Energy independence only comes with clean

Türkiye relies on fossil fuel imports for half of power generation - that can be halved by 2030 with a faster transition to clean power sources. Solar power in particular needs to be a vital component of this transition.

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About

This study presents a summary of various electricity transition pathways towards 2030 under the guidance of recently conducted modeling studies on the Turkish electricity system. The results here are aimed to guide and understand the targets to be set in the long-awaited Turkish Ministry Of Energy's new long term energy plan which is expected to be in line with Türkiye's 2053 net zero target.

Highlights

50%

The share of imported fossil fuels in power generation as of 2021 in Türkiye

40 GW

The total solar power capacity by 2030 in order to halve foreign dependence in power generation, up from 8.8 GW as of August 2022

30 GW

The total wind power capacity by 2030 in order to halve foreign dependence in power generation, up from 11.1 GW as of August 2022

Executive Summary

Planning for more clean energy will give Türkiye independence from foreign fossil fuel imports

In 2021 Türkiye announced a net zero target by 2053. Now the country needs to adjust its long term energy plan to match. A power system aligned with the net zero plan will not only decarbonize electricity, but also make Türkiye more independent.

01 Türkiye can halve dependence on imported fossil fuels in power generation by 2030

Türkiye generated 50% of its electricity from imported coal and gas in 2021. With an accelerated clean energy transition, the country can reduce foreign dependence in power generation to less than 25% by 2030. But this requires wind and solar to make up more than a third of total power generation.

02 40 GW total solar power capacity is needed to halve foreign dependence in the power sector

To lower dependence on fossil fuel imports, around 4 GW of new solar power capacity is needed every year by 2030. Recent deployment rates

hover around only 1 GW per year, despite the fact that domestic manufacturing capacity could achieve eight times that every year and solar auctions are attracting applications for capacity 10-15 times larger.

03 At least 30 GW total wind power capacity is needed by 2030

To halve dependence on fossil fuel imports, wind power capacity needs around a threefold rise by 2030, up from 11.1 GW as of August 2022. This will mean around 2.5 GW new wind power capacity added every year by 2030 - significantly higher than recent yearly wind installations (~1 GW/year).

"The world has woken up to the fact that relying on fossil fuels for electricity is expensive and unreliable. The solution is to harness cheap and clean renewables: wind and solar. Wind and solar will play a crucial role in the future to make a country with limited energy resources like Türkiye more independent."

Ufuk Alparslan
Regional Lead
Türkiye, Ukraine & the Western Balkans
Ember

Background

Türkiye aims for net zero by 2053

Six years after signing the Paris Agreement, Türkiye ratified the agreement in 2021, and the parliament's decision was followed by the announcement of a net zero target. But the country now needs a credible plan for delivering net zero.

Global agreement on combating climate change

The Paris Agreement is a legally binding international treaty on climate change. The agreement was signed by 196 Parties at COP 21 held in Paris on 12 December 2015. It then came into force on November 4th, 2016. The goal of the agreement is to limit global warming to well below 2°C and pursue efforts to limit it to 1.5°C, compared to pre-industrial levels.

The Paris Agreement requires all Parties to put forward their best efforts through nationally determined contributions (NDCs). In their NDCs, countries submit their climate action plan with a certain emission reduction target in order to reach the goals of the Paris Agreement. The agreement works on a five-year cycle with gradually more ambitious targets submitted by countries to combat climate change.

Many countries submitted their intended nationally determined contributions (INDC) in 2015, as per decision at COP19 held in Warsaw before the adoption of the Paris Agreement. INDCs were then considered as NDCs following the conclusion of the Paris Agreement by those Parties.

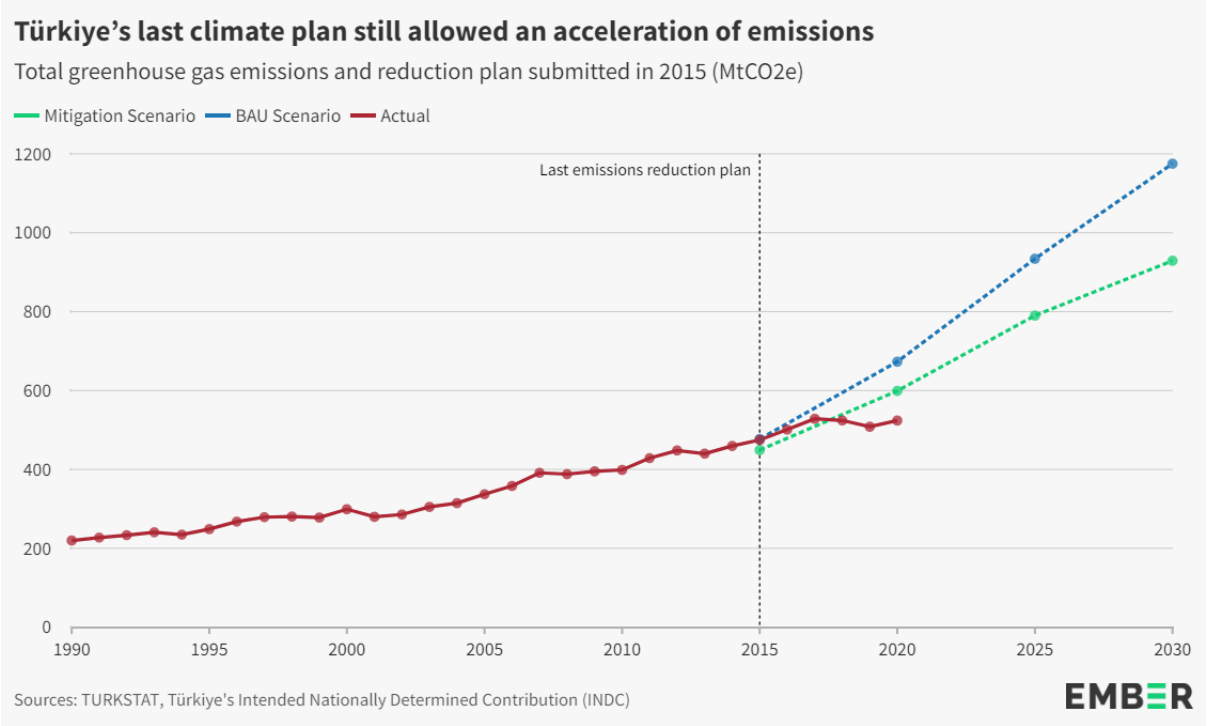
Türkiye ratified the Paris Agreement in 2021 and set a net zero target

Türkiye, despite being among the first signatories of the Paris Agreement, did not ratify the treaty until 2021. Türkiye viewed its categorization of a developed country in the annex to the agreement as inaccurate, which required the country to meet certain emissions reduction targets without benefiting from the financial support provided for developing countries. However, in late 2021, the Turkish government dropped this request, and did not only ratify

the Paris Agreement, but the government also set a net zero target by 2053 to coincide with the 130th anniversary of the Turkish Republic.

Net zero target requires an updated emission reduction plan

Türkiye submitted an emission reduction plan (INDC, or Intended Nationally Determined Contribution) once in 2015 and has not updated it since then. In its INDC, Türkiye aimed to lower greenhouse gas emissions by 21% in 2030 relative to its self-defined *Business As Usual* (BAU) scenario. By targeting 929 MtCO2e total annual emissions in 2030, this translates into a 77% rise compared to total emissions from Türkiye in 2020.



New emission reduction plan requires a new energy plan

As an emerging economy, Türkiye's rising emissions parallels its economic growth. However, the emission reduction plan Türkiye submitted back in 2015 did not promise even a slower pace in its emission rise - putting it out of step with what will be needed for the net zero target.

The average annual growth rate of Türkiye's greenhouse gas emissions was around 3.1% between 2000 and 2015. On the other hand, the average annual growth rate the BAU

scenario Türkiye assumed in its emission reduction plan was 6.2% between 2015-2030. Even in its mitigation scenario the annual growth rate in emissions was targeted at around 5%.

Following the ratification of the Paris Agreement, Türkiye now needs to submit a new emission reduction plan with an updated NDC. Accordingly, in the climate summit's declaration which was held in February 2022, the country is now working on a new NDC in line with the country's 2053 net zero target. In parallel to this, in a December 2021 edition of the Official Gazette, the Ministry of Energy was assigned to prepare a new long term national energy plan in the following year which would be subject to a revision every five years. As the Turkish Energy Minister also stated recently, the new energy roadmap will be published before COP27, the United Nations climate change conference to be held in Egypt between November 6-18, 2022.

Decarbonization pathways

Solar, wind and energy efficiency are key

Four recent models of the Turkish electricity system predict a significant rise in power demand ahead and conclude that this needs to be met by the cheapest tools: solar, wind and energy efficiency.

Four models

Since the net zero target was announced in Türkiye, four different studies were published that model how the country's power sector could move towards its 2053 target.

- The Istanbul Policy Center's (IPC) study sets a pathway to reach net zero by 2050 across all sectors.
- The World Bank's (WB) Climate and Development report considers a significant reduction in power sector emissions by 2040 in its all-sector study.
- A report from Europe Beyond Coal (EBC) and other local environmental organizations maps out how Türkiye can exit coal by 2030
- Analysis from Turkish energy transition think tank SHURA shows two main decarbonization scenarios with various sensitivity analyses: Accelerated Renewable Energy Supply (ARES) and Coal Phase Down (CPD).

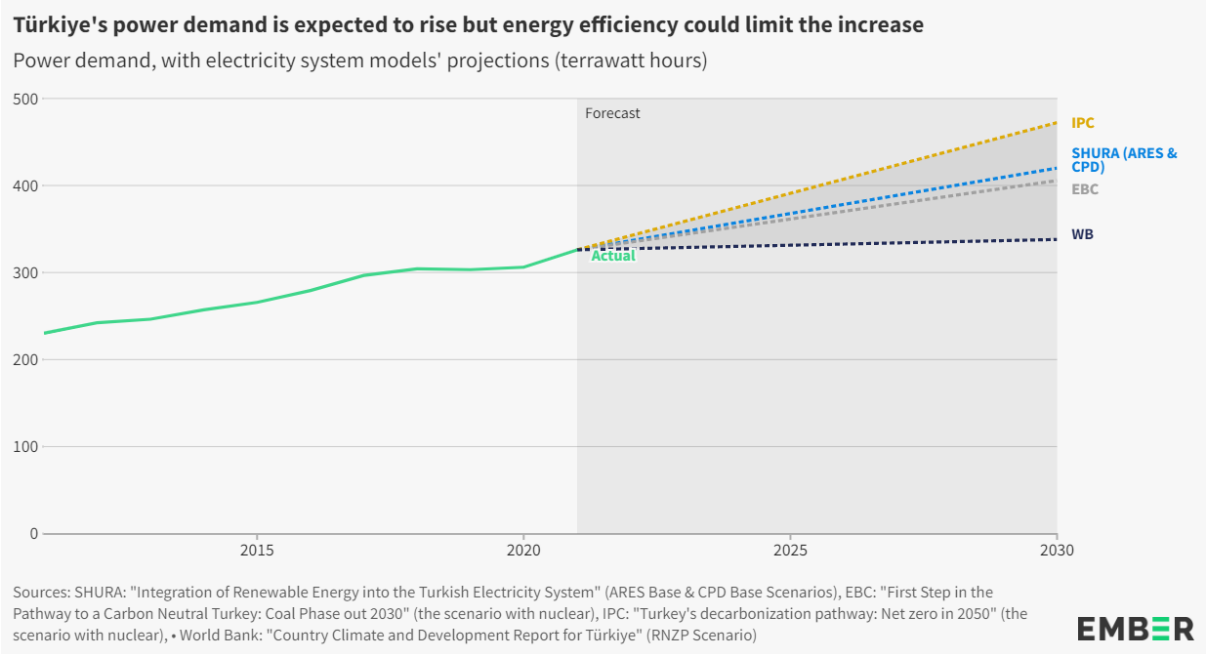
More details about these studies are provided in the Annex.

Here we will draw out overarching next steps for the power sector based on these four models to decarbonize electricity while meeting growing demand, focusing on energy efficiency, solar and wind.

Energy efficiency can play an important role in decarbonization

All the models recognize the role of energy efficiency, although they vary on how they pace the electrification of other sectors - like transport and buildings - to keep electricity demand growth in check.

The World Bank model stands out with its special focus on immediate action on energy efficiency. It projects a modest demand increase (+3.7%) between 2021-2030 in stark contrast to the historical rise (+35%) between 2012-2021. The assumption is an immediate increase in energy efficiency in key sectors and a delayed electrification of buildings. The rationale behind delayed transition in some sectors is to keep short term costs lower and to benefit from the expected decline in the cost of green technologies. As its demand projection is a significant outlier, the World Bank will be excluded in wind and solar capacity comparisons for the sake of comparability.



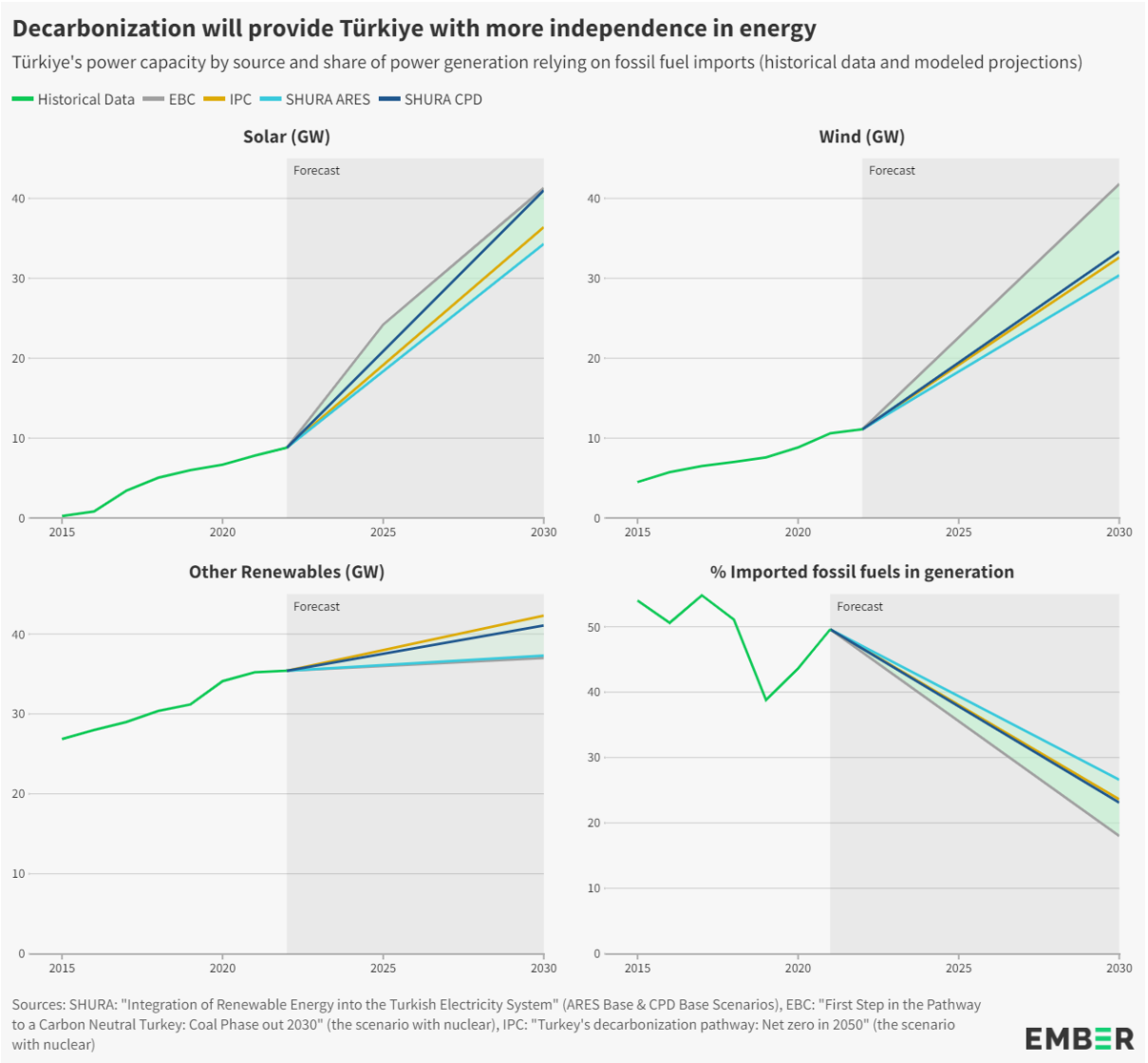
Solar power takes off in all scenarios

All four models evaluated see a crucial role for solar power, modeling 34-41 GW of solar power by 2030, up from 8.8 GW as of August 2022.

The solar power capacities at the lower end of the projections have some drawbacks. SHURA ARES scenario has the lowest solar power capacity projection (34 GW) due to the lack of ambition to replace the dirtiest generation source, with 17% coal share in power generation by 2030. This scenario also falls behind the other scenarios by having the highest foreign dependency in power generation by 2030 (27%). Another lower solar capacity projection, IPC, estimates 36 GW solar power by 2030. However, the capacity factor assumed (22.3%) for solar power generation is significantly higher than the countrywide capacity factor realized in 2021 (20%).

On the other hand, both EBC and SHURA CPD scenarios reach a lower share of power generation relying on fossil fuel imports by 2030 (18-23%) and have more realistic solar capacity factor assumptions (19.5-20.5%). The solar power capacity projection (~40 GW by 2030) made by these models therefore looks more plausible.

In order to achieve 40 GW total solar power capacity by 2030, Türkiye's current solar capacity (8.8 GW) needs more than a fourfold rise, meaning 4 GW of new solar power capacity addition every year. This is four times more than the recent solar deployment rate which barely exceeds 1 GW/year. Although the domestic panel manufacturing capacity could achieve eight times that every year and solar power auctions attract applications for capacity 10-15 times larger.



Wind capacity needs to be tripled

There exists a consensus between all different scenarios that Türkiye reaches at least 30 GW total wind power capacity by 2030. However, EBC is an outlier from the rest, projecting 42 GW wind capacity by 2030. The higher wind power target results from EBC's ambitious coal phase out plan by 2030 and the fact that it does not allow significant capacity additions other than wind and solar. The results of other scenarios are therefore taken as the basis of the wind capacity target in this analysis.

According to the modeled projections, Türkiye needs to reach at least 30 GW total wind power capacity by 2030, which is almost triple its current wind power capacity (11.1 GW). It means around 2.5 GW of new wind power capacity addition every year in the following eight years, well above the recent wind deployment rate of 1 GW/year.

The role of other renewables

According to all models, only a modest rise in other renewable energy sources is estimated in the next few years.

The models do reveal that small increases in hydropower, geothermal and biomass capacity can significantly reduce the capacity needed by wind and solar power, thanks to their relatively high capacity factors and less variation in their hourly generation.

Compared to the other models, the EBC sees 4-6 GW lower capacity in other renewables, which results in around 8 GW more wind capacity. On the other hand, SHURA ARES scenario compromises with higher coal generation share (16.5%) in 2030 by adding lower capacity in these other renewables.

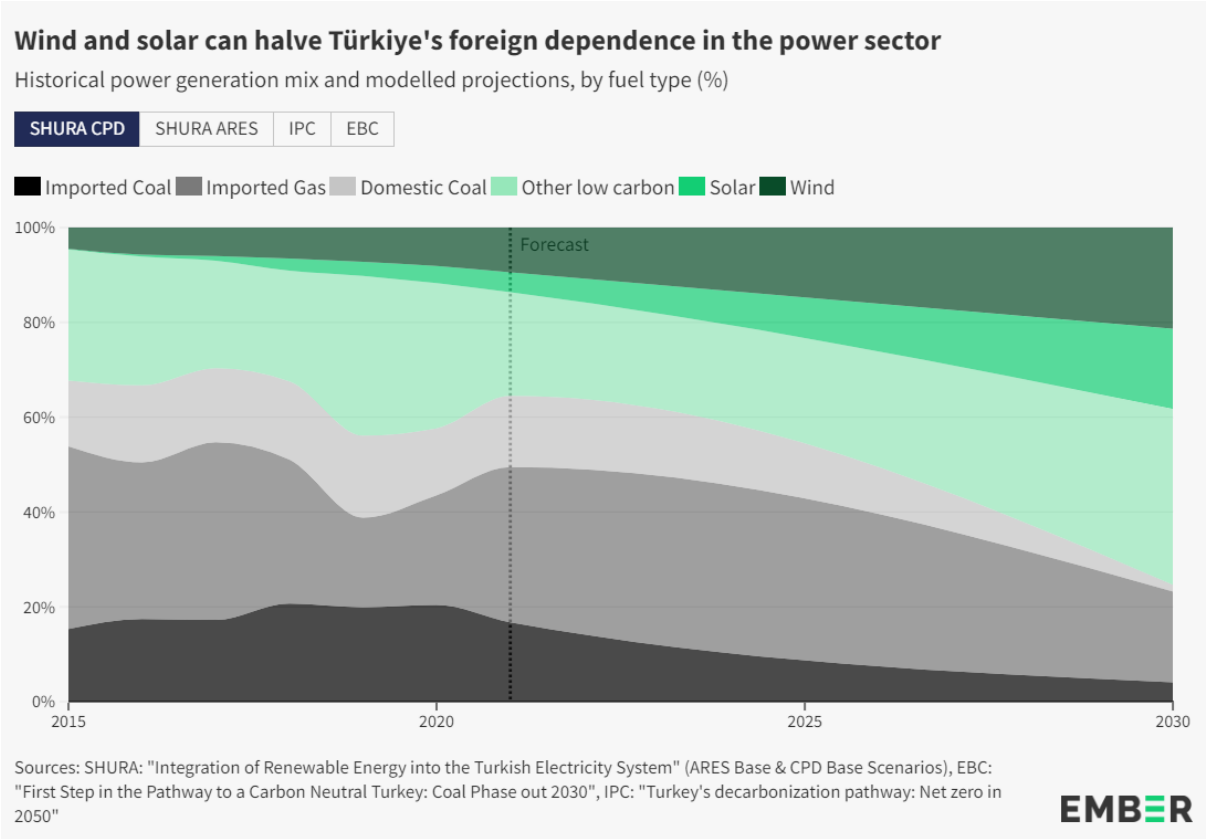
Decarbonization = Independence

Clean energy can make Türkiye more independent

Energy transition pathways aligned with Turkey's net zero goal can halve the country’s reliance on imports in power generation by 2030.

Türkiye is highly reliant on fossil fuel imports

Foreign dependence of Türkiye in power generation hovers around 50% in the last 25 years. Only two exceptions in that period were the COVID-hit year 2020, and 2019 when the country experienced record high hydropower generation. In 2021 the share of imported coal and gas in power generation was 16.7% and 32.7% respectively.



This reliance comes with a cost. The country's monthly trade deficit set an all-time record in July 2022, reaching $62 billion for the period of January-July due to rising costs of energy imports.

Wind and solar to exceed a third share by 2030

According to the decarbonization scenarios we covered above, Türkiye would need 40 GW solar and 30 GW wind power capacities in 2030. By achieving these targets, wind and solar would reach 34-38% share in total power generation by 2030. As of 2021, wind and solar account for 13.6% of total power generation in the country.

Under the same scenarios, wind and solar's 34-38% share in power generation would reduce the share of imported fossil fuels in power generation to 23-24%, down from 50% in 2021. In other words, by reaching slightly more than a third share in power generation, wind and solar can halve the share of imported fossil sources in power generation.

The many virtues of clean power

As the Turkish Ministry of Energy points out, Türkiye has enormous solar energy potential thanks to its geographical location and Türkiye has the highest solar panel manufacturing capacity in Europe. However, in 2021 Türkiye generated only around 4% of electricity from solar in 2021 and reached 8.8 GW solar power capacity as of August 2022. These statistics are very close to a much less sunny country than Türkiye: Ukraine.

Apart from power sector decarbonization and reaching net zero, Türkiye has very good reasons to realize its high solar potential. Solar power is cheap, it matches well with the countrywide demand profile peaking in summer due to growing need of air conditioning, and it can compensate for hydropower in dry seasons. Solar power can also help to shift some hydropower generation into winter in order to reduce peak gas demand which is hardly met during cold spells and gas supply issues. The solar potential is also more uniformly distributed across the country than other power generation sources.

Wind and solar will not only lower the power sector emissions and make the country closer to its net zero target, but will also lower the high costs of fossil fuel imports and can make a country with limited resources more independent. Wind and solar already saved Türkiye $7 billion between July 2021 and April 2022 when the gas prices were half of the current prices. The gas prices are expected to remain high until the end of 2024, therefore Türkiye's new energy plan will not only determine its level of emission reductions, but will also determine its level of energy independence.

Supporting Materials

Annex

The scenarios covered in this analysis

Among the aforementioned studies, The Istanbul Policy Center (IPC) and Europe Beyond Coal (EBC) ran two scenarios other than the baseline scenario, with/without nuclear. The scenarios with nuclear assumed the 4.8 GW *Akkuyu* nuclear power plant to be completed as it was planned. The World Bank's only decarbonization scenario assumed the nuclear project to be completed in time, while SHURA assumed between 2.4 and 4.8 GW nuclear capacities in all scenarios. Hence in this analysis we only use the scenarios taking the nuclear energy into account to make them comparable. As a matter of fact *Akkuyu* nuclear power plant, which is owned by the Russian government, has already received the production licenses and began construction of all four units.

SHURA has two main decarbonization scenarios: *accelerated renewable energy supply scenario* (ARES) and *coal phase down scenario* (CPD). Although several sensitivity analyses were studied on these scenarios, the results do not vary dramatically under different sensitivity analyses. Thus, in this analysis we only cover the *ARES base* and the *CPD base* scenarios.

In all of these studies the models add the cheapest power generation options into the system under various constraints and assumptions (i.e energy efficiency, electrification, net zero by 2050, a certain coal phase-out date, etc) while keeping up with the power demand. The power plants currently under construction and expected to be completed are also taken into account in the new capacity development projections of the models.

Coal share in generation varies between 0-16.5% in these scenarios. Although only EBC's study seems to propose a coal exit among all, SHURA CPD also has an ambitious coal phase down plan estimating a 5.4% coal share in power generation in 2030. However, this projection assumes *Akkuyu* Nuclear Power Plant to be partially completed with only 2.4 GW. By assuming 4.8 GW nuclear power capacity, most of the coal generation projected (23 TWh) could also have been replaced by 2030. Similarly if IPC did not assume around 50-65 TWh higher power demand by 2030, its coal generation projection (32 TWh) could also have been close to zero by 2030 (IPC's model reaches coal exit by 2035). Apart from these, the World Bank projects a 9% coal share in generation by 2030.

Acknowledgements

Contributors

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Cover image

Solar panels on a rooftop overlooking the mountains in Bursa, Turkey, in 2021.

Credit: Harun Bilal Çagiran / EyeEm / Alamy Stock Photo