Türkiye Electricity Review 2025

Wind and solar power in Türkiye permanently overtook electricity from domestic coal in 2024, even surpassing domestic coal power's historic peak.

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EMBER

About

Ember's Türkiye Electricity Review, published for the fourth consecutive year, analyses Türkiye's electricity generation and consumption data in 2024. The report also compares Türkiye with other European countries in terms of electricity generation from wind, solar and coal, and analyses the country's 2035 targets for wind and solar energy. All data sets can be accessed on Ember's Data page.

Highlights

+39%

Solar power rises by 39% year-on-year in Türkiye

18%

Wind and solar generate 18% of electricity in Türkiye in 2024

61%

Imported coal makes up 61% of Türkiye's coal-fired electricity generation in 2024



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Executive summary

Wind and solar permanently overtake domestic coal power

In recent years, wind and solar were the driving force of electricity generation from domestic sources in Türkiye. In 2024, wind and solar surpassed the peak annual electricity generation of domestic coal for the first time, permanently overtaking domestic coal.

Key takeaways

01 Wind and solar share reaches 18% as solar grows by record amount

In 2024, solar power in Türkiye increased by a record 39% year-on-year. This pushed solar's share of electricity to 7.5%, up from 5.7% in 2023. Wind remained steady at 10.7%, close to the previous year's level of 10.6%. As a result, the total share of wind and solar in electricity generation surpassed 18%.



02 Fossil share in generation falls to 31-year low despite a rise in coal

Despite an increase in electricity generation from coal (+4 TWh) in 2024, coal's share in Türkiye's electricity mix slightly declined from 36.9% to 35.6%. With coal-fired power generation continuing to decline across Europe, Türkiye overtook Germany to become the country with the most coal power generation in Europe. Meanwhile, gas power fell by 3 TWh (-4%). This brought the share of fossil fuels in power generation down to 55% — the lowest level since 1993.

03

Wind and solar surpass domestic coal power's historic peak

Annual electricity generation from wind and solar in 2024 was 62 TWh, above domestic coal (47 TWh) for the second year in a row. This even exceeded the historic peak of domestic coal generation (53 TWh in 2019) for the first time. Despite ongoing coal power plant projects in Türkiye, domestic coal power generation is unlikely to surpass wind and solar in the future.

04

05

Demand growth continues to outpace renewables deployment

Although demand growth has slowed in recent years, it is still outpacing the rate of new wind and solar additions. Demand increased by 42 TWh in the last five years, compared to 31 TWh of additional wind and solar. The rest of demand is met by imported coal and gas. As the government expects an increase in electricity demand growth by 2030, the success of targets will depend on wind and solar being deployed quickly enough to both meet increases in electricity demand and displace fossil fuels.

New 2035 targets can reduce fossil share to below one-fifth

Türkiye's newly announced 2035 installed capacity targets, unveiled during COP29, aim to quadruple the country's current wind and solar capacity. If achieved, by 2035 the share of fossil power generation could drop to below 20% and wind and solar rise to 49%.



"Wind and solar overtaking electricity from domestic coal is a huge moment for Türkiye. However, wind and solar are still not growing fast enough to meet rising electricity demand. The remaining demand growth will be met by costly imported fossil fuel power generation. Under ambitious targets in place for 2035, wind and solar could grow to provide half of Türkiye's power. The focus should now be on removing barriers to growth to scale up those domestic renewable sources as soon as possible."



Ufuk Alparslan Regional Lead (Türkiye & Caucasus), Ember



Renewables

Solar grows by record amount as wind remains steady

The remarkable increase in the installed solar power capacity in Türkiye in 2023 and 2024 started to be reflected in the share of solar energy in electricity generation. Meanwhile wind power stayed steady, and hydropower output continued to respond to periods of drought.

Solar electricity generation increased by 39% year-on-year

In 2024, Türkiye's solar power generation increased by 7.3 TWh, a massive jump of 39% compared to the previous year. This rise in 2024 alone was almost equivalent to the country's total solar electricity generation level in 2018 (7.8 TWh).

This growth in solar generation reflected the rapid pace of solar capacity rollout in Türkiye. After strong growth in 2023, 2024 was another milestone year for solar installations with installed solar capacity reaching 19.8 GW by the end of the year. This followed a huge rise in solar capacity in just two years (+8.9 GW, +82%), up from



<u>10.9 GW installed capacity in 2022.</u> Previously, the largest annual solar capacity growth in Türkiye was in 2017 and 2018, with capacity increases of 2.1 and 2.2 GW respectively. The main factor enabling this enormous step up was <u>paving the way for building solar power plants for self-consumption.</u>

New solar growth in Türkiye in 2024 almost matched its total solar generation in 2018



Solar generation (TWh)

Solar growth meets one-third of rise in power demand

The recent increase in solar electricity generation has also played an important role in meeting Türkiye's increasing electricity demand year by year.

Electricity demand increased by 5.5% (+18 TWh) in 2024 to reach a record 342 TWh. In addition to the increase in demand, the year-on-year increase in electricity generation totalled 23 TWh due to Türkiye's transition from a net importer of electricity to an exporter in 2024. The 7.3 TWh increase in solar met 32% of the increase in electricity generation.



Breaking the monthly production record with 3.2 TWh in June, solar electricity generation increased by 1.2 TWh compared to the same month the previous year. This increase in solar thus met one third of the electricity demand in June, which increased by 3.6 TWh in the same month amid a <u>rising demand for cooling</u>. As periods of extreme high heat become more common, summer electricity demand is expected to keep increasing. This highlights the role of solar power in strengthening Türkiye's energy security during peak summer demand.

Romania overtakes Türkiye for share of solar in electricity generation

Despite the record absolute increase in solar power in Türkiye, a rise in overall demand meant that solar's share of total electricity generation only slightly increased. The share of solar in electricity generation increased to 7.5% in 2024 (up from 5.7% in 2023).

Comparing Türkiye to the 20 countries with the highest electricity demand in Europe, Türkiye surpassed Switzerland in terms of the share of solar electricity generation in 2024, but lagged behind Romania. Romania generated 3.9% of electricity from solar in 2023, doubling to 7.8% in 2024.

In southern European countries with similar solar potential to Türkiye, such as Italy, Spain, Portugal and Greece, the share of solar in electricity generation varies between 14% and 22%. The share of solar in electricity generation in Poland, <u>which</u> <u>overtook Türkiye</u> for solar share last year, has reached 9%, widening the gap with Türkiye.



Despite the recent rise in solar, Türkiye still lags behind many European countries

Solar share in generation among top 20 power consuming European countries



Hybrid solar plant capacity exceeds 1 GW

From 2020, solar power plants can be installed as an auxiliary source in power plants in Türkiye. These power plants, which use multiple sources of generation, are called hybrid power plants. The capacities of the auxiliary source for hybrid plants are not included <u>in the installed capacity statistics</u> published by official sources.

The capacity of solar power plants installed as auxiliary sources reached at least 1 GW by the end of 2024, according to the data obtained <u>from the licence database</u> of the energy market regulator EMRA. Wind power plants account for 60% of this capacity. Fossil-based power plants have more hybrid solar installed capacity compared to hydroelectric power plants, also reflected in licensed capacity.



As Türkiye's energy transition progresses, increasing hybrid installations poses an important opportunity. This is particularly true for hydroelectric power plants, which can benefit from co-installations with solar to compensate for shortfalls in drought conditions.



Hybrid solar reached 1 GW installed capacity in Türkiye

Growth in electricity generation from wind has slowed

Minimal rise in wind power

Over the past two years, the growth of Turkish wind energy has slowed, following four years of steady expansion. Between 2018 and 2020, the installed capacity of wind <u>power</u> increased by 26%, with a parallel 24% increase in overall electricity generation. Then from 2020 to 2022, wind power experienced a similar level of capacity increase (29%) from 2020 to 2022, but with a bigger jump in electricity generation of 41%. This was due to favorable wind conditions and higher wind capacity factor in the country.



However, the growth of wind power has slowed since 2022. Wind power generation only grew 5% between 2022 and 2024 following a slowdown in wind capacity increase (+13%). Due to the slowdown in new wind power plant installations and increasing electricity demand, the wind share in electricity generation saw only a minimal increase in 2024, reaching 10.7%, up from 10.6% in 2023.

Wind generation growth in Türkiye exceeded capacity growth in 2021-2022, but has stagnated since then



Wind generation (TWh)

Türkiye's place in wind power ranking in Europe remains unchanged

Europe also experienced <u>a slowdown in new wind farm installations</u> in 2024. One of the reasons for this was a rise in wind power plant installation costs, which had been rapidly declining until 2021. However, wind power continues to be more cost-effective than fossil fuel power plants in Europe and the slowdown in wind energy in 2024 is expected to be temporary, with growth momentum anticipated to resume.

Türkiye continues to be ahead of Norway, Italy and France for share of wind in electricity generation in 2024, due to the limited capacity increase in these countries.



However, among the 20 countries with the highest electricity consumption in Europe, Türkiye ranks 14th in terms of the share of wind in electricity generation. In 2024, Finland experienced the highest percentage growth in wind's share of generation.



Increase in hydroelectricity despite dry year

Hydroelectricity generated 11 TWh (+17%) more in 2024 compared to 2023. This was despite a drought in Türkiye in 2024, with conditions <u>worst in the spring</u> when hydro generally reaches peak production. However, this played out very differently across different types of hydro power plants. Run-of-river hydro production declined in drought conditions, whereas dammed hydro output rose, making use of stored water reserves.



Despite hydro being a strong contributor to Turkish energy security in 2024 with 22% share in generation, this annual variance in hydro power signals the need to support it with wind and solar as complementary sources of electricity.

Decline in run-of-river hydroelectricity generation

Run-of-river hydroelectricity was markedly affected by drought conditions in 2024. In general, hydroelectricity generation in Türkiye starts to increase in winter and reaches its highest values in spring. Therefore, droughts in spring adversely affect the production of hydroelectric power plants. This is especially true for river type hydroelectric power plants that do not have dams that can store water.

Türkiye experienced <u>severe drought</u> in 2024, especially in April. The capacity factor of run-of-river power plants in April dropped to an even lower level than in 2021, a year when total hydroelectric generation in the country saw a <u>record decline due to</u> <u>drought</u>.

Drought in April 2024 significantly impacted run-of-river hydro generation in Türkiye





Third highest year for annual hydroelectricity generation

By contrast, hydro production from dams rose in 2024. The impact of the drought conditions on dams can be understood by examining <u>the amount of water coming</u> <u>to the dams</u>. The amount of water entering the basins generally follows a parallel course to the production of hydroelectric power plants from dams. However, 2024 was an exception to this. Although the amount of incoming water in 2024 was very close to 2022 and 2023, hydroelectric power generation with dams increased by 29%.



Although affected by droughts in terms of water intake, hydroelectric power plants with dams can store water and therefore have the flexibility to increase or decrease electricity generation when needed. Thus, in contrast to the decline in the generation of run-of-river hydropower plants, dammed hydropower generation increased and total hydropower generation reached 75 TWh in 2024, an increase of 17% compared to the previous year. In Türkiye, 2024 was the third highest hydropower generation year of all time, after 2019 (89 TWh) and 2020 (78 TWh).



Wind and solar can complement hydro in drought years

In 2024, hydroelectricity, together with solar energy, was one of the most important contributing sources in meeting the increase in electricity demand. Half of the year-on-year 23 TWh increase in electricity generation was due to hydroelectric power plants.

On the other hand, the decreasing water level in the dams of hydroelectric power plants, may pose a risk to Türkiye's energy security. Therefore, making more use of solar and wind power plants, which have a complementary generation profile to hydroelectricity, will play a key role in ensuring Türkiye's energy security. In particular, the addition of both terrestrial and floating solar power plants as secondary sources to existing hydroelectric power plants will reduce the risk of a shortfall from hydro in dry years. Failing this, a shortfall would have to be covered by imported fossil fuel power plants, introducing increasing reliance on costly foreign fuels.



Fossil

Türkiye generates the most electricity from coal in Europe

Electricity generation from coal reached a new record in Türkiye in 2024, surpassing Germany. However, renewable energy met most of the electricity demand increase and reduced the share of gas to a historic low.

Coal-fired electricity generation increases, but nears peak

In 2024, electricity generation from domestic coal increased by 2.4% year-on-year to 47 TWh, but remained behind its peak in 2019 (53 TWh). Electricity generation from imported coal also continued to increase. As a result, coal-fired electricity generation in Türkiye reached an all-time high of 122 TWh by 2024.

Although electricity generation from coal continued to rise, its share of total electricity generation fell to 36%, a slight decline from 37% in 2023. This was due to a rise in electricity demand which was primarily met by renewables.

Although no new coal-fired power plants are currently under construction in Türkiye, there is <u>a plan to expand by adding two new units</u> to an existing coal-fired power plant. If this project does not materialise, electricity generation from coal in Türkiye is close to peaking and is expected to stabilise with little to no growth after 2024.



Türkiye surpasses Germany in coal-fired electricity generation

In Germany and Poland, the two countries with the highest coal-fired electricity generation in Europe, coal-fired electricity generation in 2024 decreased by 17% and 8% respectively. Across the EU, this drove a <u>50 TWh year-on-year</u> decrease in electricity generation from coal (-16%). As of 2024, the share of coal in the total electricity generation of the European Union countries has fallen below 10%.

Coal-fired electricity generation in Türkiye reached a new record in 2024. As coal continued to decline in Europe, this made Türkiye the country that generates the most electricity from coal in Europe in absolute terms. In 2024, Türkiye's coal-fired electricity generation was 122 TWh, compared to 104 TWh in Germany and 91 TWh in Poland. However, when the 20 countries with the highest electricity consumption in Europe are compared, Türkiye ranks third after Poland (54%) and the Czech Republic (36.5%) in terms of the share of coal in electricity generation.

Türkiye is among the major coal generating countries in Europe

Coal power generation (TWh) and coal share in generation (%) among top 20 power consuming European countries in 2024





Share of fossil at historic low level

Record decline in fossil share driven by gas

Gas has played a significant role in Türkiye's power system since the 1980s. Electricity generation using gas began in November 1985, and its role in electricity generation rapidly increased with the <u>25-year gas import</u> agreement signed with the Soviet Union in 1986. By 1999, the share of gas in electricity generation had reached 32% and it did not fall below 30% until 2019 when it dropped to 18.2%. This was due to record hydro power production.



In the 2000s, the share of gas fluctuated to provide between a third and a half of Türkiye's power. The variability was due to hydro conditions, with gas ramping up or down in reaction to how much electricity hydro was able to produce. In 2024, the share of gas in power generation dropped back to similarly low levels as 2019, reaching 18.5%. Gas generation also fell in absolute terms, decreasing by 3 TWh yearon-year. However, this decline is likely to be temporary due to fluctuations in hydropower generation and increasing electricity demand.



With gas nearing a record low share in generation in 2024, the overall share of fossil fuels in Türkiye's electricity mix also decreased to 55%. This marks the lowest level since 1993, when fossil fuels accounted for 54% of electricity generation.

Türkiye still relies on imports both in coal and gas

Gas used in Türkiye is nearly all from imported sources. In 2020, <u>domestic gas</u> <u>production in Türkiye increased slightly</u> with the increase in production from the Sakarya natural gas field. However, this amount met only 4% of Türkiye's gas consumption in 2024 while the rest was imported.

A significant portion of gas demand in Türkiye arises from electricity generation, meaning gas power is a driver for gas imports. In 2024, <u>more than a quarter</u> of gas consumption was used for electricity generation. This rate can rise to as high as 35% in years like 2021, when electricity generation from gas reached a record high, leading to a total gas consumption of 60 billion cubic meters in the country.



Source: EPDK (Gas imports data), EPİAŞ (Generation data)

Majority of fossil fuels consumed in Türkiye are imported

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Share of imported sources in Türkiye's total gas consumption and coal generation



As with gas power, the majority of coal-fired electricity generation in Türkiye is fuelled by imports. In 2024, 61% of coal-fired electricity generation came from coal power plants relying on imports.

Wind and solar outperform domestic coal power's peak

In 2024, wind and solar generated more electricity than domestic coal for the second year in a row: wind and solar generated 62 TWh, compared to domestic coal at 47 TWh in 2024. What's more, this surpassed the historic peak domestic coal generation of 53 TWh in 2019. This is likely to be a permanent overtaking.

Even if the only new coal power plant expansion in Türkiye, <u>a 688 MW project</u>, is commissioned, electricity generation from domestic coal would still be below the total generated by wind and solar.



With gas falling to historic lows, wind and solar electricity generation (62 TWh) is already very near to the level of electricity generation from gas (63 TWh). Although the rise of wind and solar in Türkiye is expected to continue, it is too early to say they



have permanently overtaken gas in electricity generation. With hydro generation affected by drought and electricity demand increasing every year, a rise in electricity generation from gas and gas imports is likely.

In addition to the rise of wind and solar energy in Türkiye, the rise in electricity demand will be one of the key factors determining the future composition of Türkiye's electricity system and the amount of fossil fuel imports.



Demand growth slows, but still outpaces wind and solar

Although the increase in electricity demand in Türkiye has slowed since 2017, additions to wind and solar power are still below what would be needed to match demand growth.

Increase in demand due to record temperatures

Annual electricity demand in Türkiye in 2024 has increased by 5.5% (+18 TWh) compared to the previous year. In 2024, the month with the highest increase in demand was June with an increase of 3.6 TWh compared to the previous year, with February and July also showing a noteworthy increase.

Electricity demand rose in Türkiye amid record temperatures in June



Monthly demand change, year-on-year (TWh)

Source: EPİAŞ

and July

Increased cooling demand due to record high temperatures was mainly behind the increase in electricity consumption. The average temperature records were broken in June and July in Türkiye, making them the hottest months of the last 54 years. In 2024, June was two degrees warmer than the average June temperature in 2019, which was previously measured to be the hottest.

In addition, electricity consumption, which dropped sharply after the earthquake in <u>February 2023</u>, rose again in the first year after the earthquake. This was another factor that pushed the electricity demand upwards year-on-year, and explains why February is one of the months with the highest year-on-year increase in 2024.

Industry is not the source of increased electricity demand

National electricity tariffs applied to electricity consumers also have an impact on consumption. This was reflected in late 2022, as electricity demand started to decline compared to the previous year. This decline in the consumption of residential and <u>commercial consumers</u>, especially after the <u>20-30% increase in September 2022</u>, continued in January 2023. Demand from these consumer groups, which rose back to previous levels at the beginning of 2024, is the main reason for the increase in demand in January.

In the last quarter of 2024, the main source of the increase in demand was again residential and commercial consumers rather than industry. In <u>November and</u> <u>December</u>, year-on-year residential consumption increased by 18% and 12% respectively, while commercial consumption rose by 9% and 10%. As a result, total demand grew by 1.3 TWh in each of these months due to these two consumer segments.

Wind and solar need to outpace demand growth to displace fossil fuel imports

Although wind and solar energy play an important role in meeting Türkiye's electricity demand, they are not increasing at a rate to meet annual increases in power demand. Wind and solar's gains mean that fossil power grew less quickly than it otherwise would have, leading to a decline in its share of Türkiye's power. In the



five-year period from 2019 to 2024, Türkiye experienced a 14% increase in electricity consumption (+42 TWh). Three quarters of this increase was met by the rise in wind and solar generation. However, year-on-year imported fossil fuel generation still increased to meet the remaining demand growth.

The need for rapid wind and solar growth to meet demand is compounded by variability in hydro levels. Although hydro power hit its third highest level in 2024, this still marked a decrease of 14 TWh compared to 2019. This nearly matches the increases in electricity generation from wind (+15 TWh) or solar (+16 TWh) power plants between 2019 and 2024. In years with poor hydro conditions, wind and solar would have to generate enough to meet both the shortfall in hydropower and increased demand in order to reduce fossil fuel imports.

In addition to hydro power, electricity generation from domestic coal fell by 5 TWh in the same five year period. Imported coal and gas met the decline in these two sources, as well as the remaining increase in demand.

Türkiye's wind and solar make strong gains but fall short of rising demand



Change in power generation between 2019-2024 (TWh)



For the energy transition to take place in Türkiye, new wind and solar power plants that can generate at least as much electricity as the increase in electricity demand must be commissioned every year. Each unit of electricity consumption increase that cannot be met by new wind and solar power plants will be met by gas power plants. This will cause the country's import bill to increase. Considering the decrease in hydroelectricity production caused by dry years, this amount is likely to increase even more.

Growth in electricity demand has slowed since 2017

Although the long-term trend of electricity consumption in Türkiye shows a significant upward trend, the rate of this increase has slowed down. Except for <u>two</u> <u>years of economic contraction</u>, electricity demand steadily grew until 2017. After 2017, it remained stagnant for several years.

According to Türkiye's <u>new climate strategy announced</u> during COP29, demand is expected to rise by 113 TWh by 2030. This is nearly three times the demand growth over the last five years (42 TWh). For such a significant increase by 2030, a major policy change driving higher electricity consumption would be necessary or the forecast 2030 demand would be overestimated.

Türkiye's electricity demand growth has slowed, but the government projects a steep rise by 2030



Power demand in Türkiye (TWh)

Source: EPİAŞ (2018-2024), TEİAŞ (1999-2017), Long Term Climate Strategy



When analysed in terms of population, economic growth and electrification, there is no indication of factors to drive the forecast level of demand growth. Population growth in Türkiye has started to slow down. By 2030, <u>only a 3.3% increase in population</u> is expected. <u>Economic growth prospects</u> in the country are also lower than in the last five years. Likewise, electrification projections do not indicate this level of growth. Although Türkiye is expected to reach <u>2 million electric vehicles by</u> 2030 and <u>183 thousand electric cars by the end of 2024</u>, this would still fall far from the projected electricity demand increase.

Understanding the trajectory of demand growth will determine how much new wind and solar capacity needs to be installed each year to ensure energy security. It is therefore important to clearly understand the drivers behind projected demand growth, as well as how they align with wind and solar targets.



Targets

The share of fossil power in Türkiye could fall to one fifth by 2035

According to Türkiye's most recently announced targets, fossil-based electricity generation will continue to increase until 2030. This situation may reverse in 2035, but decisive policies are essential now to achieve the 2035 targets.

Wind and solar to quadruple by 2035

Türkiye's most recently announced targets include <u>installed renewable and nuclear</u> <u>capacity</u>. While 2035 targets have been raised by 45%, 2030 targets are unchanged.

The recently announced targets aim for a quadrupling of wind and solar energy capacity, from 32 GW in 2024 to 120 GW in 2035. In 2030, the target for wind and solar installed capacity is 51 GW in total. While an average of 3.1 GW wind and solar power plants are planned to be commissioned every year until 2030, to reach the new 2035 targets this amount will need to increase to 13.8 GW annually after 2030. This would be an enormous step up, and indicates that the 2030 target should be raised to start delivering towards the 2035 target in the near-term.



Türkiye plans to significantly scale up wind and solar installations by 2035, yet its 2030 target remains unambitious

New wind and solar installations in Türkiye (GW)



Source: 2053 Long Term Climate Strategy, Ember Türkiye data tool

By 2030, renewable energy capacity excluding wind and solar is planned to be raised by 4 GW compared to the end of 2024, while 4.8 GW of installed capacity is targeted for nuclear energy. A further 2.4 GW of nuclear power capacity is planned to be commissioned between 2030 and 2035, while no increase in other renewable energy capacity is foreseen in the same period.

Targets put wind and solar at half of Türkiye's electricity in 2035

Fossil fuel electricity generation is expected to fall below its 2024 level if the 2035 targets are achieved. Assuming no curtailment due to generation exceeding hourly electricity demand, the share of wind and solar in electricity generation could reach 49% in 2035 if Türkiye's plans are realised. Under these assumptions, the share of fossil fuels in electricity generation could fall to less than 20%.



The latest plan does not include a projection for the future electricity mix with the targeted capacities. For this reason, estimates for Türkiye's generation mix for 2035 based on installed capacity targets for that year were made using <u>the previous plan</u> as a reference. It is assumed that the remaining demand from renewable and nuclear energy generation will be met by fossil fuelled power plants.



Fossil share in electricity generation could fall to one fifth by 2035 in Türkiye Generation mix projection if the official capacity targets are met

However, to achieve Türkiye's 2035 targets, attention needs to turn to making progress by 2030. A decline in electricity generation from fossil fuels is unlikely by then, due to both the projected high demand growth and the unambitious wind and solar targets for that date. Demand is expected to increase by nearly 113 TWh in 2030 compared to 2024, while wind and solar are projected to increase by only 44 TWh. Taking into account electricity generation from other renewables and nuclear energy, an increase of 16 TWh in electricity generation from fossil-fuelled power plants is expected by 2030. In a dry year, this could rise to 35 TWh.

Therefore, with the most recent targets, the share of wind and solar energy in electricity generation will only increase from 18% to 23% in 2030, and the share of



fossil fuels in electricity generation will only decrease from 55% in 2024 to 45%. If electricity demand is lower than planned, these ratios will improve in favour of renewable energy.

Targeting growth in storage and exports

The climate strategy also sets <u>targets for battery storage capacity in 2030 and 2035</u> of 2.1 GW and 7.5 GW respectively. However, these capacities are considerably lower than the battery project pipeline that will be installed alongside wind and solar power plants (34 GW). The fact that most of these battery capacities allocated by the state are not expected to be commissioned until 2035, even in the official targets, raises a question mark in terms of the functionality of the capacity allocation mechanism.

With rapid wind and solar growth, storage and exports can help make use of excess generation during peak hours where demand is exceeded. Official targets map out growth for these areas, but a focus will be needed on implementation to ensure they keep pace with renewables.

Batteries are not the only way to store energy. Türkiye's hydroelectric power plants, with dams close to 24 GW capacity, work like batteries by storing water and then releasing it to generate electricity during hours of increased consumption. As a country rich in hydroelectric capacity, Türkiye can provide diversity in energy production and storage by installing pumped storage hydroelectric power plants, a technology over a hundred years old, to its portfolio, while balancing the increasing production of wind and solar.

Exporting power is another option to benefit from wind and solar when they generate more than domestic electricity demand. In Türkiye's new roadmap, a significant increase in <u>interconnection capacity</u>, that will enhance electricity exports, is also planned. The electricity export capacity, which was 2.3 GW in 2024, is planned to increase to 6.8 GW in 2035. Electricity import capacity is planned to increase from 1.4 GW to 6.6 GW.



Recommendations

The road to targets

With ambitious 2035 targets now in place, the focus must be on unblocking barriers to quickly install wind and solar.

Address limited connection capacity

It is possible for Türkiye to reach an installed solar capacity of 76.9 GW by 2035 as targeted. Türkiye's <u>rooftops</u> have a potential of <u>more than 120 GW</u>. The 5.2 GW of solar power plants that need to be commissioned on average every year from 2024 to 2035 in order to reach this target is feasible. In recent years Türkiye has seen rapid growth: <u>doubling its solar installed capacity</u> from 2022 to 2024 and commissioning approximately 4.5 GW of new solar power plants every year during this period.

On the other hand, one of the most important obstacles for new wind and solar investments is connection capacity. In order for a wind or solar power plant to be established in Türkiye, there must first be available capacity at the substation in that region, otherwise the applications <u>are rejected without being evaluated</u>. Therefore, new grid investments are required to allocate new connection capacities. For this reason, it is also important to realise the targets of high-voltage direct current (HVDC) transmission lines, 90,000 km of new grids and 942 new substations, <u>which are included for the first time in the newly announced targets</u>.



Install hybrid power plants

One of the possible solutions to limited connection capacity is hybrid power plants. By integrating solar as a secondary generation source at existing hydroelectric or wind power plants, hybrid projects optimize connection capacity and leverage the complementary characteristics of these different energy sources.

Unlike new power plant installations, these projects do not require additional grid infrastructure investments. Therefore, there is no practical reason for hybrid power plants to wait for new connection capacity openings like new power plant investments. Instead, economically viable projects could be implemented more quickly by allowing investors to decide on adding a secondary generation source provided that any electricity generation exceeding the connection capacity is either curtailed or penalized.

Ensure auctions are effective

One option for ensuring new power plant investments is auctions. Capacity auctions are already in place in Türkiye, but there remain some challenges in ensuring they work as intended. In Türkiye's wind and solar auctions held between 2017 and 2022, 5.8 GW of capacity was allocated. However, only 11% of the awarded wind capacity and 51% of the solar capacity have been commissioned.

Starting in 2025, Türkiye plans to hold <u>2 GW of auctions annually</u>, making them a key tool in achieving the 2035 targets. To be effective, these auctions must avoid the challenges faced by past ones. Domestic content requirements along with lengthy permitting processes, and the low purchase prices resulting from highly competitive auctions, could hinder the realization of projects awarded in future auctions.

Free up unused connection capacity

In an investment environment where connection capacity is limited, capacities already allocated for past investments that have not been built block future projects. To make efficient use of that capacity, it is important to have policies that will ensure



that the existing project pipeline is realised as soon as possible. For plants that have not yet been commissioned as a result of tenders organised in the past, there are questions about whether they are expected to ever be commissioned. The announcement of an energy storage target of 7.2 GW by 2035 signals that the 34 GW of capacity allocated <u>to wind and solar energy projects with storage</u> is unlikely to be delivered in full. If there are projects in the project pipeline that are not likely to be commissioned, these should be cancelled to free up connection capacity for new investments.

Introduce new types of auctions

Türkiye can add new types of auctions to the wind and solar auctions it has organised so far. The floating solar power plant tender and the offshore wind power plant tender are examples. Potential areas for offshore wind have been identified and tender announcements have been made. Türkiye's state-owned hydroelectric power plants with dams have huge reservoir areas. So much so that even if only 10% of the surface area of the existing dams is covered, <u>a floating solar power plant of 53</u> <u>GW</u> potential emerges. These areas can be allocated for the construction of largescale floating solar power plants by tender method.

Increase interconnector capacity with neighbouring countries

With the increase in wind and solar electricity generation, it will become even more important to increase grid connectivity with neighbouring countries. With the establishment of a connection between Nakhchivan and mainland Azerbaijan, the future Nakhchivan-Türkiye interconnection will enable Turkey to be part of the interconnection projects <u>between Azerbaijan and Central Asian countries</u>, which are currently in the planning stages. Türkiye and Azerbaijan, if they realise their renewable energy potential, could become clean energy hubs, bridging east and west and generating additional revenues through electricity exports. Grids with wider geographies and extensive interconnection will also protect system security against the variability of generation from wind, solar and hydroelectricity.



Supporting materials

Methodology

Data sources

Türkiye's electricity generation data is obtained from the Transparency Platform of the market operator, EPİAŞ. "Real Time Generation" dataset is used for licensed electricity generation, while the "Unlicensed Electricity Generation" dataset is used for unlicensed electricity generation.

For installed capacity data, the YTBS system of the transmission system operator, TEİAŞ, is used. This dataset may undergo backward corrections. The installed capacity data published in this report reflects the data available in YTBS as of February 17, 2025.

Electricity generation data for European countries has been sourced from Ember's <u>European Electricity Review</u>. Ukraine is excluded from the rankings of top 20 power consuming European countries due to the suspension of electricity data since the war.

Temperature data for Türkiye is based on measurements conducted by the Turkish State Meteorological Service since 1971.



Calculations for 2030 and 2035 targets

Türkiye's <u>latest targets announced at COP29</u> include electricity demand and installed capacity targets for 2030 and 2035. However, the plan does not specify the electricity mix in 2030 and 2035. The 2030 capacity targets presented in the new plan are identical to the capacity targets in <u>the previous official plan</u>. Unlike the latest plan, the previous plan also included electricity generation mix along with capacity targets. In this study, the 2030 electricity generation mix is directly taken from the previous plan. The electricity mix for the newly announced 2035 capacity targets is calculated based on the same capacity factors in the previous plan.



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Cover image

Selective focus photo of grassing sheeps and solar panels background in agricultural field, Turkiye.

Credit: <u>Süleyman Kahraman</u> / Alamy Stock Photo

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