KfW Research
Focus on Economics

Half of all firms in Germany already use electricity from renewables but use of climate-friendly heat is much less common

No. 460, 26 April 2024

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On the road to climate neutrality, significantly expanding renewables is a matter of urgency. **In Germany, industry and commerce today account for some 42% of final energy consumption.** Firms are therefore important stakeholders for the success of the energy transition. Current findings of the KfW Climate Barometer give insights into the investment activity of private enterprises in the field of renewable energy and demonstrate how widespread the use of electricity and heat from renewables already is in the business sector.

Recently, more private enterprises have invested in the generation and storage of electricity or heat from renewable energy. In 2022, the share was a respectable 4.3%, or approx. 160,000 firms. As a result of the increase in fossil fuel prices caused by Russia's war of aggression against Ukraine, investment in renewables has become more attractive.

The use of electricity from renewables is already widespread among firms. More than half of enterprises reported this to be the case in 2022. On the other hand, it is less common for them to obtain heat from renewables. Only one in ten firms reported using heat from renewable energy. Both electricity and heat from renewables are more common in larger enterprises than in smaller ones.

The provision of heat in industry and commerce is still largely based on the burning of fossil fuels. While the climate-friendly generation of building heat has strongly shaped public debate in recent years, it is now necessary to place a stronger focus on the decarbonisation of industrial process heat supply. Accounting for roughly two thirds of final energy consumption, process heat is the most energy-intensive field of use in industry and thus a key area of action of climate policy. Process heat is required in a wide variety of industrial processes, for example to generate steam and to operate furnaces and drying facilities.

Climate neutrality and energy security require massive expansion of renewables

For Germany to become climate-neutral by 2045, a fundamental restructuring of the present energy system will be necessary. Long-term scenarios describe possible technological pathways towards a climate-neutral Germany by 2045. They show that the supply of energy will essentially be based on two types of energy sources in the future: Electricity from renewables and green hydrogen generated from electricity obtained from renewables.[1] Renewable energy (RE) thus forms the backbone of the energy system of the future. Russia's war of aggression against Ukraine and the risks to Germany's supply of fossil fuels that became evident as a result also showed that expanding renewables is necessary not just for the sake of the climate. It is also a strategic key to energy security and energy affordability.

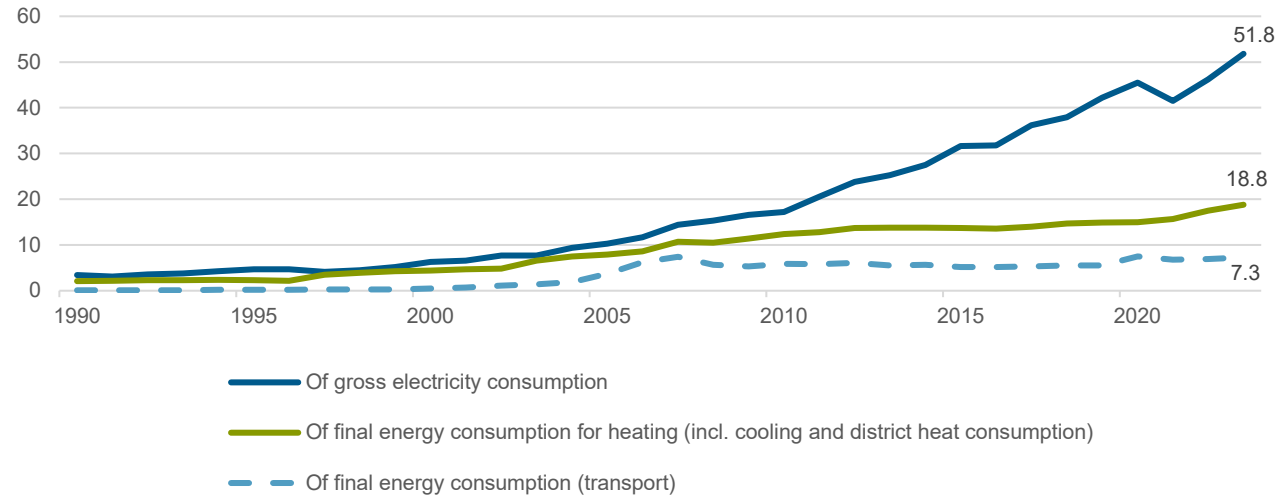
Where does Germany stand in the expansion of renewables? In 2023, renewables accounted for 22% of total gross energy consumption (2022: 20.8%).[2] Gross energy consumption comprises all types of energy consumption at the final consumer such as electricity, fuels for generating heat, district heat and fuels to drive vehicles. Particularly the electricity sector made major progress in expanding the use of renewable energy (Figure 1). In 2023, renewables covered more than half of Germany's electricity demand for the first time (51.8%, 2022: 46.2%). This increase was essentially driven by the expansion of wind power and solar photovoltaic energy. The shift to renewables in the areas of heat and transport, on the other hand, is advancing much more slowly. Last year, RE reached a share of 18.8% of the supply of heat (2022: 17.5%), primarily through the use of bioenergy, solar and geothermal energy and ambient heat harnessed with heat pumps. In the transport sector, the share of RE in final energy consumption was a mere 7.3% (2022: 6.9%). The renewable energy sources used here were primarily biofuels and green electricity used in electric mobility. It is important to note that fossil fuels still dominate the supply of heat and the transport sector – both of which account for around 80% of final energy consumption in Germany[3].

Major strategies for decarbonising the supply of heat and mobility consist in direct electrification and the use of green hydrogen generated from electricity and its derivatives in hard-to-electrify areas of final consumption such as aviation, shipping and industrial segments.[4] Electric vehicles, heat pumps, hydrogen electrolysis and low-carbon industrial production will lead to a significant increase in demand for electricity. The German Federal Ministry for Economic Affairs and Climate Action (BMWK) expects the current demand for electricity to more than double on the way to climate neutrality by 2045.[5] The expansion of renewables in the electricity sector is therefore key to achieving the climate targets in the areas of heat and transport.

The aim is a 65% reduction in greenhouse gas emissions by 2030 compared with the 1990 baseline. That is one reason the amendment to the Federal Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz – EEG) from early 2023 provides for increasing the share of electricity generated from renewables to at least 80% of gross electricity consumption in 2030. Accordingly, the expansion targets for wind and solar energy were raised significantly. Thus, installed onshore wind

Figure 1: Shares of renewables in electricity, heat and transport

In per cent (1990–2023).



Source: German Federal Environment Agency, based on the Renewable Energy Working Group Statistics 2024.

power capacity is to increase from now 61 GW to 115 GW by 2030, offshore wind power from around 9 W to 30 GW, and photovoltaics capacity from 82 GW to 215 GW.[6] These growth targets mean that the current rate of RE expansion must be accelerated massively.[7]

Investment in renewable energy increased

Industry, commerce, trade and services currently account for around 42% of final energy consumption in Germany.[8] Firms are therefore important stakeholders for the success of the energy transition. Current findings of the KfW Climate Barometer give insights into the investment activity of private enterprises in the field of renewable energy and provide information on how widespread the use of electricity and heat from renewables already is in the business sector.[9]

In the year 2022, 4.3% of firms in Germany invested in the generation and storage of electricity or heat from renewable energy sources (Figure 2). That was around 160,000 firms. The comparison with the previous year shows that significantly more firms invested here. The share of firms that implemented relevant measures increased by 1.6 percentage points. A major factor for this development was likely the strong increase in fossil fuel prices because of Russia's war of aggression against Ukraine, which made investments in the use of renewables more attractive.

In the manufacturing sector, the share of firms that invested stands at 7% and is thus higher than in other sectors. In this segment in particular, shifting away from fossil fuels to alternative energy sources is likely to play an important strategic role for competitiveness – not just today, in the wake of increased energy prices, but also in the future. Furthermore, a disproportionately high share of manufacturing firms tends to be classified as belonging to the larger size classes.

These larger firms stand out for their participation in investment activities. The larger the firms, the more likely it is to invest in renewable energy generation. Whereas only 3% of micro-enterprises with fewer than five employees made such investments in the year 2022, that figure already stood at 22% among large enterprises. The fact that larger firms invest more often is likely because they are generally better endowed with human and financial resources. Furthermore, large enterprises have incorporated climate action more deeply into their corporate strategy. For example, they formulate specific greenhouse gas reduction targets and align their investment activities accordingly.[10]

Box 1: Firm size classes

The KfW Climate Barometer divides firms into five different size classes. These are defined as follows: **Micro-enterprises** have fewer than five employees. **Small enterprises** have five to nine employees. **Medium enterprises** are defined as those that have ten to 49 employees. Companies with 50 and more employees are referred to as **larger SMEs** – provided their annual turnover does not exceed EUR 500 million. This turnover threshold applies analogously to all smaller size classes. Accordingly, **large enterprises** are defined as companies with an annual turnover exceeding EUR 500 million; their headcount does not play a role, however. In this analysis, only these designations are used for ease of reading. Where the small and medium-sized enterprises (SMEs) sector is additionally referred to as a collective, it comprises the first four size classes.

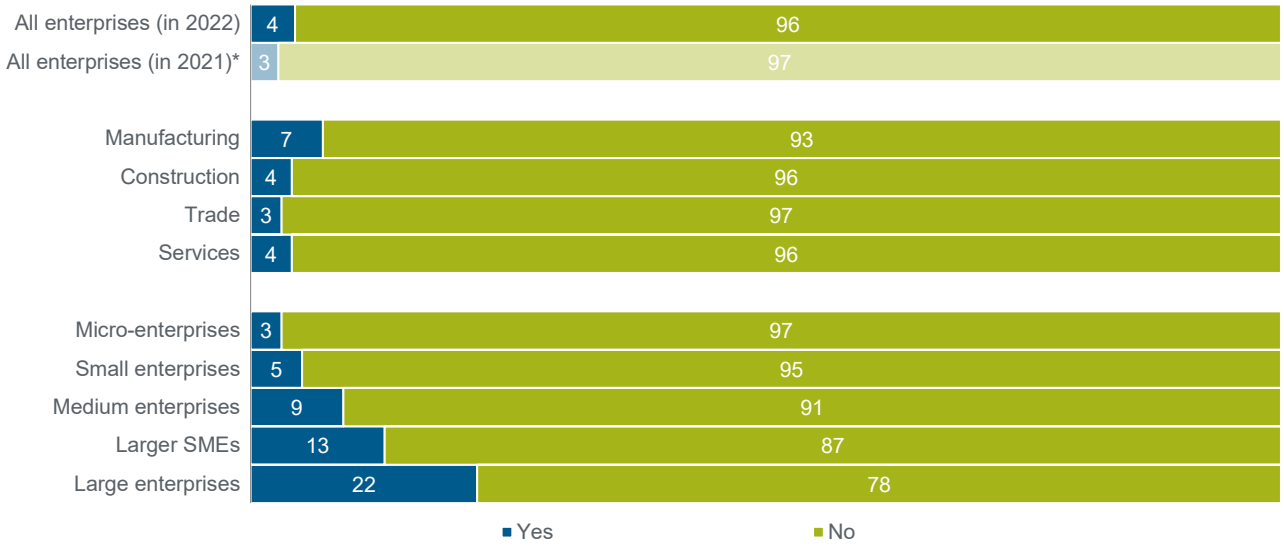
On the basis of the KfW Climate Barometer, the volume of investment for the SME sector can be quantified as follows: In the year 2022, SMEs in Germany invested a total of around EUR 7 billion in measures for the generation and storage of electricity or heat from renewable energy sources.[11] In nominal terms, that was twice the volume of the previous year, in which they invested approx. EUR 3.5 billion.[12]

More than half of firms use electricity from renewables

How widespread is the use of electricity and heat from renewable energy in the corporate sector? Figure 3 illustrates that 54% of firms in Germany already used electricity from renewables in the year 2022. They did this through a corresponding electricity tariff, for example, or by setting up

Figure 2: Investment in the generation and storage of electricity or heat from renewables

Firms that invested in 2022 / * in 2021 (shares of firms in per cent)



Note: The specific question was: 'Did your company carry out climate-positive investments in Germany in 2022? (Note: climate aspect did not have to be the top priority in the investment decision): Yes; No, but planned by the end of 2023; No, and not planned in 2023 either'. The subsequent question was: 'How much did you invest in climate action in Germany in 2022, and how were these investments divided across the following areas of measures?' The above table presents as 'Yes' the share of enterprises that answered the first question in the affirmative and provided a value greater than zero in the subsequent question for the possible response 'Generation or storage of electricity or heat from renewables approx. EUR...'. 'No' refers to all remaining enterprises.

Source: KfW Climate Barometer 2023, * KfW Climate Barometer 2022.

their own electricity supply from biomass, solar photovoltaic or wind power systems.[13]

The share of firms that use electricity from renewables is highest in the manufacturing sector, at 48%. Here, a particularly high 27% of firms also reported that energy costs made up 10% and more of their total costs.[14] To the extent that they partly rely on electricity they themselves generate from renewables, they may be able to reduce their energy costs and, in this way, improve their competitiveness.[15] In the construction industry, on the other hand, the share of companies using green electricity is the lowest, at 35%. This may be because these firms carry out their activities mainly on construction sites and have little influence on the existing site power supply.

If we analyse the shares of firms that use electricity from renewables by size class, the picture that emerges is similar to the rate of investment. The larger the enterprise, the higher the number of firms that use electricity from renewables. Large enterprises already use more than 90% electricity from renewables. They also have the option of directly accessing the energy exchange to obtain electricity generated in part from renewables. Overall, it has been found that the higher investment rate of larger enterprises is also reflected in a higher proportion of users of green electricity.

Heat from renewables is much less widespread

The use of heat generated from renewables is much less common. Figure 4 shows that 11% of firms used heat from renewables in the year 2022.

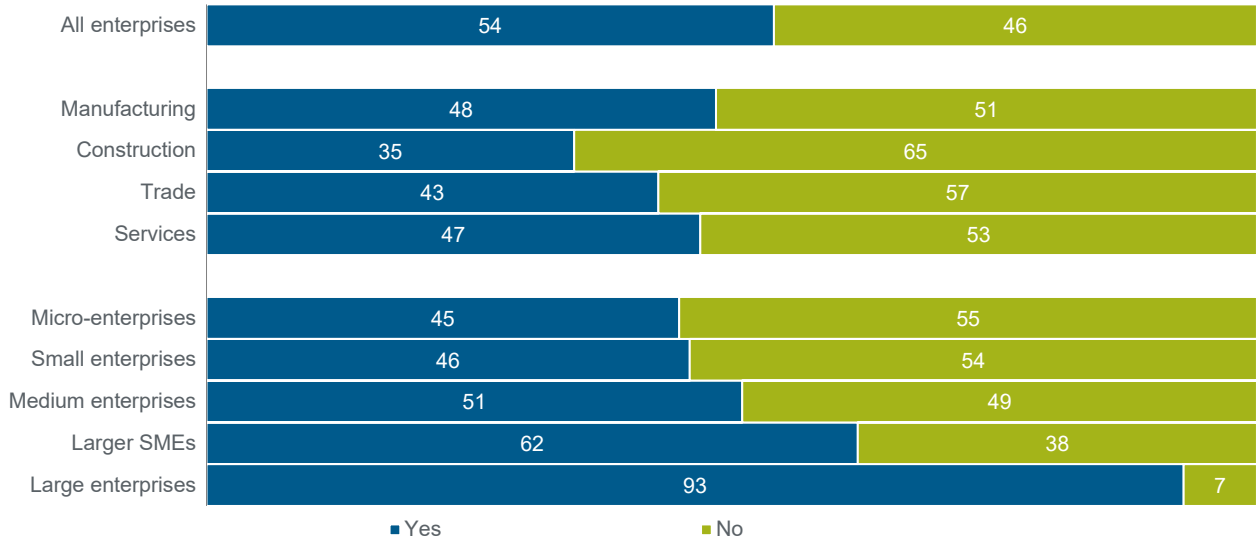
The sector comparison reveals that the share of wholesalers and retailers using heat from renewables sits at just 6%. That was lower than the average share across all economic sectors. It is safe to assume that there is a high share of tenants in wholesale and retail so that firms have only little influence on the source of energy used for heating. In construction and manufacturing, on the other hand, the share of enterprises that use heat from renewable energy is considerably higher. In the construction sector, one factor that may play a role is that some enterprises sell climate-friendly heating systems for buildings and therefore use these technologies themselves at their business premises. Manufacturing firms also have comparatively high turnover and employee numbers. They are more likely to possess the resources to address climate action concerns and have the means to invest in systems that provide heat from renewables. Another factor that may have played a role in manufacturing are the increased prices of fossil fuels in the wake of Russia's war of aggression against Ukraine.

Among large enterprises, a significantly higher share of 37% of companies already use heat from renewables. That, too, may be due to the fact that they have more cash at their disposal and have often enshrined climate action in their corporate strategy.

The survey results are largely consistent with the federal statistics mentioned above, which shows that the supply of heat is predominantly still based on fossil fuels across all sectors. In the commerce, trade and services sector, most of the heat consumed is for the heating of buildings. Here, approx. 50% of total final energy demand is required for space heating. In the industrial sector, however, the dominant use is for process heat. Process heat is by far the most energy-intensive field of use in industry, with a share of roughly two thirds of final energy consumption.[16] Process heat is required in a wide range of industrial processes, for example to generate steam and hot water, and to operate furnaces, forges and drying facilities.

Figure 3: Use of electricity from renewables

Use of energy source in 2022 (shares of firms in per cent)



Note: The specific question was: 'Which source of energy did you use in your business in 2022? (Please place check mark in relevant fields, multiple responses are possible): electricity from renewable energy sources, natural gas, coal, district heating, conventional electricity, hydrogen, petrol / diesel, heat from renewable energy'. The 'Yes' bar represents the share of firms that responded 'electricity from renewable energy'. The 'No' bar represents the share of firms that did not respond 'electricity from renewable energy'.

Source: KfW Climate Barometer 2023.

The challenge of climate-friendly buildings heat

Besides improving energy efficiency, for example with thermal insulation, the key strategy to supplying non-residential buildings such as office or production premises with climate-friendly heating is to replace fossil fuel-based systems with climate-friendly solutions. Among the potential barriers to this are high investment costs and lack of information about technical solutions. The amended Building Energy Act (Gebäudeenergiegesetz – GEG) came into force on 1 January 2024 with the aim of accelerating the market penetration of climate-friendly heating methods. This act stipulates the key requirement that only heating systems based on at least 65% renewables must be gradually installed in buildings and that the use of fossil energy for heating must be phased out by 2045. Key technologies specified in the act include heat pump systems, systems that connect buildings to heat networks with high shares of renewable energy, and heating systems based on biomass. Besides regulatory requirements, rising carbon prices for fossil fuels are to create additional incentives for switching early to climate-friendly heating technologies under the National Fuel Emissions Trading System and government support programmes.

The challenge of climate-friendly process heat

The decarbonisation of industrial process heat is one of the key challenges for achieving climate neutrality in industry. The first thing that needs to be done here, too, is to fully harness the existing energy efficiency potentials in order to reduce the need for process heat. Examples include measures for process optimisation (such as temperature reduction, optimisation of plant design and control), improved insulation of plants and ducts, and systematic waste heat utilisation. A key technology for the climate-friendly supply of process heat is direct electrification with electricity from renewables, for example through the use of (high-temperature) heat pumps, electrode boilers or induction heaters. District heat is another important option for the supply of steam and hot water for the industrial sector. Where less heat is required, the direct use of renewable heat sources such as deep geothermal and solar thermal energy can be a solution. High-temperature applications that are impossible or challenging to electrify directly (for example in cement clinker kilns and iron production) rely on the use of green hydrogen or biomass / biogas.[17]

Various challenges have so far prevented the broad use of climate-friendly technologies for the supply of process heating in industry. These include:[18]

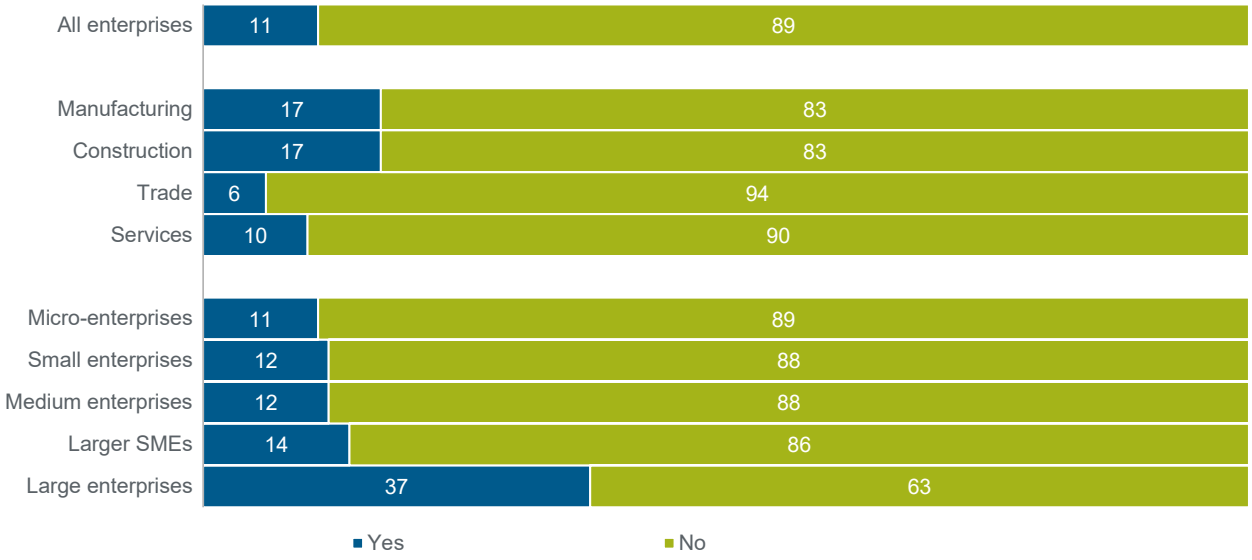
- High investment cost and technical complexity of converting the plant fleet,
- Higher energy costs in plant operation compared with plants running on fossil fuel,
- Uncertainty around the sufficient long-term availability of electricity from renewables and green hydrogen at competitive prices,[19]
- Uncertainty on the timely availability of the required infrastructure (e.g., electrical connection services at location, network infrastructure for feeding green hydrogen to production site).
- Some relevant technologies are still in the trial phase and are yet to be brought to industrial scale.

Approaches to the market ramp-up of climate-friendly process heat

Since many technologies for the provision of climate-friendly process heat in industry still have competitive disadvantages compared with conventional fossil alternatives, policy frameworks are required to enable their market penetration. A reliable and rising carbon price signal is key to this. Because

Figure 4: Use of heat from renewables

Use of energy source in 2022 (shares of firms in per cent)



Note: The specific question was: 'Which source of energy did you use in your business in 2022? (Please place check mark in relevant fields, multiple responses are possible): electricity from renewable energy sources, natural gas, coal, district heating, conventional electricity, hydrogen, petrol / diesel, heat from renewable energy'. The 'Yes' bar represents the share of firms that responded 'heat from renewable energy'. The 'No' bar represents the share of firms that did not respond 'heat from renewable energy'.

Source: KfW Climate Barometer 2023.

the carbon price will probably not rise at the pace that would be required to enable the market ramp-up of climate-friendly technologies under both the European Emissions Trading System and the National Fuel Emissions Trading System, additional policy instruments are necessary.[20] Here, the German Federal Government is committed to innovation and investment promotion programmes and supporting operating costs for large carbon emitters in energy-intensive industry (offsetting additional costs under carbon contracts for difference). As long as the level of climate action ambition varies around the world, an effective mechanism to avoid offshoring carbon emissions (carbon leakage), particularly for energy-intensive firms competing internationally, is of the essence to ensure acceptance of the green transformation. The carbon border adjustment mechanism adopted by the EU and currently under development goes in this direction. The climate club of major trading partners initiated by the G7, too, is designed to contribute to fair international competition through the development of standards and definitions for green industrial products. In order to create planning certainty for corporates to make the necessary investments, the expansion of renewable energy, electricity grids and hydrogen infrastructure needs to be pushed forward with urgency.

Conclusion

Expanding renewables is key to making climate neutrality in industry and commerce an achievable goal. Against this background, it is pleasing to see that firms in Germany have expanded their investments in the use of renewables in the past years. The use of electricity from renewables is already widespread among firms as well. And yet, major challenges remain. There is a particular need for action in the provision of heat, for which firms still rely predominantly on fossil fuels.

While the climate-friendly generation of building heat has strongly shaped public debate in recent years, it is now necessary to place a stronger focus on the decarbonisation of industrial process heat supply. Accounting for roughly two thirds of final energy consumption, process heat is by far the most energy-intensive field of use in industry and thus a key area of action of climate policy.

Box 2: The dataset: The KfW Climate Barometer

The KfW Climate Barometer is the first and thus far only representative database for the investment behaviour of all German firms – from micro-businesses to large enterprises – on the road to climate neutrality. The business survey is designed as a recurring annual survey and provides insights into the attitudes and activities of firms around the implementation of the energy transition.

The current analyses are primarily based on the data collected in the second survey wave (survey period February to June 2023), in which a total of 11,466 enterprises participated.

Further information can be obtained here.

[1] Cf. Brüggemann, A. (2022): Klimaneutralität und Energiesicherheit zusammendenken: Kapazitäten Windkraft bis 2030 verdoppeln, Photovoltaik rund vervierfachen (*Thinking climate neutrality and energy security together: wind power capacity needs to double by 2030, photovoltaic power must quadruple* – our title translation, in German), Focus on Economics No. 376, KfW Research.

[2] Cf. German Federal Environment Agency, based on the Renewable Energy Working Group Statistics – AGEE-Stat (2024): Zeitreihen zur Entwicklung der erneuerbaren Energien in Deutschland (*Time series on the development of renewable energy sources in Germany* – our title translation, in German), as at February 2024, last visited on 12 March 2024.

[3] Cf. German Environment Agency (2023): Indicator: Share of renewables in gross energy consumption, as at 22 February, 2024, last visited on 12 March 2024.

[4] See endnote 1.

[5] Cf. Federal Ministry for Economic Affairs and Climate Action (2023): Zwischenbericht der Systementwicklungsstrategie, (*Interim Report on the System Development Strategy* – our title translation, in German), last visited on 12 March 2024.

[6] Cf. Expansion targets: Renewable Energy Sources Act – EEG 2030 and the Windenergie-auf-See-Gesetz – WindSeeG 2023 (*Offshore Wind Energy Act 2023* – our translation, in German); status quo: see endnote 2.

[7] The ambitious national expansion targets are underpinned by the amendment to the EU's Renewable Energy Directive (RED III), in which the EU-wide RE expansion targets for 2013 were sharply increased.

[8] Cf. German Environment Agency (2024): Endenergieverbrauch nach Energieträgern und Sektoren, (*Final energy consumption by energy sources and sectors* – our title translation, in German), last visited on 12 March 2024.

[9] Progress made in the decarbonisation of transport in the corporate sector is shown by, among other things, survey results on the diffusion of electric mobility in companies. See: Grewenig, E. and Römer, D. (2023): Der Unternehmensfuhrpark – ein wichtiger Hebel für die Klimaneutralität *(The company vehicle fleet – an important lever for climate neutrality* – our title translation, in German), Focus on Economics No. 437, KfW Research.

[10] Cf. Brüggemann, A., Grewenig, E., Römer, D. and Schwartz, M (2023): KfW Climate Barometer 2023. Climate investments by German enterprises grew by 18% in real terms in 2022 – despite the energy crisis, KfW Research.

[11] See endnote 10.

[12] Cf. Abel-Koch, J. et al. (2022): KfW Climate Barometer 2022. In 2021, German enterprises invested around EUR 55 billion in climate action – still too little to reach climate neutrality, KfW Research.

[13] Information on the extent to which electricity and heat from renewable energy is used is not available.

[14] See endnote 10.

[15] As some of the surveyed firms cannot be assigned to a particular economic sector and they use electricity from renewables at an above-average rate, the figure for the sectors presented is below the level for all enterprises.

[16] Cf. AG Energiebilanzen e. V. – AGEB (2023): Anwendungsbilanzen zur Energiebilanz Deutschland, (*Application balances for the energy balance in Germany* - our title translation, in German), last visited on 12 March 2024.

[17] Cf. Schüwer, D. and Holtz, G. (2023): Bereitstellung klimaneutraler Prozesswärme für die Industrie – ein 4-Stufen-Modell (*Supply of climate-neutral process heat for industry – a 4-stage model* – our title translation, in German), Energiewirtschaftliche Tagesfragen, issue 10/2023; Agora Industrie (2022): Power-2-Heat: Erdgaseinsparung und Klimaschutz in der Industrie (Power-2-Heat: *Reducing natural gas use and climate action in industry* – our title translation, in German).

[18] Cf. Fleiter, T. et al. (2023): CO_2-neutrale Prozesswärmeerzeugung (*Carbon-neutral process heat generation* – our title translation, in German), Study on behalf of the Federal Environment Agency, UBA-Texte 161/2023.

[19] Cf. Rahbauer, S., Menapace, L., Menrad, K. and Lang, H. (2018): Determinants for the adoption of green electricity by German SMEs – An empirical examination, Energy Policy 123, p. 533-543.

[20] If the carbon price of the emissions trading system is the only thing that can make climate-friendly technologies competitive for the supply of process heat, a price level of at least EUR 150, and in many cases more, per tonne of carbon will be necessary, see endnote 18.