Economic Affairs and Climate Protection (BMWK) (2022b): Habeck: "We are taking a more careful approach to the CO2 price and are relieving the burden on private households and companies." Available online at <https://www.bmwk.de/Redaktion/DE/Pressreleases/2022/10/20221028-habeck-wir-gehen-beim-co2-preis-bedachter-vor-und-relieven-private-households-and-companies.html>, last checked on August 15, 2023.

Federal Ministry for Economic Affairs and Climate Protection (BMWK); Federal Ministry of Finance (BMF) (2022): Overall economic production potential and economic components. Data basis and results of the federal government's estimates. Status: Federal government's autumn projection from October 12, 2022.

Available online at [https://www.bmwk.de/Redaktion/DE/Downloads/G/gesundheits-produktionspotential-herbstprojektion-2022.pdf?\\_\\_blob=publicationFile&v=1](https://www.bmwk.de/Redaktion/DE/Downloads/G/gesundheits-produktionspotential-herbstprojektion-2022.pdf?__blob=publicationFile&v=1), last checked on August 15, 2023.

Federal Ministry for Economic Affairs and Climate Protection (BMWK); Federal Ministry of Finance (BMF) (2023): Overall economic production potential and economic components. Data basis and results of the federal government's estimates. Status: Federal government's spring projection from April 26, 2023.

Available online at [https://www.bmwk.de/Redaktion/DE/Downloads/G/kritikes-produktionspotential-fruehjahrsprojektion-2023.pdf?\\_\\_blob=publicationFile&v=4](https://www.bmwk.de/Redaktion/DE/Downloads/G/kritikes-produktionspotential-fruehjahrsprojektion-2023.pdf?__blob=publicationFile&v=4), last checked on August 15, 2023.

Federal Government (ed.) (2022a): EEG surcharge will be abolished: electricity customers will be relieved. Available online at <https://www.bundesregierung.de/breg-de/suche/eeg-umlage-faellt-weg-2011728>, last checked on August 15, 2023.

Federal Government (2022b): CO2 price for all fossil fuels. Changes in the Emissions Trading Act.

Available online at <https://www.bundesregierung.de/breg-de/suche/co2-preis-kohle-abfallbrennstoffe-2061622>, last checked on August 15, 2023.

Federal Government (2022c): Price caps for electricity, gas and heat | Federal Government. Available online at <https://www.bundesregierung.de/breg-de/service/gesetzesvorhaben/energiepreisbremsen-2145728>, last updated on September 21, 2023, last checked on September 21, 2023.

Federal Government (2023): Draft of a Budget Financing Act. Federal government bill.

Available online at <https://dserver.bundestag.de/btd/20/082/2008298.pdf>.

Carbon Pulse (2023): UKA & EUA POLL: Analysts slash UKA forecasts while leaving outlook for EUAs unchanged.

Available online at <https://carbon-pulse.com/215065/>, last checked on August 15, 2023.

Central Agricultural Commodity Marketing and Energy Network (CARMEN) (2023a): Market prices for wood chips.

Price development for forest wood chips. Available online at <https://www.carmen->

ev.de/service/marktueberblick/marktpreise-energieholz/marktpreise-hackschnitzel/, last checked on August 15, 2023.

Central Agricultural Commodity Marketing and Energy Network (CARMEN) (2023b): Market prices pellets. Price development for wood pellets. Available online at <https://www.carmen-ev.de/service/marktueberblick/marktpreise-energieholz/marktpreise-pellets/>, last checked on August 15, 2023.

Cludius, Johanna; Galster, Hannah; Healy, Sean; Noka, Victoria; Lam, Long (2022): The role of finance operators in the ETS market and the incidence of their activities in determining the allowances' price. Ed. European Parliament (EP). Policy Department for Economic, Scientific and Quality of Life Policies. Available online at [https://www.europarl.europa.eu/RegData/etudes/ATAG/2022/740053/IPOL\\_ATA\(2022\)740053\\_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/ATAG/2022/740053/IPOL_ATA(2022)740053_EN.pdf), last checked on October 28, 2023.

Deutsche Bundesbank (2021): Prospects for the German economy for the years 2021 to 2023 (Monthly Report, 15). Available online at <https://www.bundesbank.de/resource/blob/867684/14a5adcd1589295d6ad415de1c68810b/mL/2021-06-projection-data.pdf>, last checked on August 15, 2023.

German Energy Agency (dena) (ed.) (2023): Industry barometer biomethane 2023. Analysis. Available online under [https://www.dena.de/fileadmin/dena/Publikationen/PDFs/2023/ANALYSE\\_Branchenbarometer\\_Biomethan\\_2023.pdf](https://www.dena.de/fileadmin/dena/Publikationen/PDFs/2023/ANALYSE_Branchenbarometer_Biomethan_2023.pdf), last checked on December 12, 2023.

German Bundestag (2019): Law to implement the 2030 climate protection program in tax law. In: *Federal Law Gazette* 2019 (Part I No. 52), pp. 2886–2889. Available online at [https://www.bundesfinanzministerium.de/Content/DE/Rechtstexte/Rechte\\_Rechtshabende/abteilung\\_n/Department\\_IV/19\\_Legislatureperiode/Laws\\_Regulations/2019-12-30-G-implementation-climate-protection-program-tax-law/3-verkuendetes-gesetz.pdf?\\_\\_blob=publicationFile&v=2](https://www.bundesfinanzministerium.de/Content/DE/Rechtstexte/Rechte_Rechtshabende/abteilung_n/Department_IV/19_Legislatureperiode/Laws_Regulations/2019-12-30-G-implementation-climate-protection-program-tax-law/3-verkuendetes-gesetz.pdf?__blob=publicationFile&v=2), last checked on August 14, 2023.

German Bundestag (November 3rd, 2020): First law amending the Fuel Emissions Trading Act. In: *Federal Law Gazette* 2020 (Part I No. 50), pp. 2291–2292. Available online at <https://behg-blog.de/wp-content/uploads/2020/11/behg-aenderungsgesetz.pdf>, last checked on August 16, 2023.

Economics Trends Research (ETR) (ed.) (2022): Traffic forecast 2040 on behalf of the Federal Ministry for Digital and Transport. With the collaboration of Prof. Dr. Michael Brauning. Available online at <https://economic-trends-research.de/2022/02/23/verkehrsprognose-2040-im-aufruf-des-bundesministerium-fuer-digitales-und-verkehr/>, last checked on September 22, 2023.

EU (2023): Directive 2023/959 of the European Parliament and of the Council of 10 May 2023 amending Directive 2003/87/EC establishing a system for greenhouse gas emission allowance trading within the Union and Decision (EU) 2015/1814 concerning the establishment and operation of a market stability reserve for the Union greenhouse gas emission trading system. In: *Official Journal of the European Union* (L 130/134). Available online at <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32023L0959&qid=1684218852261>, last checked on October 27, 2023.

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.

European Energy Exchange (EEX) (2023a): Natural Gas Futures. Available online at <https://www.eex.com/de/marktdaten/erdgas/futures>, last checked on August 15, 2023.

European Energy Exchange (EEX) (2023b): EUA Futures. Available online at <https://www.eex.com/de/marktdaten/umweltprodukte/futures>, last checked on August 15, 2023.

Gores, Sabine; Graichen, Jacob; Kemmler, Andreas; Plötz, Patrick (2023): Overview of the proposals for the EU targets. Based on the EU Commission's "Fit for 55" package, as well as the decisions on the EU Climate Protection Regulation, the LULUCF Regulation and the ETS Directive according to the trilogue procedure. On behalf of the Federal Ministry for Economic Affairs and Climate Protection. Ed. Öko Institute, Prognos and Fraunhofer ISI. Available online at <https://www.oeko.de/fileadmin/oekodoc/Einschaetzung-Fit-for-55.pdf>, last checked on

August 15, 2023.

Intercontinental Exchange (ICE) (2023a): API2 Rotterdam Coal Futures. ICE Futures Europe. Available online at <https://www.theice.com/products/243/API2-Rotterdam-Coal-Futures>, last checked on August 15, 2023.

Intercontinental Exchange (ICE) (2023b): Brent Crude Futures. ICE Futures Europe. Available online at <https://www.theice.com/products/219/Brent-Crude-Futures>, last checked on August 15, 2023.

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 October 25, 2023.

Kluth, Tobias; Rudolf, Alexandra; Kotzagiorgis, Stefanos (2023): Moving long-term traffic forecast 2021-2022. As of March 1, 2023. Ed. Federal Ministry for Digital Affairs and Transport (BMDV). Intraplan Consult (Intraplan); TTS Trimode Transport Solutions (Trimode). Available online at [https://bmdv.bund.de/SharedDocs/DE/anlage/K/prognose-berichtgleitende-langkunft-verkehrsprognose.pdf?\\_\\_blob=publicationFile](https://bmdv.bund.de/SharedDocs/DE/anlage/K/prognose-berichtgleitende-langkunft-verkehrsprognose.pdf?__blob=publicationFile), last checked on June 22, 2023.

Mendelevitch, novel; Repenning, Julia; Matthes, Felix Chr. (2022): Framework data for the 2023 projection report. Edited by Federal Environment Agency (UBA). Dessau-Roßlau. Available online at <https://www.umweltbundesamt.de/publikationen/framingdaten-fuer-den-projektionsbericht-2023>, last checked on August 9, 2023.

Joint Diagnosis Project Group (ed.) (2023): Purchasing power returns - political uncertainty high.

German Institute for Economic Research (DIW Berlin); ifo Institute; Kiel Institute for the World Economy (IfW Kiel); Leibniz Institute for Economic Research Halle (IWH); Leibniz Institute for Economic Research (rwi) (Community Diagnosis, 2-2023). Available online at [https://gemeinschaftsdiagnose.de/wp-content/uploads/2023/10/IfW\\_Kiel\\_GD\\_2\\_2023\\_RZ\\_3\\_web.pdf](https://gemeinschaftsdiagnose.de/wp-content/uploads/2023/10/IfW_Kiel_GD_2_2023_RZ_3_web.pdf), last checked on January 31, 2024.

Repenning, Julia; Harthan, Ralph O.; Blanck, Ruth; Böttcher, Hannes; Braungardt, Sibylle; Bürger, Veit et al. (2021): Projection report 2021 for Germany. Pursuant to Article 18 of Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the governance system for the Energy Union and for climate action, amending Regulations (EC) No 663/2009 and (EC) No. 715/2009 of the European Parliament and of the Council and Section 10 (2) of the Federal Climate Protection Act. Ed.

Federal Government. Öko-Institut; Fraunhofer ISI; IREES; Thünen Institute. Berlin. Available online at [https://www.umweltbundesamt.de/sites/default/files/medien/372/documents/projektionsbericht\\_2021\\_uba\\_website.pdf](https://www.umweltbundesamt.de/sites/default/files/medien/372/documents/projektionsbericht_2021_uba_website.pdf), last checked on August 14, 2023.

Expert Council for the assessment of overall economic development (2023): Updated economic forecast for 2023 and 2024. Available online at <https://www.sachverstaendigenrat-wirtschaft.de/konjunkturprognose-2023.html>, last checked on September 22nd, 2023.

Sensfuss, Frank; Tersteegen, Bernd; Müller-Kirchenbauer, Joachim (2022): Long-term scenarios for the transformation of the energy system in Germany. Results on the development of the electricity and gas network infrastructure in five greenhouse gas-neutral T45 scenarios. Greenhouse gas neutral scenarios T45. Available online at [https://www.langfristszenarien.de/enertile-explorer-wAssets/docs/Consentec-TUBER\\_BMWK\\_LFS3\\_Webinar\\_Netze\\_T45\\_final\\_v2.pdf](https://www.langfristszenarien.de/enertile-explorer-wAssets/docs/Consentec-TUBER_BMWK_LFS3_Webinar_Netze_T45_final_v2.pdf), last checked on September 22, 2023.

Federal Statistical Office (2023a): 15th coordinated population projection - assumptions and results. Wiesbaden. Available online at <https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Bevoelkerung/Bevoelkerungsvorausberechnung/begleithaft.html>, last checked on August 15, 2023.

Federal Statistical Office (2023b): Update of the population status - Germany. (Table 12411-0001). Available online at <https://www-genesis.destatis.de/genesis//online?operation=table&code=12411-0001&bypass=true&levelindex=0&levelid=1692103843459#abreadcrumb>, last checked on August 15, 2023.

Federal Statistical Office (2023c): National accounts, gross domestic product. Available online at <https://www.destatis.de/DE/ZahlenFakten/GesamtwirtschaftUmwelt/VGR/Inlandsprodukt/Tables/Gesamtwirtschaft.html>, last checked on August 15, 2023.

Technology and funding center in the Competence Center for Renewable Raw Materials (TFZ) (ed.) (2023): Current firewood prices. Available online at <https://www.tfz.bayern.de/festbrennstoffe/energetischenutz/035134/index.php>, last checked on August 15, 2023.

Thomsen, Jessica; Fuchs, Nicolas; Meyer, Robert; Wanapinite, Natapon; Bavia Bampi, Bruno; Gorbach, Gregor et al. (2022): Bottom-up study on path options for an efficient and socially acceptable decarbonization of the heating sector. Final report. Written on behalf of the National Hydrogen Council. Ed. Fraunhofer ISE and Fraunhofer IEE. Freiburg, Kassel. Available online at [https://www.wasserstoffrat.de/fileadmin/wasserstoffrat/media/Documents/2022/221222\\_Bottom\\_Up\\_Studie\\_final-1.pdf](https://www.wasserstoffrat.de/fileadmin/wasserstoffrat/media/Documents/2022/221222_Bottom_Up_Studie_final-1.pdf), last checked on August 15, 2023.

Zaklan, Aleksandar; Graichen, Jacob; Graichen, Verena; Hermann, Hauke; Cludius, Johanna (2021): Structural Supply Side Management in the EU ETS - Reviewing the Market Stability Reserve. German Emissions Trading Authority (DEHSt) in the Federal Environment Agency (Climate Change, 39/2021). Available online at [https://www.umweltbundesamt.de/sites/default/files/medien/5750/publikationen/2021-05-19\\_cc\\_39-2021\\_msr\\_review.pdf](https://www.umweltbundesamt.de/sites/default/files/medien/5750/publikationen/2021-05-19_cc_39-2021_msr_review.pdf), last checked on August 15, 2023.