

CORNWALL INSIGHT

CREATING CLARITY

**Insight Paper**

# Is Germany going green? Charting Germany's energy transition (2nd edition)

**January 2024**

This paper includes exclusive insights from Cornwall Insight's North West Europe Benchmark Power Curve



Cornwall Insight

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# Executive summary

Following December 2023's Conference of the Parties of the United Nations Framework Convention on Climate Change (COP 28) in Dubai, there has been an increased impetus on transitioning "away from fossil fuels in energy systems"<sup>1</sup> at a global level. In Germany – and across the world at large – these agreements and wider discussions will feed into existing net zero targets and help to inform future policy decisions.

Since 2021, the German Bundestag (parliament) has been targeting "climate neutrality" by 2045.<sup>2</sup> This includes interim targets of 65% and 88% reductions in CO<sub>2</sub> levels (from a 1990 baseline) by 2030 and 2040, respectively, and is further backed by a European Union (EU) level target to reach net zero carbon emissions by 2050.<sup>3</sup> However, events over the past two years have raised questions around the viability of these ambitions, as Germany – alongside the rest of Europe – tries to maintain momentum for decarbonisation amidst elevated and volatile energy prices and increasing global competition to secure net zero value chains.

## Overcoming the fossil fuel dependency

Germany's position as Europe's largest energy consumer – it is also one of Europe's largest energy producers – and its heavy reliance on fossil fuels have posed some significant challenges when trying to decarbonise. To reach net zero targets on time, Germany needs to increasingly phase out the use of these fossil fuels by deploying more low-carbon generation, while, in the interim, also replacing more carbon-intensive fossil fuels like coal and lignite with lower-intensity fuels like natural gas. This transition has become more difficult to achieve as Russia's invasion of Ukraine in February 2022 has caused Germany to renounce its main source of both natural gas and mineral oil. Germany has since found itself needing to diversify imports, procure more energy from alternative sources, and lower the demand for the fossil fuels it has long depended on to fuel industry and power the economy.

## Navigating a changing macroeconomic landscape

The loss of Russian pipeline gas supplies to Germany – and much of Europe – has exacerbated an ongoing energy crisis across Europe, causing wholesale prices for gas and electricity to rise significantly over the course of 2022. This has had several knock-on effects in Germany as high energy prices contributed to high inflation and, consequently, high interest rates. As a result, the German economy suffered negative growth in Q422 and Q123, entering the country into technical recession in early 2023.<sup>4</sup>

Although there were signs of recovery over the course of Q223, energy prices and interest rates remained high and have contributed to further economic downturn in Germany. Stagnation then followed in Q323 before the economy contracted again in Q423, causing the Germany economy to

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<sup>1</sup> [UNFCCC](#)

<sup>2</sup> [Die Bundesregierung](#)

<sup>3</sup> [European Commission](#)

<sup>4</sup> [Destatis](#)

shrink by 0.3% in 2023.<sup>5</sup> Meanwhile, the conflict between Israel and Hamas, and Yemen's Houthi group attacks on Red Sea shipping vessels could cause further disruptions to global liquified natural gas (LNG) and oil markets, causing energy prices to rise again over the winter 2023/24 season, potentially leading to further macroeconomic volatility.

Outside of Germany, rising international competition to attract net zero capital is also a potential barrier to net zero attainment. Extensive support schemes such as the US' Inflation Reduction Act (IRA) have been successful in attracting and onshoring net zero supply chains in the US. Thus, there is a risk that German – and broader European – manufacturing could move abroad in pursuit of attractive subsidies and tax credits. Growing competition from China also remains a key concern in Germany due to its control over essential net zero supply chains and its ability to manufacture components (like electric vehicle batteries) at prices unmatched across Europe.

With the German government and EU increasingly aware of the US and China's potential influence, the past 12 months have seen the introduction of a range of policies to maintain and perhaps even strengthen Germany's ability to compete in the race towards net zero.

## Developing net zero policy pathways

Notwithstanding the issues imposed by the energy crisis, Germany is also facing longstanding systematic barriers in its transition towards net zero. Moving from an energy mix which has largely relied on fossil fuels to one increasingly using intermittent renewables has caused the transmission network to become congested. As a result, there have been significant difficulties when trying to connect the wind-rich North Sea with demand-intensive regions such as Nordrhein-Westfalen and Bayern (Figure 1). As another knock-on effect, projects have been experiencing long delays when applying for and receiving grid connections, with a typical offshore wind project facing wait times of up to seven years from permitting to commissioning.

## Decarbonising the energy system

The latest modelling from Cornwall Insight, as part of the new North West Europe Benchmark Power Curve, shows that achieving the energy transition in Germany will require holistic change across the energy sector and German society at large. Although overall demand is forecast to drop towards 2050, the energy mix will increasingly depend on the availability of renewable electricity and low-carbon hydrogen, necessitating a resulting scale-up of energy storage and other methods to balance supply and demand.

Figure 1: Map of German Länder (states)



Source: Shutterstock

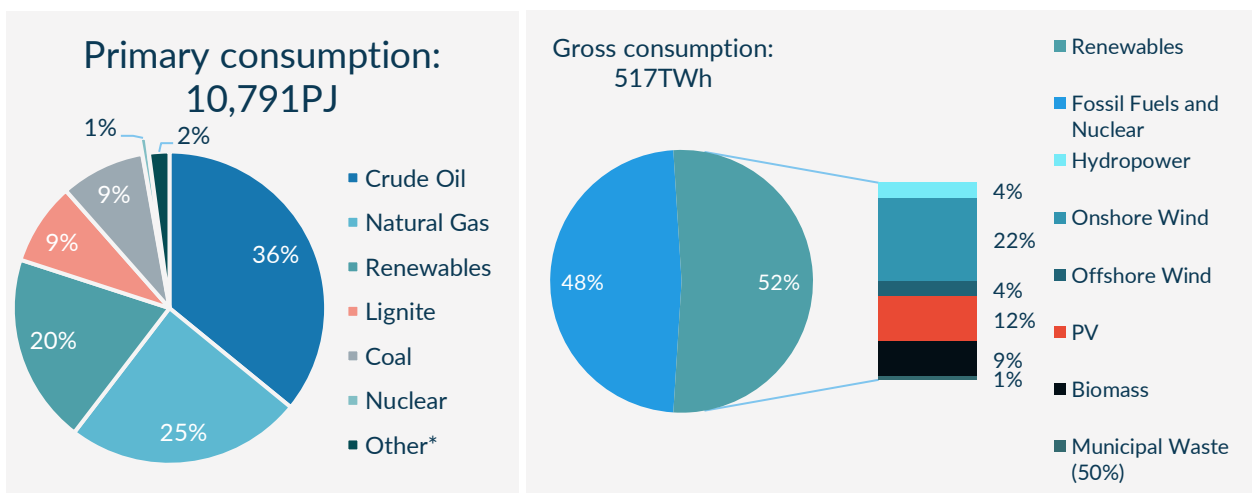
<sup>5</sup> [Destatis](#)

# Overcoming fossil fuel dependency

As in the case of all industrialised economies, Germany has long benefited from the use of fossil fuels, which have allowed the country to emerge as a world leader in manufacturing. Primary among these fuels are mineral (crude) oil, natural gas, lignite, and coal, all of which continue to feature heavily in Germany’s energy mix today (Figure 2). However, due to macroeconomic, geopolitical, and sustainability-driven developments, the relative prevalence of these fuels has changed over the course of several decades, with Germany transitioning from an energy mix with a heavy reliance on domestically mined coal and lignite in the mid-20<sup>th</sup> century to one reliant mostly on imported natural gas and mineral oil by the end of the century.

With decarbonisation increasingly factoring into the discussion from the late 1990s onwards, Germany’s energy mix has now entered another transitional period – often referred to as the *Energiewende* (energy transition) – as fossil fuels are set to be phased-out to support looming net zero targets.

**Figure 2: Primary energy consumption and gross electricity consumption in Germany, 2023**



Source: [AG Energiebilanzen](#), [Bundesverband der Energie- und Wasserwirtschaft](#)

## The energy crisis and the paradigm shift of decarbonisation

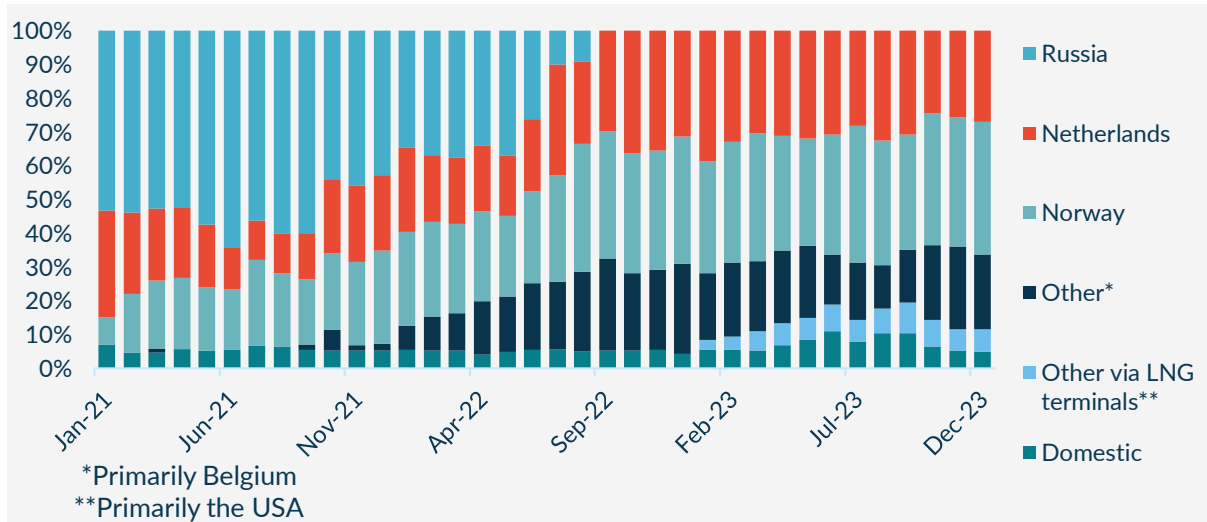
Since the early-2010s, with climate change and decarbonisation becoming an increasing priority both globally and across Europe, Germany has been faced with the need to reduce its reliance on the fossil fuels used to power its economy. As such, Germany enshrined its first decarbonisation targets in 2010’s *Energiekonzept* (energy plan). It was not until 2021, however, with the legally binding agreement to reach net zero carbon emissions by 2045,<sup>6</sup> that the death knell rang out for Germany’s fossil fuel era.

Amidst these ongoing decarbonisation efforts, geopolitical tensions have complicated matters for Germany. In response to Russia’s invasion of Ukraine in February 2022, Germany placed embargos on Russian gas imports and since September 2022 no natural gas of Russian origin has entered

<sup>6</sup> [Die Bundesregierung](#)

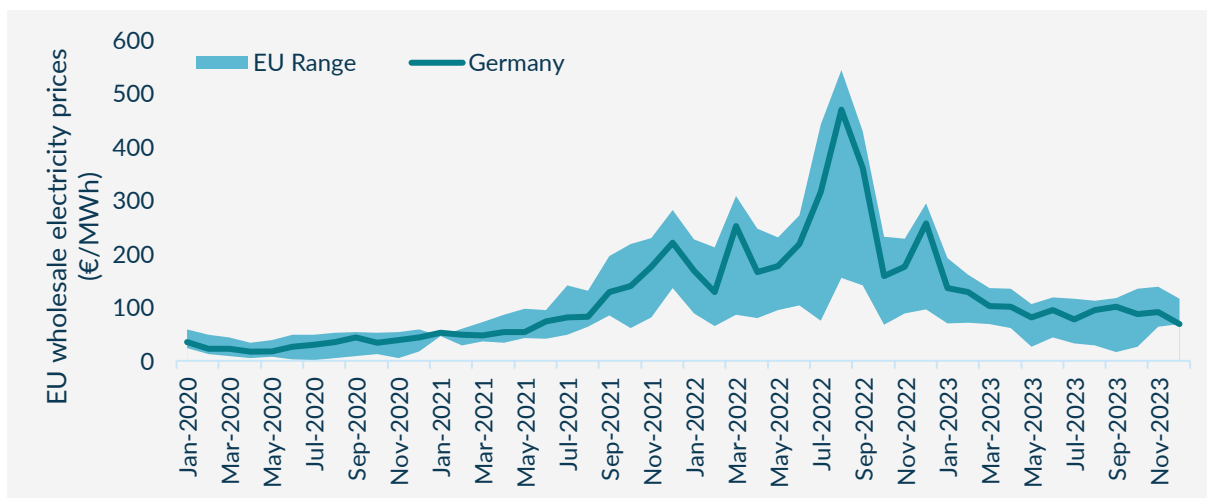
Germany via Russian pipelines (Figure 3). Not only did this end Germany's longstanding economic model, where cheap Russian gas was used to power industry, it also exacerbated the energy crisis that had been building across Europe since late 2021, causing prices for gas and electricity to surge (Figure 4).

**Figure 3: German natural gas imports, 2021-2023**



Source: [Bundesverband der Energie- und Wasserwirtschaft](#)

**Figure 4: German and EU-wide wholesale electricity prices (€/MWh) 2020-2023**



Source: [ENTSO-e](#)

## Extent of Russian dependence

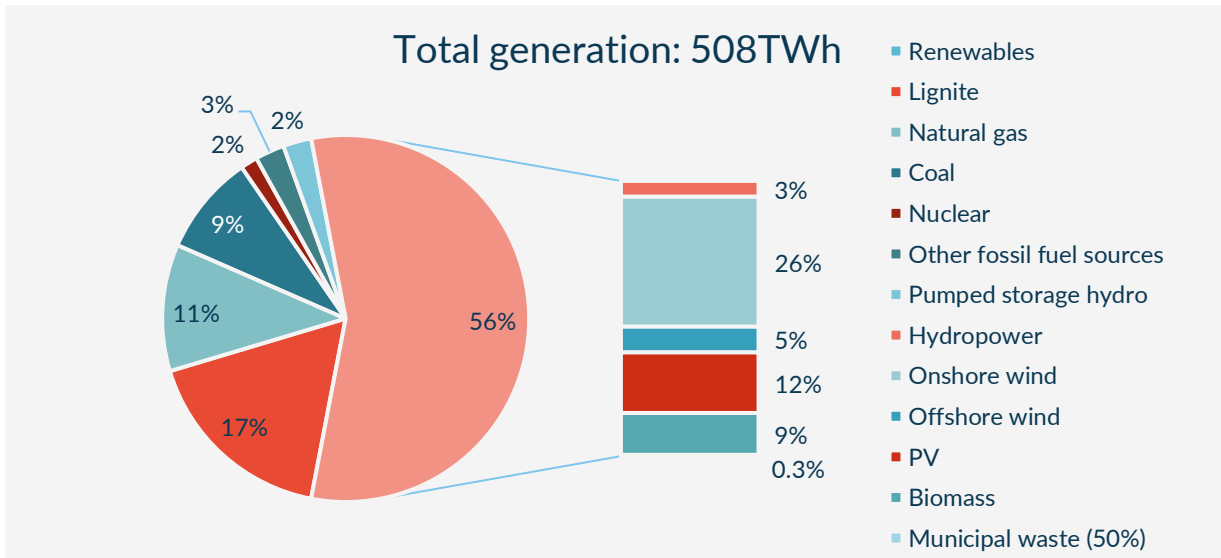
The energy crisis has had a particularly significant impact on Germany as, due to its limited supply of domestically sourced fossil fuels it has long been dependent on fossil fuel imports (Figures 5 & 6) primarily in the form of Russian natural gas and mineral oil. Over the course of 2021, Russia accounted for 55% of Germany's natural gas supply (Figure 3) and 47% of its mineral oil supply.<sup>7</sup>

<sup>7</sup> [Statistisches Bundesamt \(Destatis\)](#)



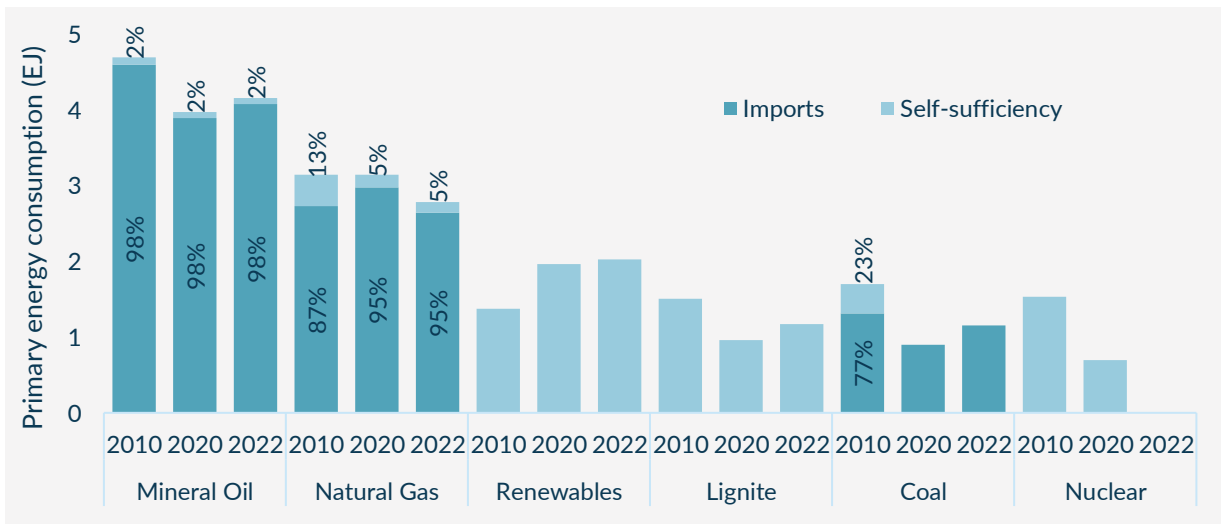
Since the invasion of Ukraine in February 2022, however, the situation has wholly changed. While the aforementioned embargo on Russian gas imports brought an end to Russian pipeline gas supplies to Germany in September 2022, a de facto EU-wide ban on Russian oil imports – taking effect in December 2022<sup>8</sup> – saw only residual mineral (crude) oil flows of Russian origin enter Germany in early 2023 before halting imports completely.<sup>9</sup>

**Figure 5: Breakdown of domestic electricity generation in Germany in 2023**



Source: [Bundesnetzagentur](#), [Bundesverband der Energie- und Wasserwirtschaft](#)

**Figure 6: Import dependency in Germany, 2010-2022**



Source: [Bundesanstalt für Geowissenschaften und Rohstoffe \(BGR\)](#), [AG Energiebilanzen](#)

## Adjusting import dependency

The loss of Russian fossil fuels has caused Germany – alongside many other European nations – to

<sup>8</sup> [European Council](#)

<sup>9</sup> [Statistisches Bundesamt \(Destatis\)](#)

diversify its imports to maintain its energy supply and protect energy security. To make up the majority of the deficit in Russian pipeline gas imports, Germany has increasingly sourced gas from neighbouring European countries like Norway and the Netherlands (Figure 3), via existing pipelines and interconnectors. However, this alone has not allowed Germany to satiate the demand once met by Russian sources and, as such, there has been a necessary reduction in demand throughout the country over the past two years. Compared to 2021, overall natural gas consumption fell by 15.7%<sup>10</sup> in 2022 followed by a further 4.3% reduction in 2023.<sup>11</sup> However, the use of natural gas in electricity generation rose slightly, by 1% from 2022 to 2023.<sup>12</sup> This situation may change further in 2024 as the German state-owned energy firm Securing Energy for Europe (SEFE) announced a €50bn deal to import gas from Norway's Equinor.<sup>13</sup> The deal will see 10bcm of natural gas imported into Germany from 1 January 2024 to 2034, covering around 33% of the country's industrial demand. This will firmly establish Norway as Germany's largest gas import source, with total volumes estimated at 60% of the country's total gas demand, the same proportion previously supplied by Russia.

To make up for some of the deficit in the meantime, certain decarbonisation trends were temporarily reversed as consumption of coal and lignite for electricity generation increased, by 16% and 5.5% respectively, from 2021 to 2022.<sup>14</sup> Accordingly, scepticism began to arise around Germany's ability to meet its prospective coal phase-out target in 2030 and even its legally binding target in 2038.<sup>15</sup> However, with energy consumption falling to a historic low in 2023 – with provisional figures showing an 8% overall reduction<sup>16</sup> – due to reduced industrial output, warmer weather, and high energy prices, the use of both coal and lignite for electricity generation has once again continued to fall, by 37% and 25% respectively.<sup>17</sup> Moreover, the German government has been active in accelerating the phase-out of coal and lignite over the course of 2023. For instance, in November 2023, the European Commission approved €2.6bn State aid to RWE to bring forward the closure of its lignite-fired power plants in line with government targets.<sup>18</sup>

To further diversify energy imports and allow for the recovery of demand, the German government and industry have also been building new infrastructure for the import of – more expensive – LNG. Since introducing the LNG Acceleration Act in May 2022, Germany has developed significant LNG import infrastructure, from having no terminals in 2022 to three terminals and floating regasification units in operation by January 2024. A further three terminals should enter in operation in early 2024. Alongside meeting gas demand, it is hoped that these terminals can help to reduce reliance on more carbon-intensive fossil fuels and support the phasing-out of coal and lignite by 2030.

In the longer-term, these LNG terminals will need to be retrofitted to support a decarbonised energy system. This could be achieved by accepting low-carbon hydrogen as has already been proposed for the LNG terminal situated in the port of Wilhelmshaven (Box 1).

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<sup>10</sup> [Bundesverband der Energieund Wasserwirtschaft](#)

<sup>11</sup> [AG Energiebilanzen](#)

<sup>12</sup> [AG Energiebilanzen](#)

<sup>13</sup> [Securing Energy for Europe](#)

<sup>14</sup> [Bundesverband der Energieund Wasserwirtschaft](#)

<sup>15</sup> [Bundesgesetzblatt](#)

<sup>16</sup> [AG Energiebilanzen](#)

<sup>17</sup> [Bundesnetzagentur](#)

<sup>18</sup> [European Commission](#)

**Box 1: The port of Wilhelmshaven – future hydrogen hub**

The deepwater port of Wilhelmshaven became the site of the first of Germany's planned LNG hubs, entering into operation in early 2023. The floating storage and regasification unit will support the import of up to 7.25Mt of LNG – which will then be converted into around 10bcm of natural gas – per year. According to terminal operators and their parent company Uniper, the terminal “will replace around 6% of Germany's [annual] gas demand in the initial phase”, equating to around 11% of Germany's gas imports from Russia in 2021.

As part of its 'Green Wilhelmshaven' project, Uniper aims to develop an ammonia import terminal and cracker alongside a 1GW electrolysis plant for the production of low-carbon hydrogen, to be connected to a 4GW offshore wind farm. It is hoped that this will support the import of 300bt of low-carbon hydrogen by 2030, equating to 10-20% of German's planned hydrogen demand.

Germany has also fostered a greater reliance on existing trading partners Norway, the UK, USA, and Kazakhstan for its supply of mineral oil and, from late 2022, has accepted supplies from the UAE.<sup>19</sup>

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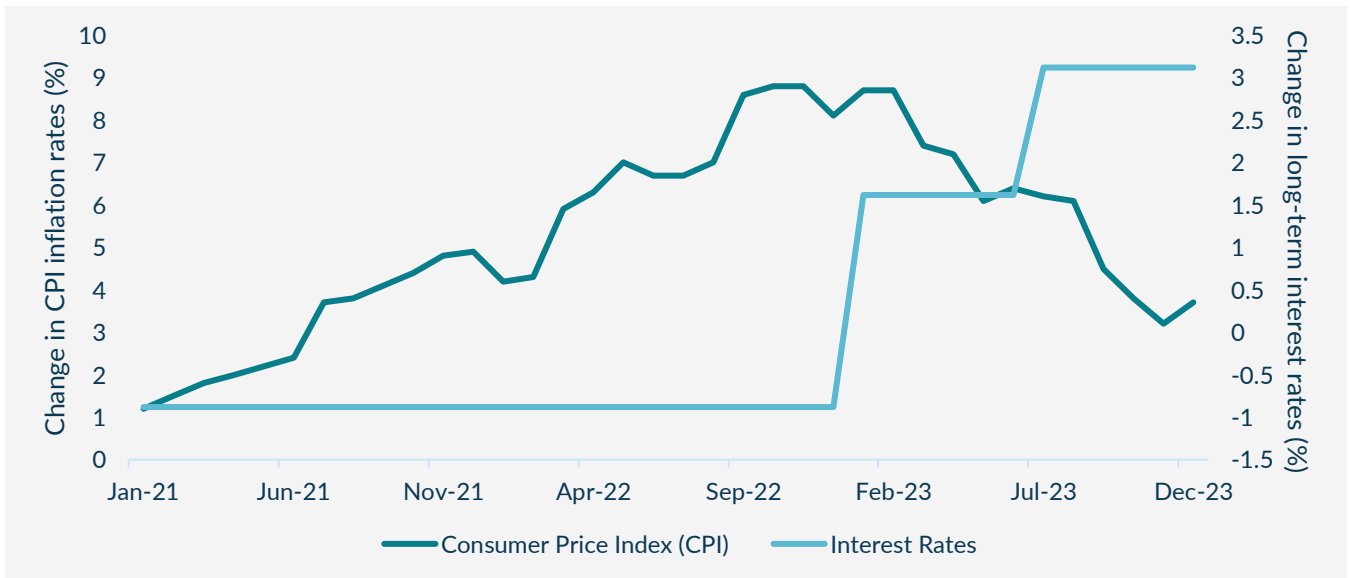
<sup>19</sup> Destatis

# Navigating a changing macroeconomic landscape

## The economics of change

The energy crisis has had several knock-on consequences for Germany’s economy, with a significant rise in both consumer price index (CPI), a measure of inflation, and interest rates over the course of 2022 and 2023 (Figure 8). Like many other European economies, this has caused social and economic challenges throughout Germany as consumers and businesses have been faced, even with government support, with significantly elevated energy bills while also struggling to meet other rising costs. Given that energy prices for domestic German consumers were already among the highest in Europe – partly due to the now-discontinued *Erneuerbare-Energien-Gesetz* (EEG; Renewable Energy Sources Act) levy used to fund renewable subsidies via consumer bills – this increase has had a particularly negative effect across Germany.

**Figure 8: Monthly inflation and basic interest rates in Germany, 2021-2023**



Source: [OECD](#), [Destatis](#), [Deutsche Bundesbank](#)

Germany’s industrial sector, collectively accounting for 29% of the country’s energy consumption in 2021,<sup>20</sup> was similarly affected by the energy crisis. Despite extensive government support, high prices led many across the sector to downscale operations – even if just temporarily – as a means to artificially reduce demand for gas and electricity in 2022 and 2023. Accordingly, industrial output has fallen almost continuously since 2022. While this can be observed across the entire German industrial sector, the most marked impact came from energy intensive industries where production fell by around 19 percentage points from January 2022 to October 2023.<sup>21</sup>

These macroeconomic drivers are also posing challenges to Germany’s net zero attainment. Higher

<sup>20</sup> [Destatis](#)

<sup>21</sup> [Destatis](#)

energy prices have made heavy industries across Europe more expensive to power, driving up the cost of essential commodities and inflating the capital expenditure required to finance new energy infrastructure projects. Meanwhile, rising CPI has also increased businesses operating expenditure, diminishing their ability to invest in new projects and prioritise attainment of net zero targets. Attracting outside investment has also become more difficult as the rising cost of capital is requiring investors to demand higher rates of return when financing projects, something which many developers cannot afford.<sup>22</sup>

While the situation begun to settle somewhat in late 2023 – as interest rates and energy prices fell – the energy crisis has formed lasting effects as the German economy has suffered periods of recession and low growth that may take time to overcome. According to Destatis (the German Federal Statistical Office), the German economy entered into technical recession following two quarters of negative year-on-year (y-o-y) growth in Q422 and Q123, making it the only G7 economy to do so in 2023.<sup>23</sup> Despite some brief recovery in Q223, the German economy stagnated in Q323 and incurred negative y-o-y growth in Q423.<sup>24</sup> Combined, this saw Germany end 2023 with an overall 0.3% decline in its GDP growth. In spite of these difficult economic conditions, however, the Deutsche Bundesbank believes that the German economy will be able to “return to an expansion path and gradually pick up speed” in 2024.<sup>25</sup>

## International competition is rising

Increasing competition at a global level could see Germany’s investment attractiveness further subside as mobile capital may favour other international markets with lower energy costs and more extensive net zero support schemes. It is important to note, however, that this problem is not unique to Germany and it is being faced across European economies. We discussed this in a UK context in our November 2023 paper, *“Race to net zero – rebuilding investor confidence in the UK”*.<sup>26</sup>

Most notable among these schemes is the US’ IRA,<sup>27</sup> introduced in August 2022. The IRA plans to allocate an estimated \$369bn from 2022 to 2032 to incentivise investment in low-carbon technologies, while bolstering domestic supply chains, lowering inflation, and aiding decarbonisation. Since its introduction, the IRA has been the subject of intense criticism from the US’ international competitors and trading partners, largely because it allegedly favours domestic supply chains while excluding those from abroad, as local content requirements must be met to unlock some of the more generous tax credit offerings.

Particularly relevant to Germany – as a major automotive manufacturing hub – is the ‘Clean Vehicle Credit’<sup>28</sup> which can only be granted in full where a zero-emission vehicle has “undergone final assembly in North America” and if the “critical minerals” contained in the vehicle’s battery have not been “extracted, processed, or recycled by a foreign entity”. While the IRA cannot be regarded as a silver bullet solution as it has not yet been able to boost investment in all US net zero industries – notably, the offshore wind sector – there are concerns across Europe that the IRA could incentivise

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<sup>22</sup> This is discussed in a UK context in Cornwall Insight’s paper *“WACC-A-MOLE: Implications of the rising cost of capital for the fifth round of the Contracts for Difference scheme”*

<sup>23</sup> [Destatis](#)

<sup>24</sup> [Destatis](#)

<sup>25</sup> [Deutsche Bundesbank](#)

<sup>26</sup> [Cornwall Insight - "Race to net zero - rebuilding investor confidence in the UK"](#)

<sup>27</sup> [CONGRESS.GOV](#)

<sup>28</sup> [Internal Revenue Service](#)

manufacturers of vital net zero technologies to relocate, or at least increase their presence, overseas.

Compounding Germany's competitive worries is the growing fear of de-industrialisation as the country suffers from high energy prices and reduced industrial production. With the rising prominence of China in international export markets, particularly in automobiles and machinery – two areas of German expertise – the German government and industry are concerned that vital manufacturing industries could move out of Germany as domestic manufacturing becomes more expensive and companies increasingly purchase commodities from China at reduced prices. These competitive fears were further substantiated in a survey published by the German Chamber of Commerce and Industry (Deutscher Industrie- und Handelskammertag, DIHK) in August 2023.<sup>29</sup> The survey of 3,572 German businesses highlighted that almost one-third of industrial companies are “planning or realising the relocation of capacities abroad or the restriction of production at home as a reaction” to the energy crisis and the German government's policy response. Compared to the same survey held in 2022, this represented a rise of 16 percentage points.

## Remaining competitive

In response to rising international competition amid the energy crisis, Germany – through its central government and as a Member State of the EU – has begun to pursue and implement its own policy programmes to re-shore production domestically and elsewhere in Europe. These include:

At a domestic level:

- Supporting private investment – In July 2023 the European Commission approved a €3bn scheme<sup>30</sup> in Germany to support private investments in specific strategic goods that are needed to aid the transition to a net zero economy. The scheme was approved under the Temporary Crisis and Transition Framework and will be open to companies producing batteries, solar panels, wind turbines, heat pumps, electrolysers, and CCUS equipment with grants available until the end of 2025.
- Carbon Contracts for Difference – Germany launched a funding programme of around €50bn which opened in June 2023<sup>31</sup> to help protect companies from unexpected price volatility and encourage climate-friendly production processes in energy-intensive industries such as steel, cement, paper, and glass.
- Preventing carbon leakage – In August 2023 the European Commission approved a €6.5bn German scheme<sup>32</sup> to support energy-intensive companies exposed to international competition by covering part of the higher fuel prices from the German fuel emission trading system. The scheme will cover 65% to 95% of costs incurred between 2021 and 2030 depending on the emission intensity of the beneficiaries. It is hoped that this will prevent ‘carbon leakage’, where companies relocate their production to countries with less stringent emissions rules contributing to increased global greenhouse gas emissions.

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<sup>29</sup> [Deutscher Industrie- und Handelskammertag](#)

<sup>30</sup> [European Commission](#)

<sup>31</sup> [Bundesministerium für Wirtschaft und Klimaschutz](#)

<sup>32</sup> [European Commission](#)

At an EU level:

- The Green Deal Industrial Plan (GDIP)<sup>33</sup> – First introduced in February 2023, the GDIP seeks to cut the so-called regulatory ‘red tape’ to further net zero investment in the EU and boost domestic supply chains. To do so, the GDIP proposes a wide range of legislative and regulatory reforms to tackle long-standing barriers to net zero and add further clarity and certainty to the market.
- The Carbon Border Adjustment Mechanism (CBAM)<sup>34</sup> – Entering into force on 16 May 2023, the CBAM will apply in its transitional phase from 1 October 2023, with a permanent system in place from 1 January 2026. The CBAM aims to reduce carbon leakage by charging importers for the embedded emissions of their goods, with the amount charged based on the difference between the carbon price paid during the production of the good and the carbon price that would have been paid if the good was produced in the EU. The CBAM reduces the incentive to move the carbon-intensive production stages for goods to jurisdictions with less stringent environmental and climate policies than the EU, therefore likely strengthening domestic supply chains.

While, due to the lack of ‘money on the table’, the net zero policy schemes implemented by the German government and EU since the beginning of the energy crisis do not *directly* compete with the IRA, an industry source argues that the allure of their plans lie elsewhere. For renewable generators and project developers, they find that these policies could provide significant incentives to remain within Germany.

Through the imposition of more stringent renewable energy procurement targets – both in terms of domestic consumption and imports – German industry will find itself increasingly reliant on clean energy, creating a wealth of potential off-takers and further stimulating the market. As a result, this demand for renewables could further support manufacturers of vital net zero components such as batteries or electrolysers as they will have a greater client-base to service. The question remains, however, if this demand will be satisfied by German manufacturers or by cheap imports from abroad. With the introduction of the CBAM to reduce carbon offshoring, alongside policies to unlock supply chains and access to raw materials, German and EU policy seem to be striving to ensure that this process is contained largely within the EU.

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<sup>33</sup> [European Commission](#)

<sup>34</sup> [European Commission](#)

# Developing net zero policy pathways

If Germany is to ensure a smooth transition towards net zero whilst also keeping energy prices relatively low and maintaining energy security, it must create a strong and robust policy framework to underpin and guide it. Currently, the “Federal Climate Change Act”,<sup>35</sup> the “Climate Action Programme 2030”,<sup>36</sup> and the “2022 Immediate Climate Action Programme”<sup>37</sup> form the legal and aspirational basis of this framework, setting the targets and ambitions for 2045 and before.

In the wake of the energy crisis, however, these policies do not go far enough. As such, the German government’s 2023 Projection Report,<sup>38</sup> coordinated by Umweltbundesamt (the German Environment Agency) stated that the 2030 and 2045 national climate targets are unlikely to be met without additional measures. To meet the 2030 target, additional greenhouse gas emissions reductions will need to be made in the years to 2030, corresponding to around 40% of Germany’s emissions for the entire year of 2022. It also projects that Germany will miss its EU-level climate targets.

## Consumer support comes first

Exposed to rising energy prices following Russia’s invasion of Ukraine, the German government faced calls to support consumers by partially shielding them from energy bill hikes. In April 2022, the German government responded by introducing a €30bn energy bill support package to insulate domestic consumers, with further smaller schemes following throughout the year.<sup>39</sup> For energy and trade intensive industrial consumers, support came a little later, with a €5bn State aid scheme enacted in July 2022 to “mitigate the impact of the rising input costs on these companies and support the continuation of their activities...” during the crisis.<sup>40</sup>

Owing to continued extreme energy price volatility in the autumn, the government announced plans for further support in September 2022. Despite a lack of consensus at the EU-level – as some Member States feared a subsidy race – Germany announced additional funding for the Wirtschaftsstabilisierungsfonds (Economic Stabilisation Fund). Through a €200bn aid programme, the government would provide a ‘protective shield’ to both domestic and small business consumers.<sup>41</sup> Primarily, funding was earmarked for increasing energy supply and reducing consumption, alongside the introduction of electricity and gas ‘price brakes’. While these price brakes were intended to continue until March 2024,<sup>42</sup> budget concerns in late 2023 saw the support period reduced, ending after December 2023. Meanwhile, support for energy intensive industries was increased in November 2023, following the introduction of a €28bn power price package to be carried out over the next five years, worth €12bn in 2024 alone.<sup>43</sup>

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<sup>35</sup> [Die Bundesregierung](#)

<sup>36</sup> [Die Bundesregierung](#)

<sup>37</sup> [Bundesministerium der Finanzen](#)

<sup>38</sup> [Umweltbundesamt](#)

<sup>39</sup> [Die Bundesregierung](#)

<sup>40</sup> [European Commission](#)

<sup>41</sup> [Die Bundesregierung](#)

<sup>42</sup> [Bundestag](#)

<sup>43</sup> [Die Bundesregierung](#)



However, this financial and political focus on keeping energy bills low and supporting vulnerable consumers has impacted Germany's focus on decarbonisation goals. In its efforts to meet energy demand while maintaining energy security and protecting consumers, Germany has had to enact policies to allow for the continued use of carbon-intensive fossil fuels. That is, despite a legal obligation to phase-out lignite and coal in power generation by 2038<sup>44</sup> – and a target to bring this forward to 2030 – Germany saw the temporary return of around 8GW of electricity generation from lignite and coal, until June 2023 and March 2024, respectively.<sup>45</sup> While this represents a sizeable return of fossil fuel power generation and resulting emissions, the German government ultimately considers these plans to be an unfortunate necessity. To compensate for this and prove its continued desire to reach net zero and advance progress, the German government has introduced further decarbonisation commitments during the course of the energy crisis.

## Unlocking net zero through policy

Cognisant of the need to expedite decarbonisation efforts amid the energy crisis, the coalition government has sought to increase Germany's net zero targets, announcing, in July 2022, the "largest acceleration package for [the] expansion of renewables in decades".<sup>46</sup> As a result, Germany plans to "triple the pace of expansion of renewables" and "double" their share in gross electricity consumption over the coming decade with a view to provide further energy security and reduce reliance on fossil fuels. This comes alongside desire to achieve net zero amongst German consumers.

Responding to a need for further clarity and investment incentives, the German government also updated the EEG for 2023 in July 2022. Not only did the EEG 2023 increase support for consumers by removing the EEG levy, with funding now moved from consumer bills to general taxation, it also sought to further incentivise the development of renewables. Alongside increased renewable capacity targets – 215GW of solar PV and 115GW of onshore wind by 2030<sup>47</sup> – the EEG 2023 introduced provisions to digitise and simplify regulatory processes for new projects and allows for greater funding under the renewable feed-in tariff scheme.

This produced favourable results for Germany, with the April 2023 auction round for ground-mounted solar PV oversubscribed – and almost 2GW of capacity contracted – thanks to the added revenue stability and clarity afforded by the updated feed-in tariffs.<sup>48</sup> Similarly, offshore wind tenders in July<sup>49</sup> and August<sup>50</sup> 2023 were successful in Germany as 8.8GW of new generation capacity was contracted, with sites set to come online in 2028 and 2030; this would more than double Germany's current 7.7GW capacity as of 2023. This also represents a significant increase in renewable investment within Germany. Combined, 2023 offshore wind auctions amounted to over €13bn. The EEG's success may come as no surprise as it remains predominantly responsible for Germany's current build-out of renewables – as of 2022 145GW of renewable capacity was funded by the EEG, with only 5GW existing outside its remit.<sup>51</sup> However, there is still work to be done to ensure that projects are able to advance at pace and without regulatory roadblocks.

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<sup>44</sup> [Bundesgesetzblatt](#)

<sup>45</sup> [Bundesnetzagentur](#)

<sup>46</sup> [Bundesministerium für Wirtschaft und Klimaschutz](#)

<sup>47</sup> [Bundesministerium für Wirtschaft und Klimaschutz](#)

<sup>48</sup> [Bundesnetzagentur](#)

<sup>49</sup> [Bundesnetzagentur](#)

<sup>50</sup> [Bundesnetzagentur](#)

<sup>51</sup> [Bundesnetzagentur](#)

# Decarbonising the energy system

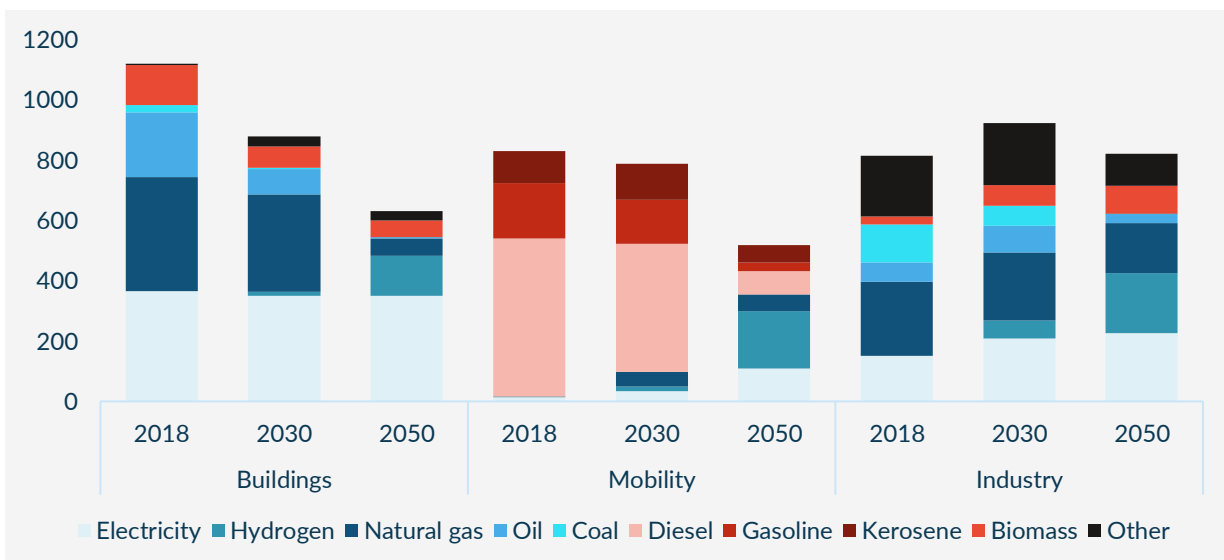
This section is based on exclusive insights from Cornwall Insight’s new North West Europe Benchmark Power Curve. Our modelling indicates that Germany’s net zero transition will require large-scale change, both in terms of required capacity and the range of energy sources needed to meet demand. Germany’s net zero energy mix is expected to be dominated by intermittent renewables and ‘green’ hydrogen, which is produced using electrolysis with electricity from renewable sources. As the result of such a fundamental shift in the energy mix, current infrastructure will need to be updated or retrofitted to ensure that energy is able to flow throughout the country unconstrained.

## Demand drivers

Moving towards 2050, final energy demand is forecast to drop in Germany. In the buildings, mobility, and industrial sectors, consumption will decline towards 2050, likely as a result of increased energy efficiency and continued efforts to reduce German energy consumption. In both the buildings and mobility sectors, future energy demand will be substantially lower, while industrial sector demand will only experience a minimal decline. These demand reductions are coupled with a transition away from fossil fuels as a direct energy source, with increasing electrification – particularly in the mobility sector – and hydrogen acting to displace hydrocarbon-based fuels.

By 2050, electricity and low carbon hydrogen are forecast to meet ~52% of industrial energy demand, ~58% of mobility sector energy demand, and ~77% of the energy demand from buildings (Figure 9). Despite overall demand dropping substantially, a focus on electrification will necessitate a further build-out of renewables within Germany to meet the *increasing* demand for electricity.

**Figure 9: Forecasts of German final energy demand for buildings, mobility and industry sectors by source (2018, 2030, 2050)**



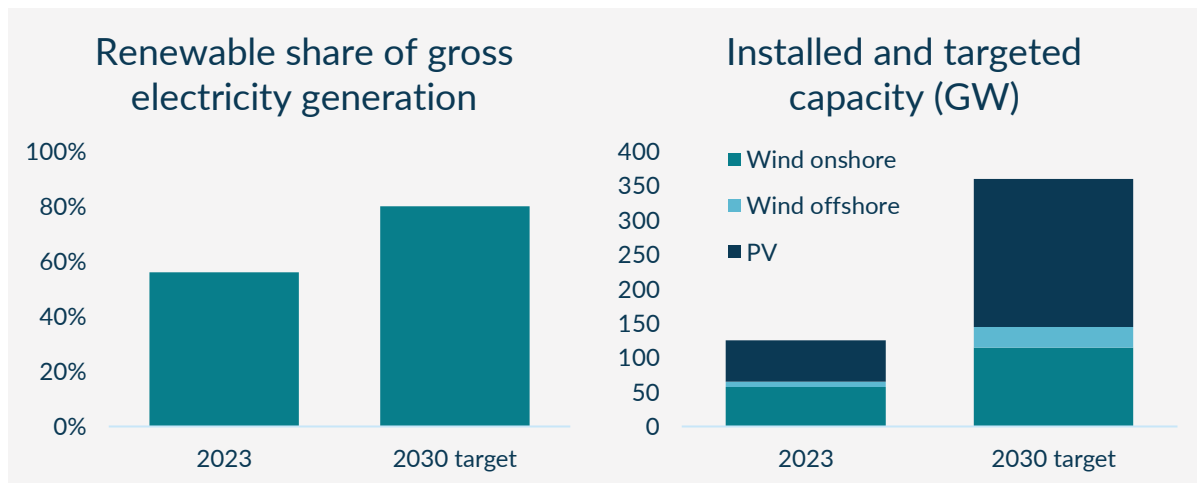
Source: Cornwall Insight, EWI, Eurostat

## Renewable energy mix

Alongside changing energy demand, meeting EU and domestic emissions reductions targets will require that the electricity and hydrogen displacing fossil fuels is produced from low-carbon sources. For the electricity mix, Germany is targeting 80% of electricity supply to be derived from renewable sources by 2030, up from 56% in 2023 (Figure 10). In terms of installed capacity, renewable electricity is expected to be dominated by solar PV and onshore wind, with offshore wind making up a smaller component (Figure 10).

Other renewable sources are not forecast to contribute substantially to renewable electricity capacity or generation. For example, Germany’s hydropower capacity is expected to rise from ~5GW in 2023 to ~6GW in 2050, as the potential for locating new hydropower parks is largely exhausted.

**Figure 10: Renewable share of German gross electricity generation and installed and forecast capacity of solar PV, onshore wind, and offshore wind**



Source: Cornwall Insight, [Bundesnetzagentur](#)

## Phasing out nuclear and coal

As part of this transition to greater renewable penetration in the electricity generation mix, Germany has committed to phasing out electricity generation from both nuclear and coal. The last three German nuclear reactors, which accounted for ~12% of electricity production in 2021 and ~3% in 2022, closed in April 2023, reducing capacity on the system by 4GW. Meanwhile, the *Kohleausstiegsgesetz* (Coal Phase-out Act)<sup>52</sup> adopted in July 2020, commits Germany to phasing out coal and lignite for use in electricity production by 2038. While the current federal government is targeting to bring the complete phase-out forward to 2030 through negotiations with individual companies, modelling suggests that this is unlikely to be achieved at present (Figure 11).

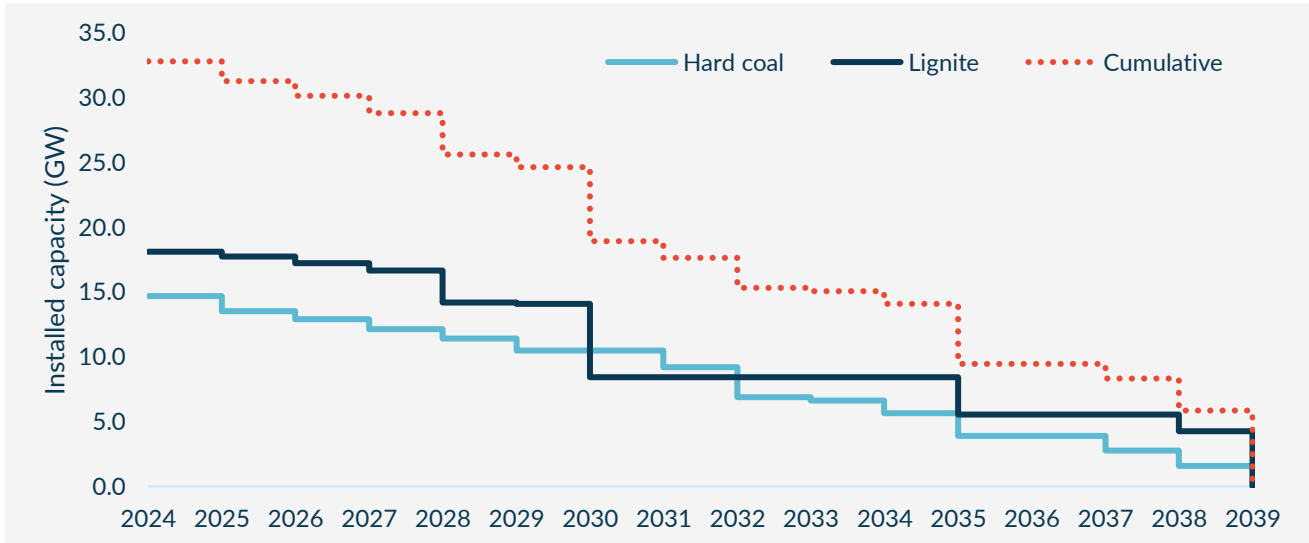
## Low-carbon hydrogen

If coal-fired power is phased-out by 2030 then, alongside the closure of the nuclear fleet, there will be a deficit of baseload capacity that will need to be at least partly replaced by gas-fired power

<sup>52</sup> [Bundesgesetzblatt](#)

plants, before later being powered by low-carbon hydrogen.

**Figure 11: Coal phase-out trajectory (2023-2039)**



Source: Cornwall Insight

The extent of hydrogen’s future role is potentially vast, as our modelling shows that by 2050 low-carbon hydrogen could generate over 200TWh/year. To facilitate this transition, the government has been working to develop a power plant strategy, funded by €60bn and with a goal to aid the construction of 25GW new capacity by 2030. These power plants would be required to be hydrogen-ready but would initially be fuelled by natural gas.

While industry has been eagerly awaiting the strategy’s publication, problems arising from the 2024 budget are likely to delay it further. In late 2023, €60bn of the proposed 2024 budget was deemed unconstitutional by the Constitutional Court, as it had been reallocated from unused debt in the country’s Covid-19 pandemic fund.<sup>53</sup> While the coalition government reached an agreement on the budget in December 2023, it will come with some major concessions as the Klima- und Transformationsfonds (climate and transformation fund) has been cut by €12bn for 2024 and €45bn for future budgets until 2027.<sup>54</sup> While it remains to be seen what impact this will have on the viability of the power plant strategy, other areas of Germany’s net zero industry will experience cuts in 2024.

Despite this setback, the German government remains focused on its transition towards low-carbon hydrogen as a replacement for coal and natural gas. Underpinning this, the National Hydrogen Strategy<sup>55</sup> – originally published in 2020 and updated in July 2023 – sets out a target of 10GW low-carbon hydrogen capacity by 2030. While this was originally set to be met by ‘green’ hydrogen derived from renewable electricity electrolysis, the updated strategy also allows for the transitional use of ‘blue’ hydrogen, derived from fossil fuels but with the use of carbon capture use and storage (CCUS). To fund the transition, Germany earmarked €18.6bn<sup>56</sup> for hydrogen between 2024 and 2027– of which €3.8bn would be made available in 2024 – however, the budget crisis has also put

<sup>53</sup> [Bundesverfassungsgericht](#)

<sup>54</sup> [Die Bundesregierung](#)

<sup>55</sup> [Die Bundesregierung](#)

<sup>56</sup> [Bundesministerium der Finanzen](#)

this into question. This comes following previous government commitments to invest billions of euros to speed up the domestic production of hydrogen and to foster international partnerships as domestic low-carbon hydrogen production alone will not be sufficient to meet the country’s hydrogen demand (as forecast in Figure 9). Ambitions must be met by on-the-ground development, however, if they are to be achieved.

Nonetheless, Germany is making progress on hydrogen deployment, with electrolyzers set to come online in late 2025 and early 2026, helping to satisfy current demand and stimulating future utilisation. As the country will remain strongly dependent on low-carbon hydrogen imports (with government estimates ranging from 50-70% of its 95-130TWh demand by 2030)<sup>57</sup> the German government has also entered into agreements with multiple partner countries to import the fuel, citing it as an opportunity for mutual growth. Among others, Germany has signed agreements to import low-carbon hydrogen from Canada and Norway, and to export CO<sub>2</sub> to the latter. Further agreements are likely to come in the future as July 2023’s update to the National Hydrogen Strategy also signalled the creation of a ‘separate import strategy’ for low-carbon hydrogen to facilitate relationships with ‘diversified import channels and avoid new dependencies.’

## Flexibility

To help curtail the capacity deficit and allow better utilisation of renewables on the system – particularly wind and solar – forecasts indicate there will be increased flexibility provision in Germany, from both demand side management (DSM) and energy storage. The Federal Network Agency (Bundesnetzagentur) expects (Figure 12) that DSM, domestic energy storage – which is becoming increasingly popular for those with solar PV installations<sup>58</sup> – and large-scale storage are forecast to see substantial rises in deployment moving towards 2045. Germany is also developing power-to-X to both provide additional flexibility and to reduce reliance on fossil fuels. This is where electricity generated from renewables including wind, solar, hydropower, and geothermal power plants is converted into a variety of end products (X), including ammonia and sustainable synthetic hydrocarbons. The different forms of synthetic hydrocarbons can help ‘de-fossilise’ the chemical industry, maritime shipping, and aviation through the switching from fossil carbon to renewable carbon.

**Figure 12: Storage build-out trajectory in Germany, 2020-2045**

Technology type	2020	2037	2045
DSM	1.2GW	7.2GW	12GW
Domestic storage	1.3GW	67.4GW	113.4GW
Large-scale storage	0.5GW	24.2GW	54.5GW

Source: [Netzentwicklungsplan Strom](#)

## Transmission

Increasing levels of renewable generation being added to the grid over the coming years poses a challenge to Germany’s net zero transition through system congestion. With large volumes of renewable generation to be located along the coast of the Baltic and North Sea (in the north) and the

<sup>57</sup> [Bundesministerium für Wirtschaft und Klimaschutz](#)

<sup>58</sup> [Bundesverband Solarwirtschaft e.V.](#)

major demand centres in North-Rhine Westphalia and Bavaria (in the centre and the south), constraints on grid infrastructure and electricity transmission are set to worsen. Although plans are in place to develop four additional high voltage direct current cables, significant local opposition could delay their development. Furthermore, while nearly €4.2bn was spent in 2022 on congestion measures<sup>59</sup> – from a mixture of redispatch, curtailment, and reserve capacity costs – further substantial investment is required to upgrade the grid infrastructure. It is possible that the development of a low-carbon hydrogen storage and transport network could help resolve some of the grid issues. However, there are also technicalities in establishing the transport and distribution infrastructure for hydrogen itself.

Energy storage will play a crucial role in the integration of renewable energy into the energy infrastructure and help maintain grid security. The TransnetBW's Netzbooster project<sup>60</sup> was introduced in the 2030 German Grid Development Plan,<sup>61</sup> published in 2019, as an innovative energy storage concept. It uses a 'grid booster', a battery storage device, connected to the power grid, which acts as a reserve in the event of a bottleneck or line failure. It aims to allow transmission lines to be better utilised with higher load factors, reduce curtailment of renewable generation in the north and save on redispatch costs. It is also designed to reduce the necessity of laying additional high voltage lines by allowing for the existing grid to be used to a greater extent, whilst maintaining security of supply on the system. The German Grid Development Plan set out proposals for a 250MW Netzbooster pilot project in Kupferzell which is expected to be operational by 2025.<sup>62</sup>

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<sup>59</sup> [Bundesnetzagentur](#)

<sup>60</sup> [Transnet BW](#)

<sup>61</sup> [Bundesnetzagentur](#)

<sup>62</sup> [Fluence](#)

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## Concluding remarks

To reach its net zero targets on time, Germany will have to overcome several new and long-standing obstacles – within the energy sector and broader macroeconomic and geopolitical spheres – in both the short- and long-term. While, given the magnitude of change required, this was always going to be a challenge, the energy crisis has given rise to additional considerations and has complicated matters for Germany.

Overhauling the historically fossil-fuel dependent energy system to rely on an increasing supply of renewables and low-carbon fuels will require large scale change in a relatively tight timeframe. To achieve targeted levels of renewables deployment in Germany, grid inefficiencies must be resolved, while the transmission network needs to be reinforced to avoid congestion. This will also be necessary to support the planned phase-out of fossil fuels as it necessitates a move towards large-scale electrification. Likewise, Germany must continue to support the development of low-carbon hydrogen infrastructure as, while it could play a key role in the future energy mix, it remains in its early stages.

The energy crisis has further compounded these challenges as energy prices have risen and high inflation and interest rates have followed. The change in Germany's energy mix and source of energy imports has also led to unforeseen challenges. Moreover, the crisis has seen the discussion surrounding energy move from one exclusively centered on decarbonisation to one increasingly including the need to maintain security of supply and consumer affordability. While net zero undoubtedly remains a key priority, this has caused some temporary concessions to be made in favour of fossil fuels and has slowed some progress towards decarbonisation in the short-term.

Ultimately, however, these changes are only intended to be temporary and the desire to reach net zero by 2045 remains strong in Germany, among the government, citizens, and industry alike. Recent successes in offshore wind and solar PV tenders and the promise of enhanced policy support for net zero are positive signs and could allow Germany to get back on the right tracks over the coming months and years. However, longstanding issues still remain unresolved while the macroeconomic environment within Germany remains challenging and could form lasting effects. It is crucial that this does not deter the apparent enthusiasm for net zero in Germany and progress continues to be made, even in spite of short-term difficulties.



## North West Europe\* Benchmark Power Curve

*\*Germany, Austria and Benelux*

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