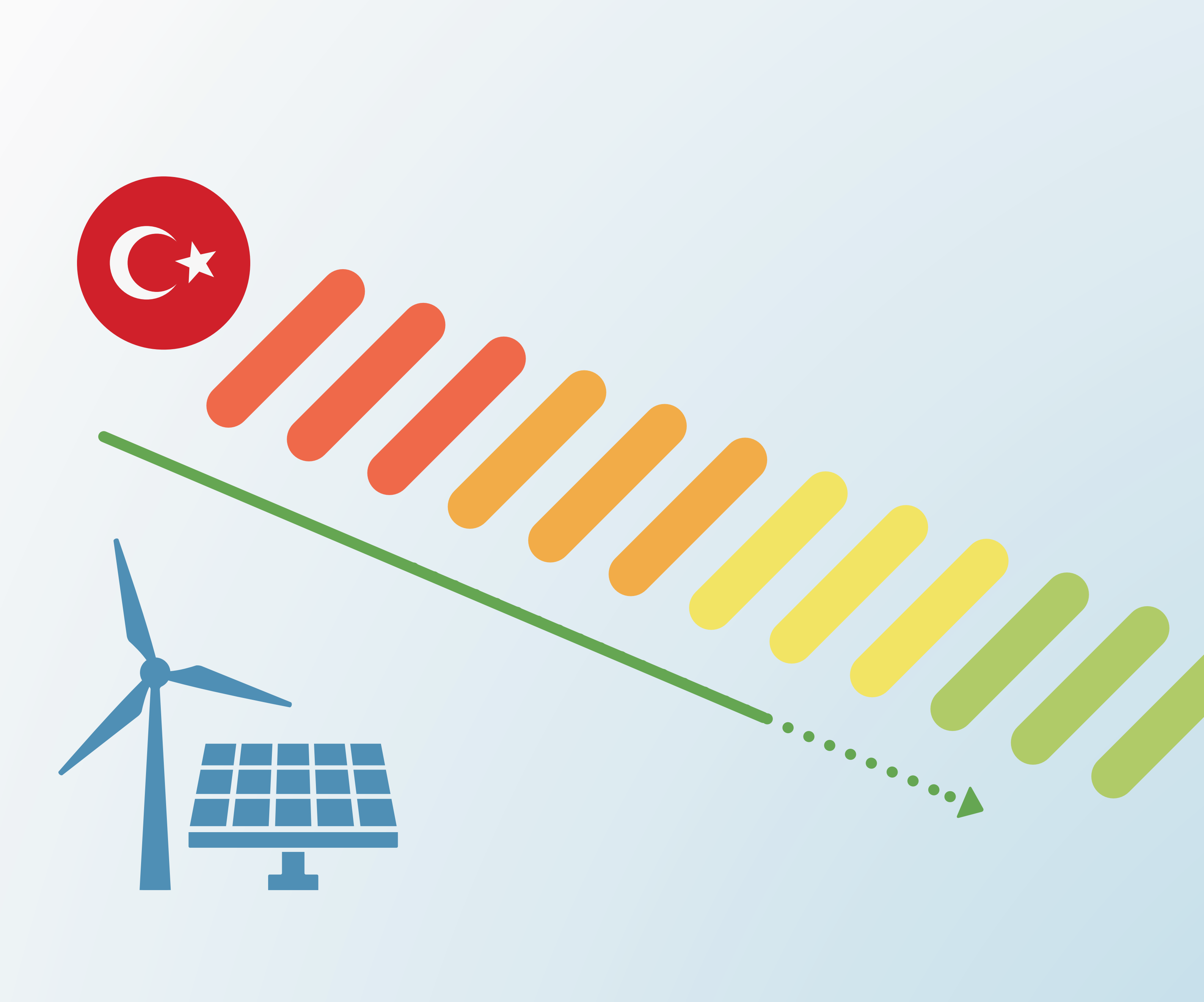

Climate Action Tracker

Wind and Solar benchmarks for a 1.5°C world

TÜRKIYE

February 2026

CLIMATE ANALYTICS

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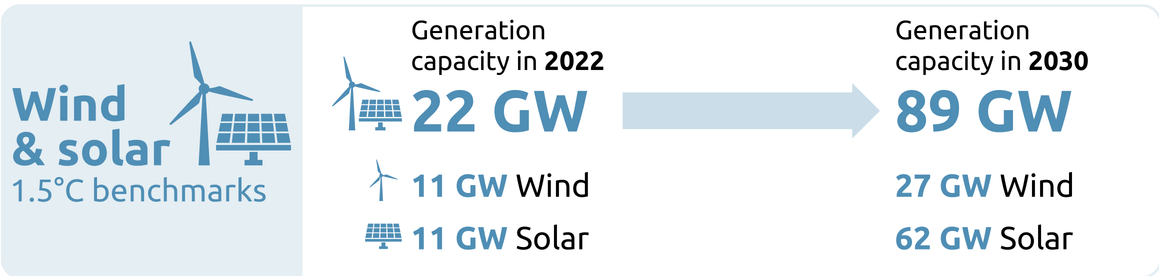
Executive Summary

Context

- Türkiye became the second largest coal-fired power generator in Europe in 2023. While there is abundant potential for wind and solar deployment in Türkiye, further action will be necessary to transform the Turkish electricity system into one powered predominantly by renewables.
- Türkiye's transition to wind and solar slowed in 2023, with wind generation falling for the first time, and Poland overtaking Türkiye in the share of solar in the electricity mix.
- In this report, we explore the level of wind and solar that Türkiye would need to install as part of a global 1.5°C compatible pathway. Our benchmarks are also compatible with tripling renewables capacity by 2030.

Key findings

- There is no room for complacency in the transition to wind and solar. Wind and solar generation in Türkiye needs to grow three to four times by 2030, reaching 160–215 TWh in 2030, up from 50 TWh in 2022.
- This would require reaching 90 GW of wind and solar installed capacity by 2030 (60 GW of solar, 30 GW of wind).
- This would be equivalent to achieving the wind and solar capacity targets set by the National Electricity Plan for 2035 five years early.
- Türkiye needs to update its renewables targets, and drive the acceleration of the energy transition needed to deliver on them.



Context

At COP28, governments agreed to triple global renewable capacity by 2030 globally to stay in line with 1.5°C. This report highlights the potential implications of this COP28 decision at the national level, focusing on **Türkiye**.

Wind and solar deployment is accelerating around the world. However, expected wind and solar capacity deployment under current policies falls short of what is needed for 1.5°C, and is concentrated mainly in a few regions.

Research is needed to understand the pace of wind and solar deployment that aligns with the highest plausible ambition and is compatible with 1.5°C

This project aims at answering the following questions:

- **How much wind and solar generation is needed (TWh) at the national level?**
- **How much wind and solar needs to be built (GW of capacity)?**
- **When does it need to be built by, and how quickly?**

Policy context

Türkiye's 2030 NDC is to cut emissions by 41% below a business-as-usual projection in 2030, to reach **695 MtCO2e**. This still allows emissions to almost double relative to 2010 levels. In 2021, Türkiye announced a net zero by 2053 target.

Türkiye's current renewable targets are to reach **33 GW of solar and 18 GW of wind by 2030**, as of the National Energy Plan published in 2022.

Under current policies and market conditions, the IEA estimates that **solar capacity will reach 49 GW in 2030**, up from 11 GW of solar in 2022. Meanwhile, **wind capacity is projected to reach 21 GW in 2030**, up from 11 GW in 2022. Türkiye is therefore on track to overachieve its current wind and solar targets.

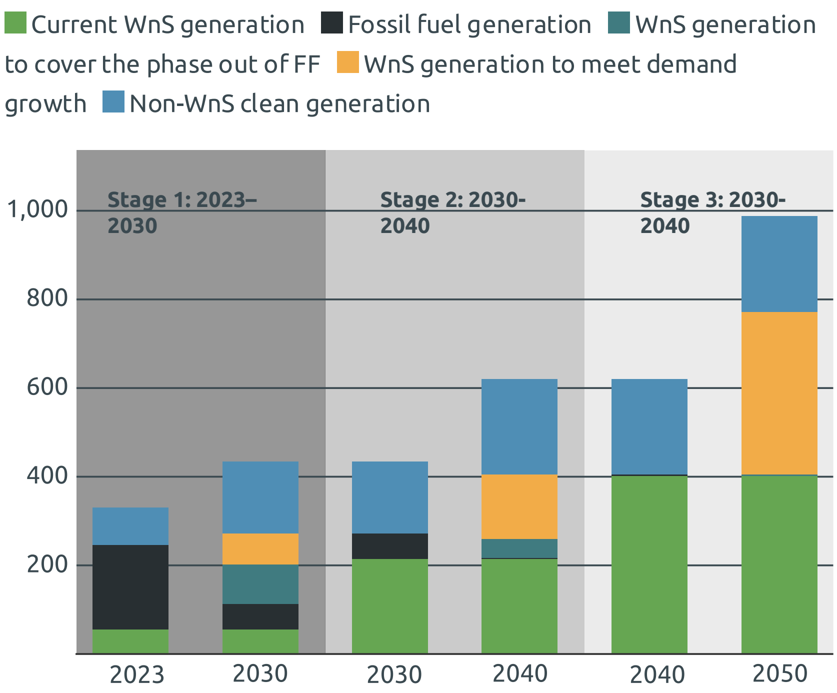
National enabling factors

Key enabling factors for ambitious wind and solar rollout include:

- **Institutional capacity.** A rapid build-out of wind and solar will require the governance and institutional capacity to develop, implement and enforce policy frameworks.
- **Just transition.** A just transition will be needed to take along all stakeholders, particularly those employed by the fossil economy.
- **Grid development.** Substantial increases in both transmission and distribution grid infrastructure will be necessary to integrate large-scale new wind and solar generation into the power system.
- **Fossil fuel phase-out.** Existing fossil fuel infrastructure often will need to be retired earlier than its economic lifetime. Policies need to be developed to achieve the early phase out of fossil fuel plants.
- **System flexibility.** Energy storage (diurnal and seasonal), flexible generation technologies such as hydro and geothermal, and increased demand side flexibility will all be crucial.
- **Market design.** Reform of market designs and regulation adapted to RE-based systems that incentivise and mobilise investments to install renewable energy at the scale needed (e.g., minimise cost of capital, ensure revenue certainty, etc).

Results

Stages of power sector decarbonisation



The stages of the electricity system transition in Türkiye

WnS = Wind and Solar

Figure 1 – Electricity generation in each stage in TWh

In a 1.5°C pathway, countries must add solar, wind, and other clean technologies to meet rising power demand while replacing phased-out fossil fuels. The evolution of the power capacity mix over successive decades varies across countries.

From now until 2030, Türkiye would need to add 5.7 GW of wind and 21 GW of solar capacity to meet growing demand alone. Another 7.3 GW of wind and 27 GW of solar will be needed to displace the share of fossil fuels in the electricity generation mix.

Power sector transformation and the increasing participation of variable renewable energy (VRE) – mainly wind and solar – in a country's power mix gives rise to a set of technical challenges linked to the integration of VRE sources. Six phases can be distinguished here, from phase 0 (pre-development with negligible amount of VRE shares) to phase E (with over 80% VRE shares). More information about these phases can be found in Annex A.

Meeting the benchmarks for 2030 will put Türkiye in Phase D, with wind and solar making up 50% of the generation mix. Periods in which VRE availability exceeds demand occur more frequently than in earlier phases. Ensuring system stability while continuing to increase renewable penetration requires additional measures, such as expanded demand response, stronger interconnections and large-scale energy storage. Market design and regulatory frameworks become increasingly important to enable these solutions. Although particularly critical in this phase, many of these measures should begin in earlier phases (B and C) to provide long-term investment signals and facilitate a smoother system transformation.

Figure 1 and Table 1 both show the stages of the transition to a decarbonised power sector in terms of the volumes of existing wind and solar and what is needed to displace fossil fuels and meet demand increases. Figure 1 shows the stages in terms of electricity generation, and Table 1 shows it in terms of generation, capacity and share of the electricity mix.

Table 1: Stages of the electricity system transition detailing how much generation capacity of wind and solar will be needed to displace fossil fuels in the system and meet growing electricity demand

	2023	→	2030	→	2040	→	2050
Grid integration phase (share of variable renewable energy in total electricity generation)							
Phase	Phase B		Phase D		Phase D		Phase D
Share of VRE	**< 25%**		**< 70%**		**< 70%**		**< 70%**
Share of electricity generation							
Wind & Solar	**17 %**		**50 %**		**65 %**		**78 %**
Other renewables	25 %		37 %		35 %		22 %
Fossil Fuels	**58 %**		**13 %**		**0 %**		**0 %**
Generation capacity							
To displace fossil fuels		**+34 GW**		**+28 GW**		**+1.3 GW**	
Wind & Solar	**29 GW**	**+8.6 GW/yr**	**89 GW**	**+12 GW/yr**	**210 GW**	**+19 GW/yr**	**400 GW**
To meet demand increase		**+27 GW**		**+96 GW**		**+190 GW**	
Generation							
Total	**330 TWh**	30%	**430 TWh**	44%	**620 TWh**	60%	**990 TWh**
Wind & Solar	56 TWh		220 TWh		400 TWh		770 TWh
Generation Capacity of VRE (variable renewable energy)							
To displace fossil fuels			7.3 GW		1.5 GW		0.2 GW
Wind capacity	**14 GW**		**27 GW**		**34 GW**		**69 GW**
To meet demand increase			5.7 GW		5 GW		35 GW
To displace fossil fuels			27 GW		27 GW		1 GW
Solar capacity	**15 GW**		**62 GW**		**180 GW**		**330 GW**
To meet demand increase			21 GW		91 GW		150 GW

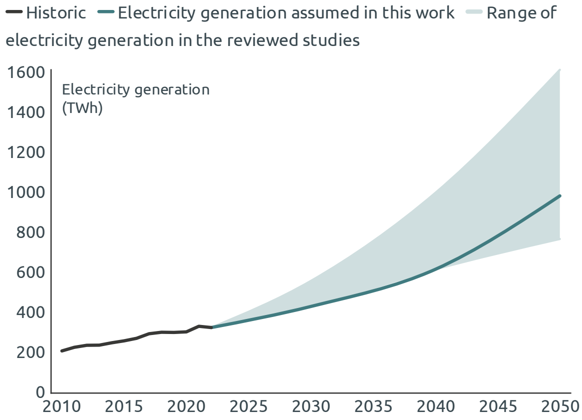
Note: Numbers are rounded to two significant figures, which may contribute to minor differences in totals. The calculations assume that wind, solar, and other renewables contribute equally and proportionally to displacing fossil fuels and meeting demand growth.

Future electricity demand

Electricity demand is taken from Shura's study exploring net zero by 2053 pathways for Türkiye, and the implications for the electricity sector.

In this study, total electricity generation in Türkiye triples by 2050 relative to 2022 levels, reaching almost 1000 TWh. This is driven by strong economic development and increased electrification.

However, there is a significant range in the studies in terms of the expected electricity generation in 2050 ranging from 770 TWh to 1620 TWh. This would affect the necessary growth of wind and solar significantly. Our demand projection is at the lower end of the literature studies assessed.



Electricity generation triples in Türkiye over 2022–2050

The solid line shows the electricity generation projection used to develop the benchmarks

Figure 2 – Total electricity generation in TWh

Pace of fossil fuel phase-out needed

The rate of fossil fuel phase-out is set by the overlap between country-level studies, downscaled 1.5°C compatible global pathways and the global milestones of the IEA's Net Zero roadmap, in which Türkiye achieves a clean power system by 2045.

To align with 1.5°C, fossil fuels must exit the Turkish power sector before 2045.

Fossil fuel generation falls by 41 to 70% between 2022 and 2030.

To align with 1.5°C, fossil fuels must exit the power sector in Türkiye by 2045, even as electricity demand grows rapidly

Türkiye would need to achieve clean electricity by 2045

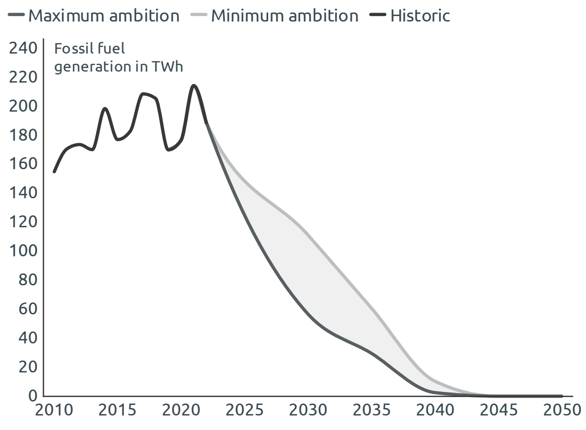


Figure 3 – Fossil fuel generation in TWh

Coal and gas phase-out in Türkiye

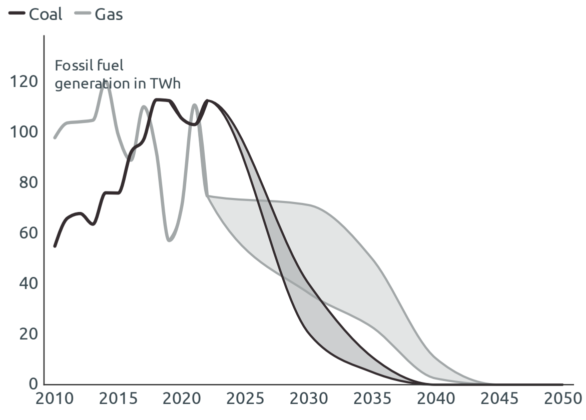


Figure 4 – Fossil fuel generation by fuel type in TWh

The role of other clean electricity generation

While wind and solar will be the workhorse of the energy transition, other clean electricity generation may play a role. We estimate the role of non- wind and solar clean electricity generation* (largely hydro, biomass, nuclear and geothermal) from country-level studies.

In our modelling, we assume that generation from clean technologies other than wind and solar in Türkiye would reach 160 TWh by 2030 and over 200 TWh by 2050. This is provided by a mix of hydropower (which provides on average almost 100 TWh of generation by 2050 in the reviewed national studies), biomass (over 50 TWh by 2050), other renewables such as geothermal and solar CSP (30 TWh by 2050) and a small amount of nuclear (30 TWh by 2050).

Total wind and solar generation needed to align with 1.5°C

The wind and solar rollout is then calculated by combining projected electricity demand growth, the fossil phase-out necessary to align with 1.5°C, and the assumed generation from other clean technologies.

To align with 1.5°C, wind and solar generation in Turkey would need to reach between 160-215 TWh by 2030. Generation in 2022 was 50 TWh. This is therefore a 3 to 4-fold growth in wind and solar.

Wind and solar provides 37–50% of overall electricity generation in 2030, and 78% of overall generation in 2050.

To align with 1.5°C, wind and solar generation would need to grow rapidly in Türkiye

Wind and solar generation needs to grow 3-4x by 2030 relative to 2022 in Türkiye

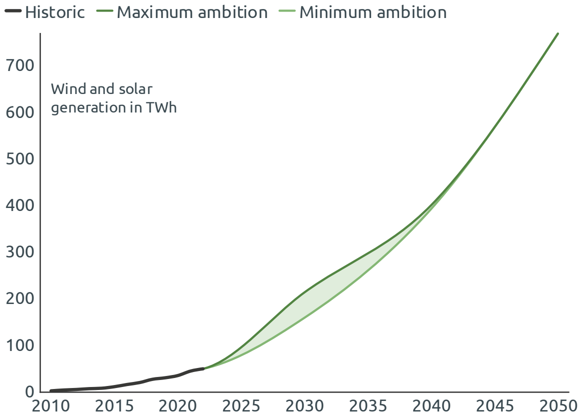


Figure 5 – Wind and solar electricity generation in TWh

Wind and solar would need to provide around 80% of electricity generation in Türkiye by 2050

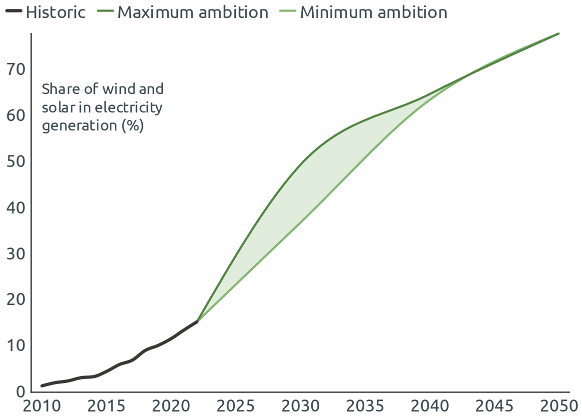


Figure 6 – Wind and solar electricity generation share (%)

* We do not consider CCS in the power sector, as we do not consider CCS a viable source of large-scale emissions reductions in the power sector.

Possible splits between wind and solar

The relative share of wind and solar deployment will vary depending on how various factors develop in the future. We explore one key uncertainty, the relative cost of solar and wind electricity generation (see methods). When accounting for this uncertainty, we see a range of possible future generation mixes between wind and solar.

We highlight the median of the range as our **central benchmark**, but do not suggest that this is the only possible breakdown into wind vs. solar. In the central benchmarking scenario, solar becomes the main source of generation, providing on average twice more generation as wind in the electricity mix by 2050. This will require a rapid uptake of non-fossil flexibility options.

In Türkiye, the level of uncertainty seen in our benchmarks across wind and solar costs is small. This does not mean that there is no uncertainty in the possible split of wind and solar, as a range of other uncertainties could also impact on the split, including grid capacity, supply chains, national policies and more.

In this scenario, **wind and solar capacity in Türkiye would need to reach around 90 GW of by 2030, and 150 GW by 2035**. By 2050, total wind and solar capacity would need to reach towards 400 GW. Due to its higher capacity factor, greater wind deployment would reduce total capacity requirements.

Türkiye needs to install around 90 GW of wind and solar by 2030 to align with 1.5°C

Solar capacity would reach 62 GW in Türkiye by 2030 in a 1.5°C-aligned scenario

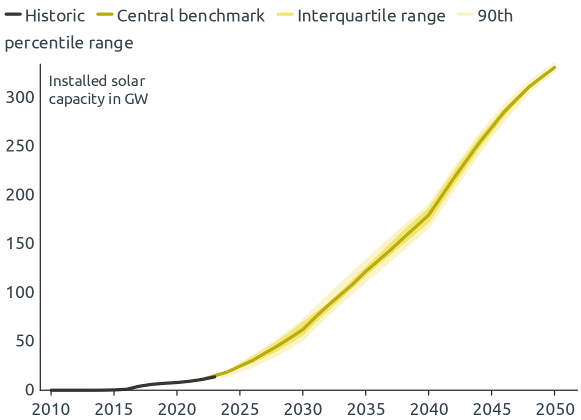


Figure 7 – 1.5°C compatible capacity benchmarks for solar in GW

Wind capacity would reach 27 GW in Türkiye by 2030 in a 1.5°C-aligned scenario

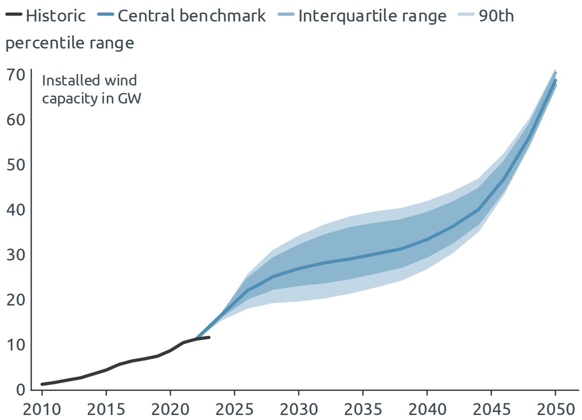


Figure 8 – 1.5°C compatible capacity benchmarks for wind in GW

Note: The benchmarks assume action from 2022.

The following table shows the wind and solar deployment needed to align with the central 1.5°C compatible benchmark produced. 2022 is historical data. All benchmark data from 2030 onwards is reported to two significant figures.

Table 2: Wind and solar electricity generation and capacity (2022–2050)

Scenario	Variable	Unit	2022	2030	2035	2040	2050
Central 1.5°Cbenchmark	Solar generation	TWh	17	100	200	290	530
Central 1.5°Cbenchmark	Wind generation	TWh	34	90	92	110	250
Central 1.5°Cbenchmark	Solar capacity	GW	11	62	120	180	330
Central 1.5°Cbenchmark	Wind capacity	GW	11	27	30	34	69

Table 3: Benchmarks translated into CAT format

Variable	Ambition	Unit	2030	2035	2040	2045	2050
Share of coal	Minimum	%	9	3	0	0	0
	Maximum	%	5	1	0	0	0
Share of gas	Minimum	%	16	9	2	0	0
	Maximum	%	8	4	0	0	0
Share of renewables	Minimum	%	80	89	95	96	97
	Maximum	%	67	83	93	96	97
Share of wind and solar	Minimum	%	37	53	64	74	78
	Maximum	%	50	59	65	74	78

Comparison to current rollout and country target

Under current policies and market conditions, deployment of wind and solar come close to aligning with the benchmarks set out here, although there remains a gap of around 13 GW of solar and 6 GW of wind that would need to be closed.

Meanwhile, the targets announced in the 2022 National Energy Plan are not ambitious enough to align with 1.5°C and should be updated.

There is strong support from businesses for high ambition from the government to phase out fossil fuels and transition the electricity system to be powered by renewables, with 98% of executives in Türkiye polled in the Global Business Poll in favour and 55% wanting to see this transition by 2030.

Türkiye's rollout of wind and solar come close to alignment with 1.5°C, but targets need updating

Current rollout of solar in Türkiye comes close to aligning with 1.5°C, but targets need updating

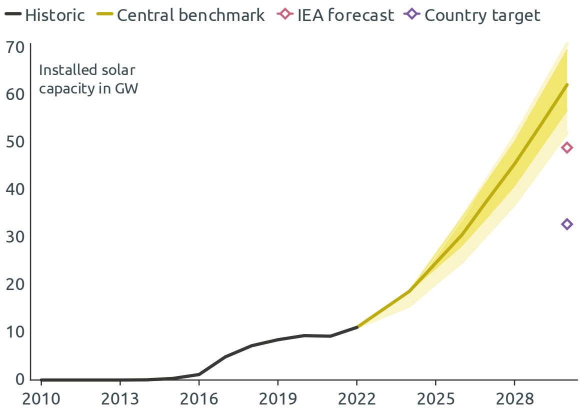


Figure 9 – Installed solar capacity in 2030 compared to targets and current policy projections in GW

Current rollout of wind in Türkiye comes close to aligning with 1.5°C, but targets need updating

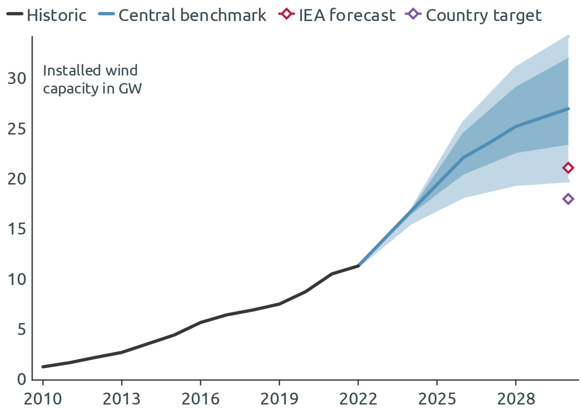


Figure 10 – Installed wind capacity in 2030 compared to targets and current policy projections in GW

Note: The target data was last pulled from Ember in January 2025. The current policies data was last pulled from the IEA in June 2025.

Wind and solar capacity additions in Türkiye need to accelerate to align with 1.5°C

Türkiye would need to add on average 6.0 GW/yr of solar capacity until 2030, and 13.0 GW/yr by over 2030–2050

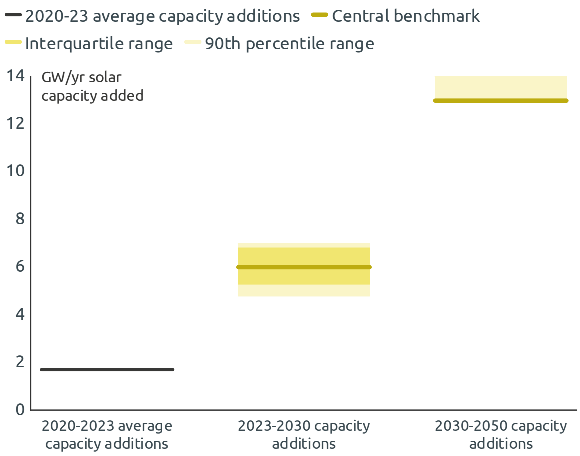


Figure 11 – Solar capacity additions per year in GW/y

Türkiye would need to add on average 1.8 GW/yr of wind capacity until 2030, and 2.4 GW/yr by over 2030–2050

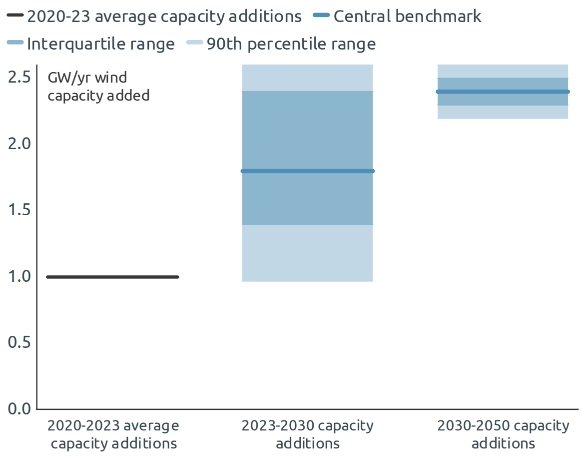


Figure 12 – Wind capacity additions per year in GW/y

Comparison with other studies

We compare the wind and solar generation seen in our analysis to that in the literature review of country-level studies. In particular, we highlight the results of modelling from Shura's study exploring net zero by 2053 pathways for Türkiye's power sector.

We see that the wind and solar generation that our method produces is broadly within the range of the national literature in 2030. In 2050, our model generally deploys more solar generation than the national studies reviewed, while it remains in the center for wind generation (two studies reporting higher generation, two reporting lower).

In 2050, our analysis deploys more solar and less wind than the study highlighted from Shura.

In 2050, our benchmarks show higher solar and less wind than the net zero roadmap from Shura

Electricity generation from solar: comparison with literature in Türkiye

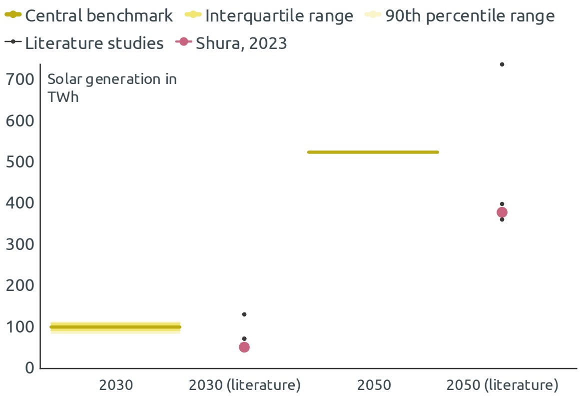


Figure 13 – Solar electricity generation in TWh

Electricity generation from wind: comparison with literature in Türkiye

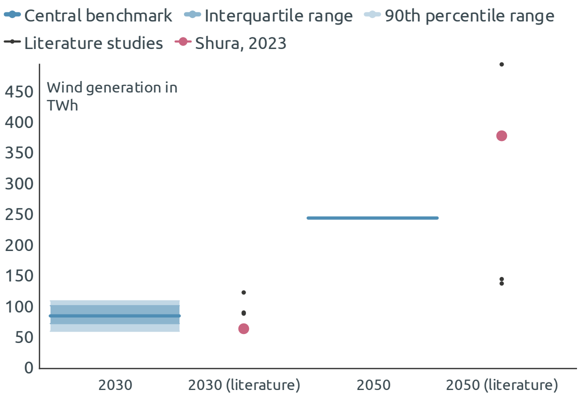


Figure 14 – Wind electricity generation in TWh

In Türkiye, our benchmarks generally suggest that solar will provide more generation than wind

Share of wind and solar generation that comes from solar: comparison with literature in Türkiye

The area above the blue dashed line represents a power system in which solar provides more electricity generation than wind

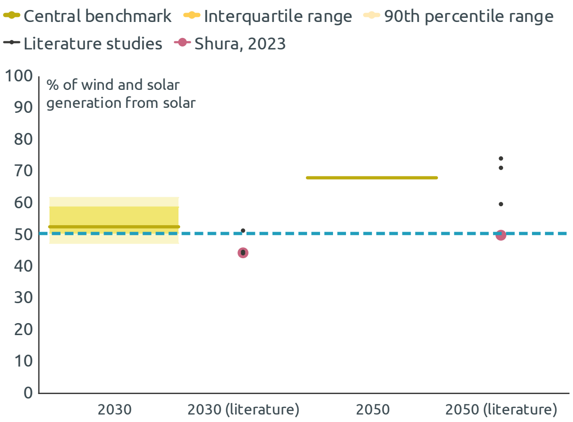


Figure 15 – Generation split between wind and solar (%)

Methodology

Summary of our method

Method for calculating CAT 1.5°C benchmarks for wind & solar

- STEP 1 — **Total electricity demand** TWh
- STEP 2 — **Fossil fuel phase-out timeline and pathway** TWh
- STEP 3 — **Clean electricity generation** TWh
- STEP 4 — **Subtract other clean fuels for wind & solar**
- STEP 5 — **Wind & solar split and capacity calculations** GW

Our method takes a series of steps to calculate the wind and solar generation needed for 1.5°C, and the resulting capacity deployment. The key methodological steps are highlighted below.

1. We project future electricity demand in the country.
2. We calculate the pace of fossil fuel phase-out needed to align with 1.5°C.
3. Bringing these trajectories together defines the level of clean electricity generation required to meet electricity demand growth while phasing out fossil fuels in the power sector.
4. We project non-wind and solar clean electricity generation based on country-level literature. This allows us to identify the wind and solar generation necessary to align with 1.5°C.
5. Having produced this wind and solar generation trajectory, we feed it into a simplified electricity system model (PyPSA), which calculates for a given set of cost assumptions around wind and solar, a split into wind versus solar and the associated capacity requirements.

Overlap of different elements

1.5°C compatible IPCC global pathways	Link to global goal of tripling renewable capacity by 2030
High-ambition country-level studies	Used as inputs to inform key parameters of the methodology
Renewable energy potential and power system analysis	Capture local potential for wind and solar
Key global milestones	Include key global guardrails on the pace of fossil fuel phase-out and the level of electrification

Climate Action Tracker

1.5°C benchmarks for wind & solar

Our method focuses on the overlap between different elements. By looking at the range of fossil fuel phase-out which is outlined in both high ambition country-level studies and downscaled 1.5°Ccompatible global pathways, and is informed by key global milestones, we identify benchmarks which are both consistent with a global least cost pathway to limiting warming to 1.5°C but are also aligned with national–level modelling.

Combining multiple different analytical elements can help identify the most robust path to achieving a zero-carbon energy system.

For more details see the Methods Annex.

List of scenarios selected

Table 4: Country level studies for Türkiye

Study	Publication	Scenario selected
Shura, 2023	Net Zero by 2053: A Roadmap for the Turkish Electricity Sector	Net Zero 2053
Teske et al., 2023	Net-zero 1.5°C sectorial pathways for G20 countries: energy and emissions data to inform science-based decarbonization targets	1.5 °C
Sahin et al., 2023	Turkey's decarbonization pathways - Net zero in 2050	• Net-Zero Scenario (NZS) • Nuclear-Free NZS

Annex A

Phases of grid integration

The grid integration phase is adapted from a de Vivero et al. report detailing a qualitative assessment framework for power system transformation and an IEA report on integrating solar and wind. We use the share of VRE sources in electricity generation to classify countries into a phase. More information about the characteristics and key challenges of each phase can be found in the report.

Phase 0 (less than 5% annual VRE share): we assign this phase when wind and solar make up 0-5% of a country's electricity generation mix. Installed VRE capacity is limited, and the impact on power system operation is negligible. Integration does not require significant operational or structural changes.

Phase A (between 5% and 15% annual VRE share): we assign this phase when wind and solar make up 5-15% of a country's electricity generation mix. Conventional power system operation remains largely sufficient for day-to-day system management. However, system planning must anticipate higher future VRE shares. This includes improving forecasting tools, integrating forecasting into dispatch decisions and moving toward shorter scheduling intervals and more real-time system operation.

Phase B (between 15% and 25% of annual VRE share): we assign this phase when wind and solar make up 15-25% of a country's electricity generation mix. The contribution of VRE varies significantly over time, with periods of very low output and periods of high penetration. This variability increases the need for operational flexibility. Enhanced coordination between system operators, network operators, and distribution system operators becomes critical to maintain system efficiency and security.

Phase C (between 25% and 40% of annual VRE share): we assign this phase when wind and solar make up 25-45% of a country's electricity generation mix. Periods in which VRE dominates system behaviour become increasingly frequent. A key operational challenge is maintaining system stability during sudden disruptions in supply or demand. Curtailment of VRE may become necessary to preserve system security. Without structural adjustments, integration constraints of VRE into the system may slow further increases in renewable energy shares despite additional installed capacity.

Phase D (between 40% and 70% of annual VRE share): we assign this phase when wind and solar make up 45-80% of a country's electricity generation mix. Periods in which VRE availability exceeds demand occur more frequently than in earlier phases. Ensuring system stability while continuing to increase renewable penetration requires additional measures, such as expanded demand response, stronger interconnections and large-scale energy storage. Market design and regulatory frameworks become increasingly important to enable these solutions. Although particularly critical in this phase, many of these measures should begin in earlier phases (B and C) to provide long-term investment signals and facilitate a smoother system transformation.

Phase E (more than 70% share of annual VRE share): we assign this phase when wind and solar make up 80-100% of a country's electricity generation mix. The power system reaches very high VRE penetration. The primary challenge becomes ensuring adequacy during extended periods of low wind and solar availability. Addressing this requires long-duration energy storage, sector coupling allowing for export and import of power between economic sectors in the same country and extensive electricity trade both within regions and between countries.

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The Consortium

The Climate Action Tracker (CAT) is an independent scientific analysis produced by three research organisations tracking climate action since 2009. We track progress towards the globally agreed aim of holding warming well below 2°C, and pursuing efforts to limit warming to 1.5°C.

climateactiontracker.org

Climate Analytics is a non-profit institute leading research on climate science and policy in relation to the 1.5°Climit in the Paris Agreement. It has offices in Germany, the United States, Togo, Australia, Nepal and Trinidad and Tobago.

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NewClimate Institute is an independent non-profit organisation that develops solutions to tackle climate change and drives their implementation worldwide. Through research, policy advice and knowledge sharing, we aim to raise the ambition for climate action and support sustainable development.

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