DIW Weekly Report 3 2026

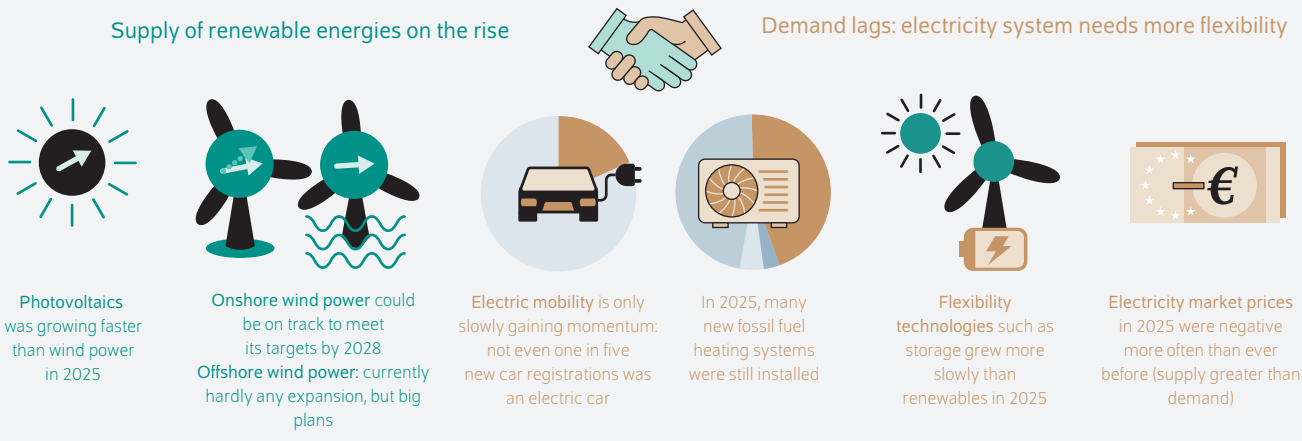
AT A GLANCE

Favorable conditions allow accelerating the renewabe energy transition

By Wolf-Peter Schill, Nicolas Aichner, and Alexander Roth

- Report provides update on the energy transition and current developments in key technologies based on the Open Energy Tracker
- Growth in photovoltaics is flattening—onshore wind power is lagging behind target path, but already approved plants could close the gap in the near future
- Electromobility is developing slowly, with progress also sluggish for heat pumps and electrolyzers; there is also a need to catch up in the area of electricity storage
- The pace of expansion of renewable energy should be maintained and sector coupling greatly accelerated
- A technology-neutral approach does not appear to be effective; instead, the focus should be on available and efficient technologies such as battery-electric vehicles and heat pumps

The conditions for renewables are good—but there is a need to catch up in terms of storage and sector coupling



Source: Own representation.

FROM THE AUTHORS

"The conditions for accelerating the energy transition are better than ever. We should stay the course and not change it."

— Wolf-Peter Schill —

MEDIA

Audio Interview with Wolf-Peter Schill (in German)
www.diw.de/mediathek

Favorable conditions allow accelerating the renewabe energy transition

By Wolf-Peter Schill, Nicolas Aichner, and Alexander Roth

ABSTRACT

Germany's current government is planning to realign its energy transition. Against this backdrop, this report provides an overview of current developments in key technologies and indicators for flexibility in the electricity sector. For photovoltaics, growth appears to be leveling off, especially for rooftop installations. Onshore wind power continues to lag its target path, but this gap could close by 2028 if all presently approved projects are fully implemented. Electromobility continues to develop slowly, while progress is also sluggish for heat pumps and electrolysis. Finally, the development of storage facilities and other flexibility technologies has progressed more slowly than the expansion of renewable electricity generation. However, policymakers should not slow the expansion of renewables, rather should maintain the pace. In doing so, they can benefit from significantly improved conditions. Sector coupling should be greatly accelerated, whereby a clear commitment to available, efficient, and scalable technologies, such as battery vehicles and heat pumps, appears to be more effective than a technology-neutral model. At the same time, these technologies should operate as flexibly as possible and in line with electricity market prices.

The energy transition is an essential part of Germany's climate protection strategy. Its core elements include a major expansion of renewable energy sources and what is known as sector coupling, i.e., the electrification of end uses in the heating, transport, and industrial sectors in order to replace fossil fuels with renewable electricity.

The previous federal government, made up of the SPD, Greens, and FDP (2021 to 2024), wanted to significantly accelerate the energy transition.[1] Although it was indeed able to substantially increase the pace in many areas, overall development fell short of the new targets.[2] The current government now sees the energy transition at a crossroads and is planning a realignment, highlighting the costs of the transformation. It is calling for a stronger focus on competitive electricity prices and maintaining security of supply, which it believes will be achieved through greater pragmatism and technology neutrality, among other things. In addition, the expansion paths for renewable energy sources are to be based on lower electricity demand scenarios than before.[3]

Against this backdrop, this report provides an overview of current trends in various key technologies for the energy transition. It looks at the expansion of renewables, the dynamics of sector coupling, as well as the supply and demand for flexibility in the electricity sector. The report is based on data provided by the *Open Energy Tracker* platform that is regularly updated.[4]

1 Wolf-Peter Schill, Adeline Guéret, and Alexander Roth (2022): Ampel-Monitor Energiewende Shows the Pace of the Energy Transition Must Be Accelerated Significantly. DIW Weekly Report No. 26/27/28, 171–179 (available online; accessed on November 6, 2025. This also applies to all other online sources in this report).

2 Wolf-Peter Schill et al. (2025): Bilanz des Ampel-Monitors: Mehr Tempo für die Energiewende. DIW Wochenbericht No. 7, 87–95 (in German; available online).

3 Bundesministerium für Wirtschaft und Energie, BMWE (2025): Klimaneutral werden – wettbewerbsfähig bleiben (in German; available online).

4 See Open Energy Tracker (available online). The Open Energy Tracker and this weekly report were developed as part of the Kopernikus project Ariadne, Fkz FKZ 03SFK5N0-2, funded by the Federal Ministry of Research, Technology, and Space (BMFTR). Most of the data reported here is of October 2025, if not otherwise stated, reflecting the time when the German version of this report was written. For most indicators presented here, more recent data is meanwhile available on the Open Energy Tracker.

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Different growth rates for solar and wind energy

Photovoltaics continues to grow strongly

Since 2023, solar photovoltaics (PV) has grown faster than planned in the Renewable Energy Sources Act (EEG)[5] (Figure 1). This is mainly due to the strong expansion of building PV, most of which are rooftop systems. In addition to feed-in tariffs, these benefit from self-consumption, which have become significantly more attractive for homeowners and businesses in recent years due to rising electricity prices. Recently, however, the share of rooftop systems in total PV expansion has declined, from around 70 percent in 2023 to around 50 percent in 2025.[6] At the same time, the share of ground-mounted PV systems rose from 28 to 46 percent. This trend is in line with the target set out in the previous federal government's photovoltaic strategy, according to which further expansion should be divided equally between rooftop and ground-mounted systems.[7] The cumulative output of very small plug-in PV systems, also known as balcony solar systems, has grown by around 70 percent by October 2025. Nevertheless, balcony systems still account for only a very small share of the total installed PV capacity, at around one percent. In addition, there is an unknown number of unreported balcony systems.

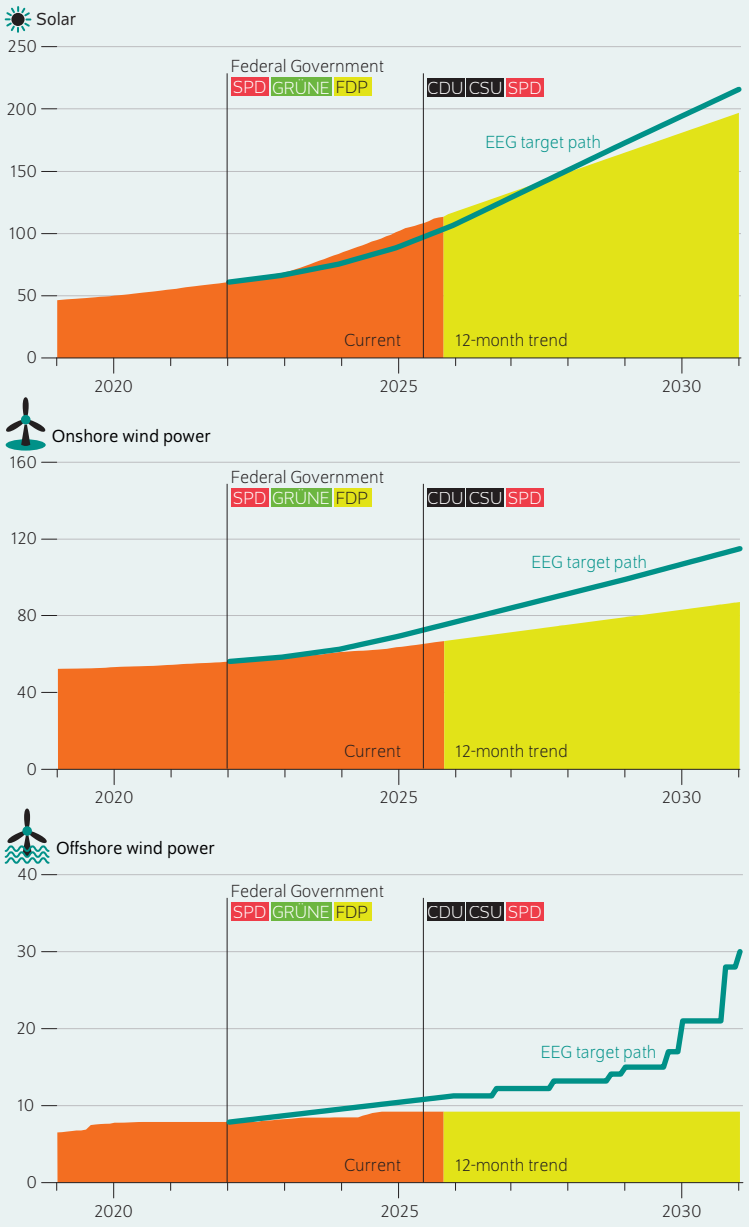
Growth in photovoltaics has recently stagnated across all types of systems. According to the expansion path, it should actually increase by 2026, when a net monthly increase of 1.83 gigawatts (GW)—i.e., minus old systems that are being decommissioned—is planned. In the first three quarters of 2025, the average was only 1.32 GW per month, although this figure could still increase slightly due to late registrations. Thus, despite the current overfulfillment of the EEG target path, a further increase in the expansion rate is necessary to achieve the target of 215 gigawatts of photovoltaic capacity in 2030.

Onshore wind power could soon catch up significantly

Since the beginning of 2022, the expansion of onshore wind power has been below the new EEG expansion path, which targets 115 GW in 2030 (Figure 1). Although expansion has picked up somewhat since mid-2024, the expansion gap has actually widened due to a simultaneous increase in the target path. In the first three quarters of 2025, an average of 0.32 GW per month was added on a net basis, around 50 percent more than in 2024. However, the target path for 2025 envisages a monthly net increase of 0.63 GW, which is almost twice as high.

Figure 1

Installed capacity of solar and wind power
In gigawatts



Sources: Market master data register of the Federal Network Agency, Open Energy Tracker (available online).

Photovoltaics is still growing significantly faster than wind power.

One key reason for missing the target is that, historically, the planning and approval processes for wind power projects have been very time consuming. Thus, there have simply not been enough projects fully planned and ready for implementation to achieve the increasing expansion path. However, the coalition government has significantly accelerated the planning and approval of wind energy projects with a package of measures: in 2024, a record of more than 14 gigawatts of capacity was newly approved. In 2025, this

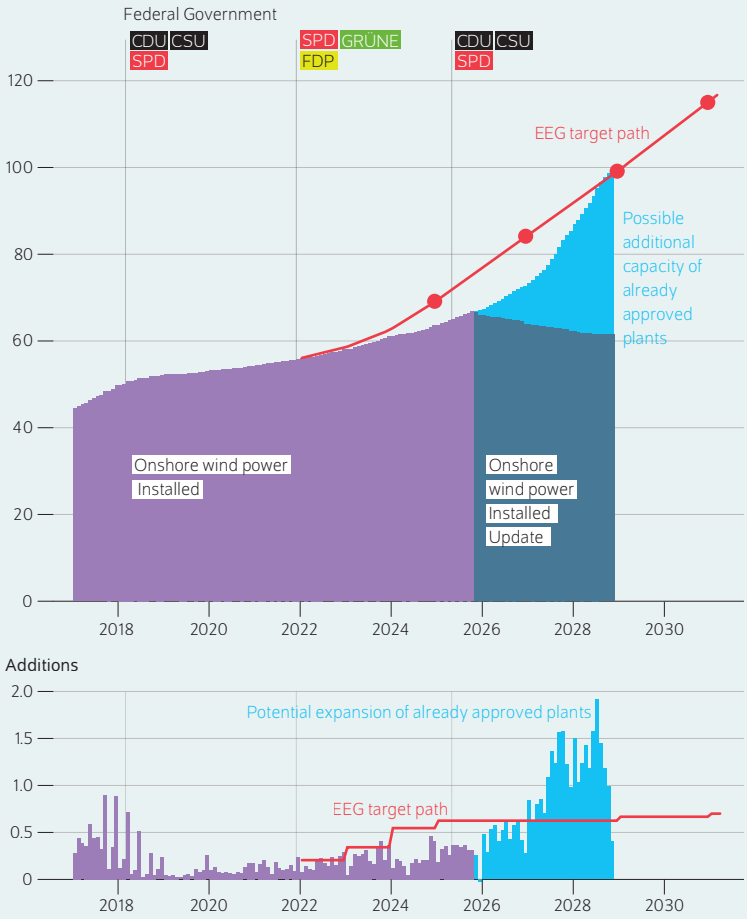
5 The Renewable Energy Sources Act was enacted in 2000 and has since been amended several times and extensively. It forms the legal framework for the targets and support measures for the expansion of solar and wind energy in Germany. In the EEG 2023, the expansion targets were significantly increased, cf. Schill et al. (2025), ibis.

6 Data used regarding the expansion of renewable energies in this report is as of the end of October 2025.

7 Bundesministerium für Wirtschaft und Klimaschutz, BMWK (2023): Photovoltaik-Strategie (in German; available online).

Figure 2

Installed capacity and potential future expansion[1] for onshore wind power
In gigawatts



1 Only plants that have already been approved are taken into account. The expansion possibilities shown for plants that have already been approved should not be interpreted as a forecast of actual developments. In the online version of the figure, the assumed implementation rate and duration can be varied. The lower part of the figure shows the monthly net additions, taking into account old plants that will be decommissioned.

Sources: Own calculations based on the market master data register of the Federal Network Agency, approval figures from the *Fachagentur Wind und Solar* (available online), Open Energy Tracker (available online).

With the timely implementation of already approved plants, the 2028 target is achievable.

figure was already exceeded in October.[8] As a result, there are now more approved wind turbines in the pipeline in Germany than ever before.

Timely implementing all of the already approved plans would make it possible to close the gap with the target path by 2028 (Figure 2). This assumes that the implementation period for the approved projects is 30 months.[9] It also takes into account the decommissioning of old wind turbines 20 years after they were commissioned.

A shorter implementation period would close the gap to the target path more quickly, while the expansion would be somewhat weaker if not all approved plants are realized.[10] It should be noted that the curve shown is not a forecast, but an estimate of the expansion that would be possible in the near future based on already approved plans. This will require many new installations each month in 2027 and 2028. This could necessitate a temporary increase in the volume of tenders.[11]

Offshore wind power: little expansion now, but big plans

There was no expansion in offshore wind power in the first three quartes of 2025, which is why the total installed capacity remained constant at 9.2 GW (Figure 1). The current target for 2030 is 30 GW, which is more than triple the 2025 capacity. Due to delays in grid connections and supply chain problems, it is now expected that the 2030 target will not be achieved until one to two years later.[12]

Two large wind farms in the North Sea with a total capacity of 1.9 GW have been nearing completion at the time of writing.[13] In addition, projects with a capacity of almost 17 gigawatts were successfully tendered in 2023 and 2024. However, the last tender in August 2025 for 2.5 GW received no bids.[14]

Share of renewable energy in electricity consumption rises

The EEG requires a minimum share of renewable energy sources of 80 percent of gross electricity consumption in 2030. In 2024, the figure was 54.4 percent, which means that it was roughly on track to meet the target. Although final data is not yet available, the 2025 share is likely to be similar.[15] It should be noted that achieving this relative target depends not only on the expansion of renewables, but also on the development of electricity demand. The lower the demand,

8 Fachagentur Wind und Solar (2025): Genehmigungen (in German; available online).

9 According to the market master data register, the current average is around 27 months.

10 Further information on the underlying assumptions and an interactive version of this figure with alternative assumptions on the share of realized plants and the realization duration can be found on the Open Energy Tracker (in German; available online).

11 The tender volumes are regularly adjusted anyway to compensate for missing volumes from past auctions. In the first three quarters of 2025, eleven gigawatts of wind power capacity were already successfully awarded, the same amount as in the entire previous year. Another tender will take place in November 2025. The results are continuously visualized on the Open Energy Tracker (in German; available online).

12 Energy Economics Institute at the University of Cologne/BET Consulting (2025): Energiewende. Effizient. Machen. Monitoringbericht zum Start der 21. Legislaturperiode. September 2025 (in German; available online).

13 These are the "He Dreiht" and "Borkum Riffgrund 3" wind farms.

14 Further information can be found on the website of the Federal Network Agency (in German; available online).

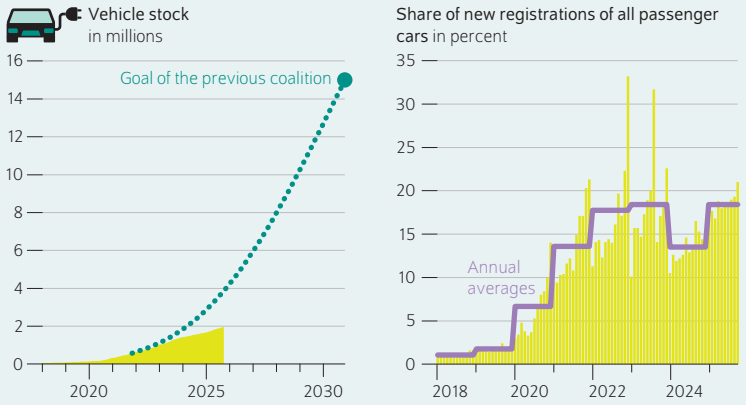
15 Early indicators for this are the monthly reports of the Federal Environment Agency (in German; available online), electricity data from the Working Group on Energy Balances and the German Association of Energy and Water Industries (in German; available online), and the share of renewable energies in net electricity generation, which is published regularly by the Fraunhofer Institute for Solar Energy Systems (in German; available online). Data on gross electricity consumption is available only with a time delay.

the greater the renewable share for a given renewable electricity production.

The EEG's electricity volume planning anticipates an increase in gross electricity consumption to around 750 terawatt hours (TWh) by 2030, compared to an average of around 570 TWh over the last ten years and 528 TWh[16] in 2024. The reason for the planned increase is the expected additional electricity demand from so-called sector coupling, i.e., new heat pumps, electric cars, and electrolyzers for the production of green hydrogen. In recent years, however, electricity consumption has developed more weakly than anticipated, even declining slightly. This is due, among other things, to weak economic development and the fact that sector coupling is progressing very slowly. According to current studies, the expected electricity consumption in 2030 will be in the range of 600 to 700 TWh,[17] with the Federal Ministry for Economic Affairs and Energy assuming a value at the lower end of this range.[18] In this case, lower wind and solar energy capacities than required by the EEG would be sufficient to achieve the 80 percent target. However, this would also mean that fewer fossil fuels would be replaced in other sectors.[19]

Figure 3

Existing fleet and new registrations of battery-electric passenger cars



Sources: Federal Motor Transport Authority, Open Energy Tracker (available online).

The number of electric cars is increasing much more slowly than planned by the previous coalition.

Sector coupling is lagging behind

Electric mobility is only slowly gaining momentum

The fleet of battery-electric cars in Germany has grown only slowly so far (Figure 3, left). As of October 2025, there were just under two million purely electric cars (four percent) among the nearly 50 million passenger cars, and the share of new registrations was a good 18 percent, which is more than in 2024 and roughly corresponds to the share in 2023 (Figure 3, right). Since just under three million new passenger cars are typically registered in Germany each year, virtually every new car would have to be electric from now on in order to achieve the previous federal government's target of 15 million electric cars by 2030. The current federal government has not yet formulated a new target for 2030 and there are barely any concrete new measures in place: Although purchase incentives for electric mobility were announced in the coalition agreement,[20] no further support measures have been implemented so far except for tax breaks for electric company cars. The charging infrastructure is no longer likely to be a major bottleneck for the ramp-up of electric cars. Currently, the fast-charging infrastructure is growing significantly faster than the electric car fleet.

German manufacturers dominated the market for newly registered electric cars in the first three quarters of 2025, with a share of 55 percent. Other European manufacturers hold a market share of 25 percent. The share of US manufacturers, mainly Tesla, was only four percent in the first three quarters of 2025, which represents a significant decline from the ten, 13, and 15 percent achieved in previous years. The share of Chinese manufacturers, on the other hand, has grown, albeit from a very low level. In the first three quarters of 2025, it stood at just over five percent.

The federal government has not set any specific fleet targets for vehicle segments other than passenger cars. In some cases, electric mobility is growing even more slowly in these segments. In the third quarter of 2025, a good ten percent of new truck registrations were purely battery-electric, while the figure for heavier semi-trucks was a good four percent.[21] The momentum is stronger for buses, with a share of 19 percent.

For the first time, more new heat pumps than natural gas heating systems

In the field of space heating, heat pumps are considered the key technology for sector coupling.[22] With the help of electricity, they allow environmental heat, for example from the ambient air or the ground, to be used for heating.[23] By

16 This consumption is the gross electricity consumption relevant for the renewable energy target, including generation from pumped storage, according to the Working Group on Energy Balances (in German; available online).

17 EWI/BET (2025), ibid.

18 BMWE (2025), ibid.

19 For an in-depth discussion of this topic, listen to the podcast "fossilfrei", episode 35: Monitoringbericht: Energiewende am Scheideweg? (in German; available online).

20 CDU/CSU/SPD (2025): Responsibility for Germany. Coalition agreement between the CDU, CSU, and SPD. 21st legislative period (in German; available online).

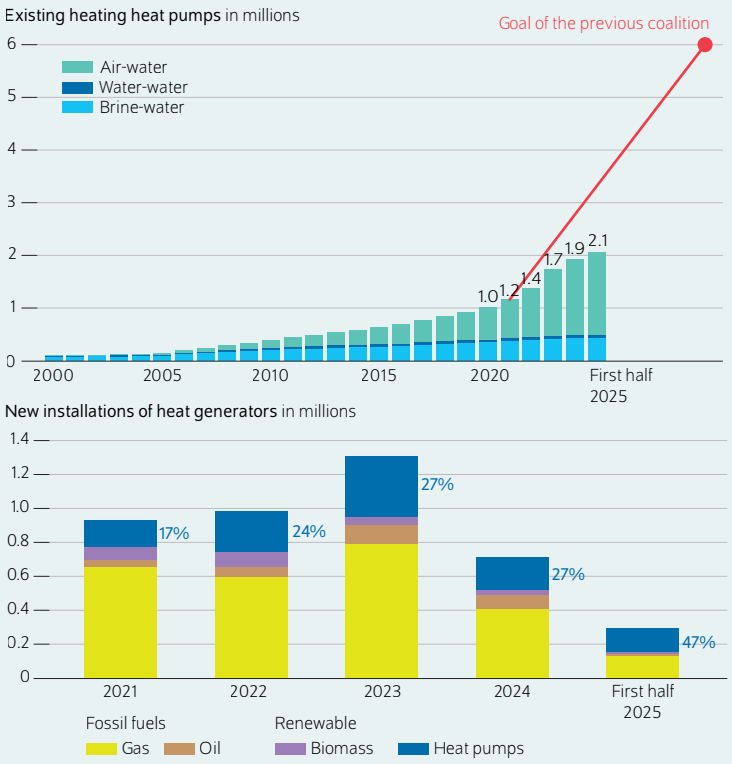
21 Wolf-Peter Schill, Julius Jöhrens, and Felix Spathelf (2025): Antriebswende im Schwerlastverkehr: Treibhausgasquote benachteiligt batterieelektrische Lkw. DIW Wochenbericht No. 46, 723–732 (in German; available online). Regularly updated data on commercial vehicles is available on the Open Energy Tracker (in German; available online).

22 Jan Rosenow et al. (2022): Heating up the global heat pump market. Nature Energy 7, 901–904.

23 See Alexander Roth et al. (2022): Expanding Solar Energy Capacity to Power the Transition to Heat Pumps. DIW Weekly Report No. 22/23, 151–159 (available online).

Figure 4

Existing heating heat pumps and new installations of heat generators



Note: Only heating heat pumps for water-based heating systems. Pure air-to-air heat pumps (air conditioning units) are not included here.

Sources: AGEE-Stat, Bundesverband der Deutschen Heizungsindustrie (BDH), Open Energy Tracker (available online).

For the first time, during the first half of 2025, more heat pumps were installed than natural gas heating systems.

mid-2025, the number of space heat pumps in Germany reached 2.1 million units (Figure 4, above).[24] This growth was driven primarily by air-to-water heat pumps, which extract heat from the outside air and, thus, are relatively easy to install. However, current installations are well below the expansion path set by the previous government, which sought six million installed units by 2030. The new federal government does not appear to want to further pursue this target, rather announcing its intention to achieve emission reductions in the space heating sector using a technology-neutral approach.[25]

In recent years, significantly more natural gas heating systems than heat pumps have been newly installed (Figure 4, below). This trend reversed for the first time in the first half of 2025: the share of heat pumps (47 percent) was slightly higher than that of natural gas heating systems (45 percent); however, there were also some new oil heating systems (just under four percent). New heating systems typically operate for 15 to 20 years. Therefore, the newly installed fossil fuel heating systems are further delaying the electrification of space heating, though the latter is highly desirable from a climate protection perspective.

Still very few electrolysers for green hydrogen

Hydrogen produced in electrolysers using renewable electricity is referred to as "green" hydrogen. It plays an important role in many climate neutrality scenarios for reducing emissions in areas where direct electrification does not appear technically or economically realistic from today's perspective. Some energy-intensive industries, such as steel production, are likely to rely on hydrogen to become climate-neutral. Hydrogen derivatives such as methanol can also be used as raw materials for the chemical industry.[26]

The National Hydrogen Strategy of 2023 set a target of ten gigawatts of electrolysis capacity by 2030.[27] This should enable at least part of future hydrogen demand to be generated domestically, ensuring that Germany will not be completely dependent on imports of green hydrogen or its derivatives in the future. However, only just under two percent of this target has been achieved so far. If all currently planned projects are added together, more than ten gigawatts could be achieved by 2030. However, this requires the implementation of almost all planned projects, many of which are still in the early conceptual planning stages (Figure 5). The current government has already announced that it will move away from the ten GW target, but has not yet formulated a concrete new target.[28]

Power system needs more flexibility

The electricity sector must become increasingly flexible in order to efficiently integrate fluctuating wind and solar energy. There are several technical and economic options for achieving this. In addition to the expansion of electricity grids—a topic we do not purse in this Weekly Report—these include, in particular, various types of market- or grid-oriented energy storage systems.[29]

Growth mainly in home battery storage systems

Electricity storage systems can be used to absorb temporary surpluses of renewable electricity and release them again later. In simple terms, they can be divided into short-duration,

24 Figures for the third quarter of 2025 were not yet available at the time the German version of this report went to press. More up-to-date numbers are available on the Open Energy Tracker The statistics only cover heat pumps for water-based heating systems. Pure air-to-air heat pumps (air conditioning units) are not included.

25 CDU/CSU/SPD (2025), ibid.

26 See Martin Kittel et al. (2023): National Hydrogen Strategy: Clear Focus and Consistent Implementation Necessary. DIW Weekly Report No. 40/41/42, 269–278 (available online).

27 Bundesregierung (2023): Fortschreibung der Nationalen Wasserstoffstrategie (in German; online verfügbar).

28 BMWE (2025), ibid.

29 Wolf-Peter Schill et al. (2025): Hintergrund: Welche Rolle spielen Speicher in der Energiewende? Ariadne Hintergrund (in German; available online).

medium-duration, and long-duration storage systems. Short duration systems tend to have high investment costs for energy capacity and low costs for electricity generation capacity.[30] They are usually dimensioned such that, when full, they can generate electricity only for a maximum of a few hours before they are completely empty. With long-duration storage systems, the opposite is true.

Due to technical advances and significant cost reductions, particularly in lithium-ion systems, stationary batteries have become increasingly attractive as short-duration storage options in recent years. Their cumulative power generation capacity has grown rapidly in Germany in recent years (Figure 6, left). In the first three quarters of 2025 alone, almost three gigawatts of battery storage were added, an increase of almost a quarter compared to the capacity at the beginning of the year. After years of dominance by pumped storage, batteries now account for the largest share of installed storage power generation capacity in Germany.

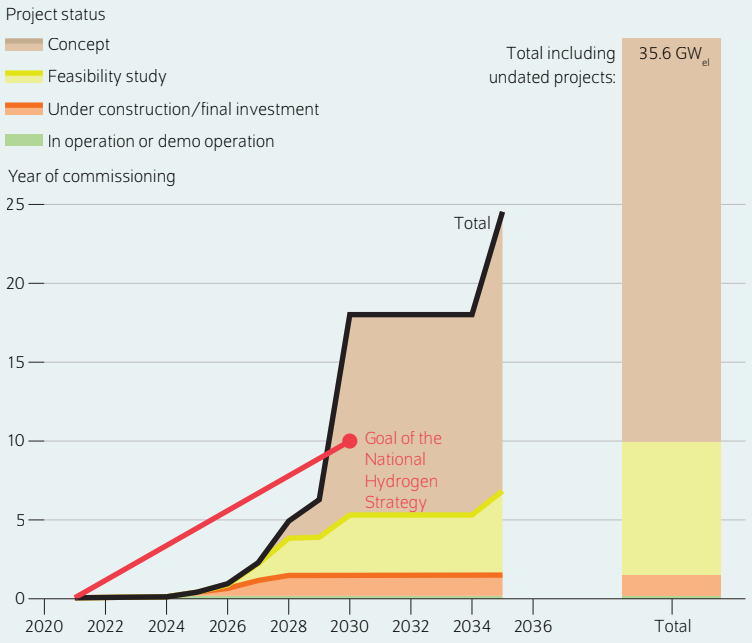
However, the majority of battery expansion was accounted for by home storage systems linked to PV systems. These are generally used to optimize the self-consumption benefits of PV systems, meaning that their operation is not based on wholesale prices for electricity. Due to fixed feed-in and grid electricity tariffs, there are usually no incentives for system-oriented use.[31]

The situation is different for large batteries. In previous years, these were primarily installed to provide fast control reserves, i.e., to balance very short-term and unplanned fluctuations in supply and demand. However, energy arbitrage in the wholesale market, i.e., exploiting market price differences, has now also become very attractive for large batteries. Grid connections are currently a major bottleneck for their further expansion.[32]

Before the recent battery boom, pumped storage was the only economical technology for storing large amounts of electricity for decades. Pumped storage facilities located in Germany or directly connected to the German transmission grid still have a significantly higher energy storage capacity than batteries (Figure 6, right). This is because their cost structure makes them more suitable for medium-term storage, meaning they can be built more cheaply with higher storage energy capacity. However, battery storage is catching up here too, with an increase of just under 5 GWh in the first three quarters of 2025. This corresponds to an increase of around a quarter compared to the capacity at the beginning of 2025. In contrast, there was no increase in pumped storage capacity in 2025.

Figure 5

Installed electrolysis capacity by project status
In gigawatts (electric)



Sources: Data from the IEA, Open Energy Tracker (available online).

A large proportion of the announced projects are in the early, conceptual planning stages.

However, the capacities of home storage batteries, on the one hand, and large-scale batteries and pumped storage facilities, on the other, cannot be directly compared, as the latter typically operate on the wholesale electricity market. To do this, they exploit price differences between hours with high and low electricity prices (arbitrage). The usage pattern of pumped storage facilities has changed significantly: whereas they used to be charged mainly at night and discharged during the day, two charging cycles per day have now become the norm, especially during the summer.[33] Pumped storage facilities are charged both at night and around midday, when PV surpluses regularly occur. They are discharged in the morning and evening.

Long-term electricity storage is not yet required, but is considered indispensable in energy systems based on fluctuating

30 Storage capacity indicates how much energy can be stored and is measured, for example, in kilowatt hours. Electricity generation capacity, on the other hand, describes the maximum amount of electricity that can be generated by the storage facility and is measured, for example, in kilowatts.

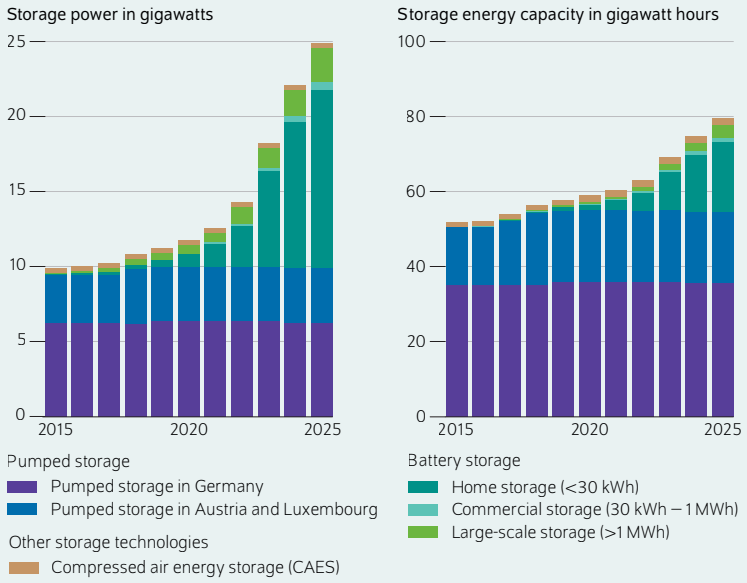
31 See Felix Schmidt, Alexander Roth and Wolf-Peter Schill (2024): Ausbau der Solarenergie: viel Licht, aber auch Schatten. DIW Wochenbericht Nr. 33, 507–517 DIW Weekly Report No. 33, 507–517 (in German; available online).

32 There are now grid connection requests totaling several hundred gigawatts, but these are likely to be based on a much smaller number of projects that are actually planned. See Sandra Enkhardt (2025): Mittlerweile mehr als 500 Gigawatt Netzanschlussfragen für große Batteriespeicher. PV Magazine August 29, 2025 (in German; available online). See also the podcast "fossil-frei," episode 28: Batteriespeicher: Revolution für den Strommarkt? (in German; available online). According to the Federal Network Agency, connection commitments for battery storage amounting to around 25 GW and 46 GWh were granted in 2024 (in German; available online).

33 An animated illustration on the Open Energy Tracker visualizes this changed storage usage pattern (available online).

Figure 6

Installed electricity storage capacity and power



Note: Includes pumped storage facilities in Luxembourg and Austria that are directly connected to the German transmission grid. The energy capacity of some pumped storage facilities is estimated.

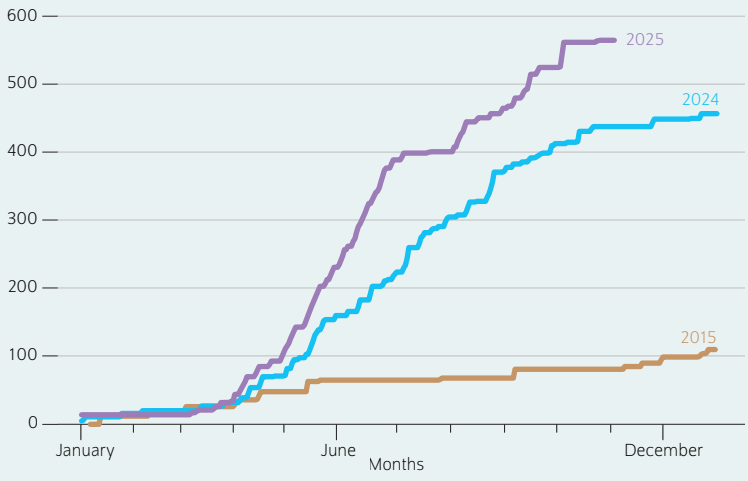
Sources: Market master data register of the Federal Network Agency, Open Energy Tracker (available online).

Home storage batteries are increasingly being installed.

Figure 7

Hours with negative electricity market prices

Cumulative number of hours per year



Note: Hourly prices on the wholesale market for electricity (day-ahead) for the German market area. Data for 2025 until the end of October.

Sources: SMARD data from the Federal Network Agency, Open Energy Tracker (available online).

There have never been so many hours with negative prices as in 2025.

renewable energies to bridge the *Dunkelflaute*.[34] A combination of electrolysis, hydrogen caverns, and hydrogen gas turbines for reconversion into electricity is currently considered a particularly plausible technology for long-term storage, where specific energy storage costs must be very low.[35] The new German government has not yet presented any specific funding instruments for the market ramp-up of such long-term storage facilities.

Demand must become more flexible

Flexibility can also be tapped on the demand side. An important prerequisite for this is dynamic electricity tariffs that, in turn, require intelligent metering systems (often referred to as smart meters). Although the installation of these metering systems has recently picked up speed, progress is still slow.[36] For households with high electricity consumption and operators of larger photovoltaic systems, heat pumps, or charging stations for electric cars, the installation of a smart meter has been mandatory since the beginning of 2025.[37] Other consumers now have the right to have a smart meter installed. Other European countries are much faster in expanding smart meters, although the definition and functional scope of the devices sometimes differ.[38]

Maximum flexibility in electricity consumption is particularly important for new loads related to sector coupling, as they are associated with relatively high power capacities and energy consumption. For example, the electricity consumption of heat pumps can already be significantly optimized with the help of small heat buffer storage tanks.[39] Controlled charging is important for electric cars; however, bidirectional charging with the option of feeding energy back into the grid could unlock even greater flexibility benefits.[40] The German government has announced its intention to exploit potential for flexibility,[41] but no concrete measures have been taken so far.

34 Martin Kittel, Alexander Roth, and Wolf-Peter Schill (2025): Coping with the Dunkelflaute: Power system implications of variable renewable energy droughts in Europe. arXiv:2411.17683 (available online).

35 Dana Kirchem et al. (2025): Was sind Wasserstoffspeicher und welche Rolle spielen sie in der Stromversorgung der Zukunft? Kopernikus-Projekt Ariadne, Potsdam (in German; available online); Dana Kirchem and Wolf-Peter Schill (2023): Heimische Produktion von grünem Wasserstoff kann mit Kavernenspeicherung günstiger werden. DIW Wochenbericht Nr. 41, 573–580 (in German; available online).

36 Current figures on this can be found on the website of the Federal Network Agency (in German; available online).

37 Gesetz zum Neustart der Digitalisierung der Energiewende. Bundesgesetzblatt Nr. 133, May 26, 2023 (in German; available online).

38 European Union Agency for the Cooperation of Energy Regulators, ACER, and Council of European Energy Regulators, CEER (2024): Energy retail—Active consumer participation is key to driving the energy transition: how can it happen? 2024 Market Monitoring Report (available online).

39 Alexander Roth et al. (2024): Power sector benefits of flexible heat pumps in 2030 scenarios. Communications Earth & Environment 5, 718.

40 Adeline Guéret, Wolf-Peter Schill, and Carlos Gaete-Morales (2025): A moderate share of V2G outperforms large-scale smart charging of electric vehicles and benefits other consumers. arXiv :2509.15284 (available online).

41 BMWE (2025), ibid.

Flexibility has recently grown more slowly than renewables

Market-oriented storage and other flexibility technologies have recently developed much more slowly than the expansion of renewables, partly due to a lack of grid connections. One indicator of this is the decline in market values, especially for solar energy. The so-called market value factor, also referred to as capture rate, describes the ratio of the average revenues that can be achieved by wind or solar plants when selling electricity on the wholesale market relative to the average price.[42] On average, the monthly market value factors for photovoltaics fell by 15 percent in the first three quarters of 2025 compared to the same period in 2024.[43]

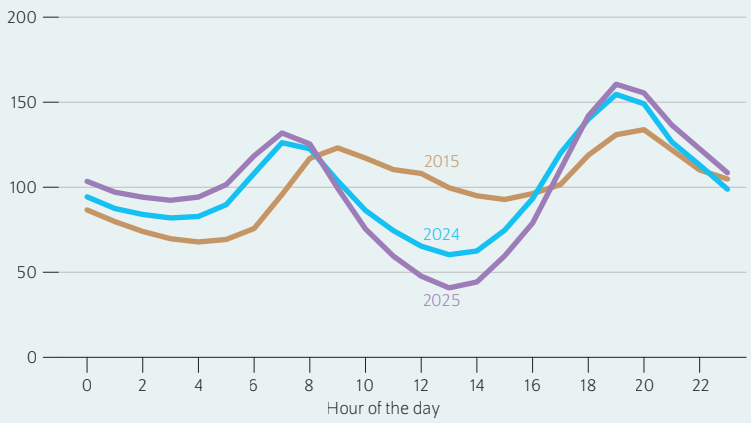
Another indication of the slow growth in flexibility in the electricity sector is the number of hours during which the price on the wholesale electricity market becomes negative. During such hours, supply exceeds demand, for example due to inflexible conventional or renewable power generation plants.

By October 2025, there were already over 560 hours with negative prices in Germany (Figure 7). That was just under eight percent of all hours, more than ever before. One of the main reasons for this increase is likely the sharp rise in the number of rooftop photovoltaic systems. Due to fixed feed-in tariffs, most have no incentive to stop feeding electricity into the grid when prices are negative.[44] Data from the Federal Network Agency show that during the hours in question, photovoltaic systems were the main source of electricity production, followed by wind power. Coal and lignite-fired power plants, which in previous years had accounted for a larger share of electricity generation during hours with negative prices, played almost no role at all during these hours in 2025.[45]

The average daily pattern of hourly prices on the wholesale electricity market is also an indicator of the current lack of flexibility in the electricity system. Ten years ago in 2015, prices were significantly higher during the day than at night on average (Figure 8). This is now reversed, with average prices lower at midday than at night. At the same time, prices have risen in the morning and evening when electricity demand is high and PV supply is low. A comparison of the average daily pattern in 2024 versus 2025 through October shows that this trend has continued to increase in 2025.

Figure 8

Average electricity market prices over the course of the day
Prices relative to the annual average in percent



Note: Hourly prices on the wholesale electricity market (day-ahead) for the German market area. Data for 2025 to the end of October.

Sources: SMARD data from the Federal Network Agency, Open Energy Tracker (available online).

Prices at midday continued to fall in 2025.

Conclusion: Accelerate the energy transition instead of slowing it down

The German government has announced its intention to realign the energy transition. In view of the lack of growth in electricity demand, there is talk of reducing the expansion targets for wind power and photovoltaics. Furthermore, there are no signs that the government considers a faster ramp-up of heat pumps or electric vehicles to be an energy policy priority.

Against the backdrop of current developments in key technologies, it makes sense to set different priorities. The conditions for the further expansion of wind and solar energy have improved significantly recently, thanks in part to faster planning and approval procedures alongside lower technology costs. The government should take advantage of these favorable conditions and not slow down expansion, but rather largely stick to the previous expansion targets, continuing to accelerate the pace, especially for onshore wind power.

In order to make the market and system integration of fluctuating wind and solar power as efficient as possible, it is important to remove barriers to various flexibility options. These include prioritized grid connection for large battery storage systems and the accelerated rollout of smart metering systems as a basis for dynamic electricity tariffs.

Accelerating sector coupling appears to be particularly important. A faster ramp-up of electric vehicles and heat pumps is urgently needed to achieve Germany's climate targets. Domestic hydrogen production should also be ramped up significantly from its current extremely low level. There is no reason to celebrate if electricity consumption rises less sharply than predicted—because this only means that fewer fossil fuels will be replaced in other sectors.

42 See evaluations of monthly market values on the Open Energy Tracker (available online).

43 In contrast, the market value factors for wind energy have risen slightly, which is likely due in part to a poorer wind year.

44 This was changed at the beginning of the year for new rooftop installations with the so-called Solarspitzengesetz (in German; available online).

45 This is shown in an interactive illustration on the Open Energy Tracker (available online).

The government's recent repeated emphasis on a technology-neutral approach seems unhelpful at this point. Rather, a clear commitment to available, efficient, and scalable technologies such as battery vehicles and heat pumps is likely to be more effective. Such technological clarity would not only be helpful for the reliable expansion of renewable energy sources, but also, and above all, for the ramp-up of electric vehicles and heat pumps.[46]

46 See also Wolf-Peter Schill et al. (2025): Germany should accelerate its renewable energy transition. Communications Earth & Environment 6, 859.

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LEGAL AND EDITORIAL DETAILS

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