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Briefing · November 2024

Renewable energy in India: Is ambition being realised?

Key points:

- To meet its objective of 500 GW of non-fossil installed capacity by the early 2030s, India will need to add 300 GW of new renewable capacity in this decade.
- Annual new capacity falls far below the 50 GW/year aspiration; less than 13 GW of new capacity was built between 2022 and 2023. Although 20.7 were registered between January and September 2024, this is still below the rate required to achieve 50 GW/year.
- The government is promoting the development of ultra mega renewable energy power parks as a key plank of its renewables agenda, aiming to produce 40 GW of capacity by 2025-26.
- With roughly half the installed capacity as solar, India's ambition for wind energy has historically been much lower, and the country is a relative latecomer to the potential for offshore wind generation.
- Investment in renewable energy has been growing since 2020, reaching USD 12.4 billion in 2023. Despite these increases, investment looks likely to be far below the USD 200 billion estimated to be necessary to deliver India's 500 GW of non-fossil fuel electricity capacity by 2030.

Does performance on solar and wind match India's 500-GW aspiration?

India has a target of 500 GW of non-fossil fuel electricity capacity. Initially set for 2030, the government has accepted that the target won't be met until 2031-32 in early 2024. As of the end of September 2024, India had around 201.5 GW of renewable capacity.[1] This means that if most or all of this non-fossil fuel target is to come from renewables, around 300 GW of new renewable capacity will be required by the early 2030s.

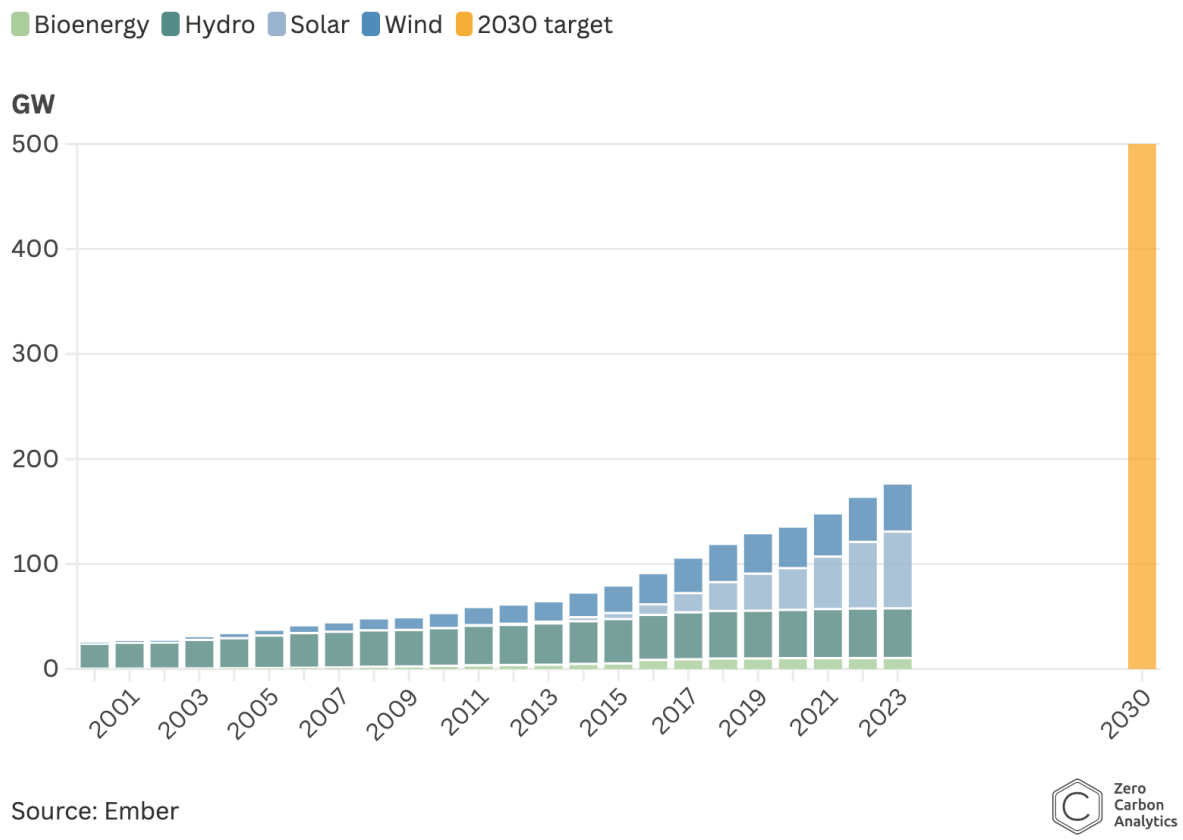
To meet the target, the government has announced annual tenders for 50 GW/year between mid-2024 and 2030.[2] In financial year 2023/2024, the responsible Implementing Agencies exceeded this target and issued tenders for 53.32 GW of capacity.

[1] This capacity includes large-scale hydro which was reclassified as a renewable energy source in 2019.
[2] Tenders (or auctions) require developers to bid for contracts to generate renewable electricity. The developers that bid the lowest price for the output from their projects are awarded contracts. Tender/auction schemes are intended to lead to the construction of new renewable capacity at the lowest price to the taxpayer or consumer while also giving developers the certainty of having a contract to buy their output.

However, while the target for tenders was exceeded, the record on delivering the contracted capacity is not encouraging. Annual new capacity falls far below the 50 GW/year aspiration, with less than 13 GW of new capacity built between 2022 and 2023 (Figure 1). Having said that, 20.7 GW of new renewable capacity was added in the first nine months of 2024, exceeding the total additions for 2023.[3] It is too soon to say if this is the start of a trend to expedite capacity, though auction trends suggest not.

Recent rounds of tenders have often been undersubscribed, particularly for wind power. For example, national tenders in 2023 for up to 4.7 GW of capacity resulted in only 1.2 GW of bids and 0.7 GW of contracts awarded. Holding annual tenders for 50 GW of renewable capacity will, therefore, not necessarily result in 50 GW of capacity being built a year.

Fig. 1: Renewables capacity and 2030 target (GW)



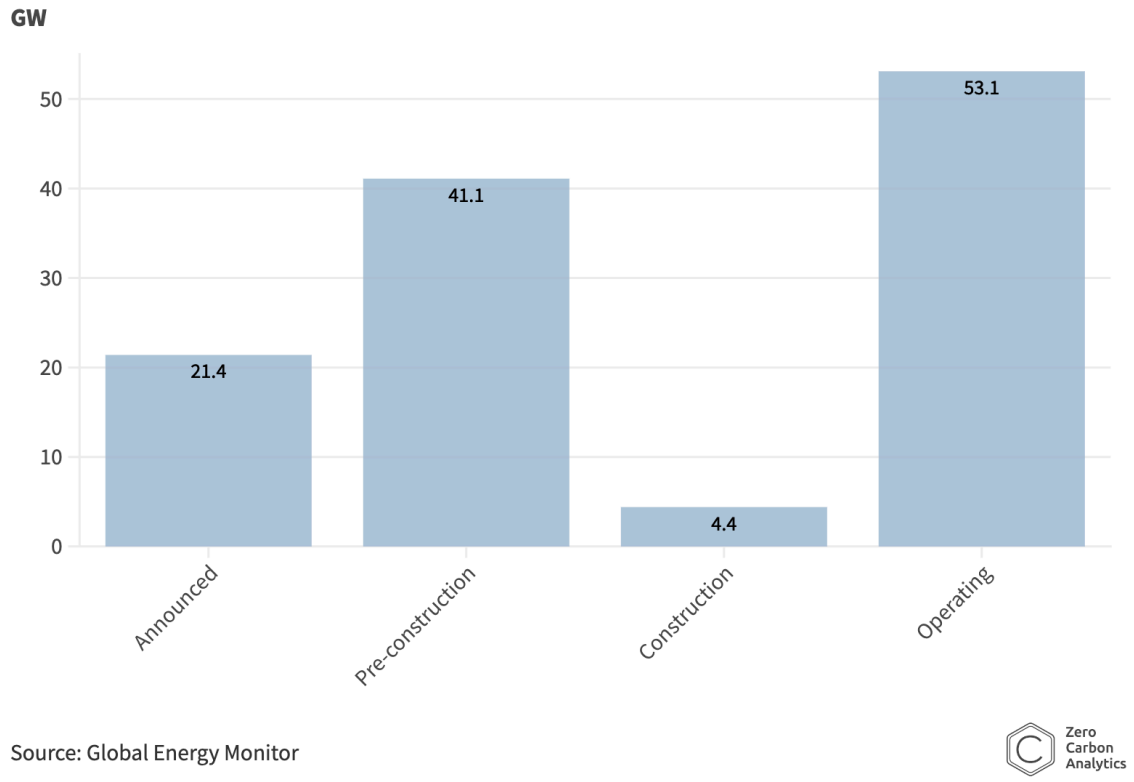
Current capacity

Solar PV

As of June 2024, there was just over 53 GW of operational solar capacity from photovoltaic (PV) plants over 1 MW, with a small pipeline of 4.4 GW under construction. An additional 62 GW has been announced or is in the pre-construction development phase (Figure 2).

[3] Total renewables capacity stood at 133.89 GW at the end of 2023, and 148.08 GW by June 2024. This does not include large-scale hydro.

Fig. 2: Solar projects over 1 MW by development phase (June 2024)



Wind

India's installed wind capacity currently totals 47 GW, compared with 90 GW for solar PV. The ambition of large-scale wind farm development is arguably much lower than that of solar PV, with only two wind farms of above 500 MW currently operating. An additional 540-MW wind farm is being built in Tamil Nadu.

The largest onshore wind proposal was a 900-MW project in Rajasthan developed by Greenko, although this appears to have been shelved for the moment.

India does not currently have any operational offshore wind farms, which tend to be larger than onshore wind developments. However, it now has a target of 37 GW of offshore wind by 2030 to be built off the coasts of Gujarat and Tamil Nadu, and has set out a schedule for tenders for contracts intended to achieve this. Meeting this target by 2030 might be a challenge – total global offshore wind capacity at the end of 2023 was 75 GW, only twice the Indian ambition for 2030.

Three 500-MW offshore wind projects have been announced, and one with capacity of 600 MW. In comparison, the largest offshore wind farm in the world is the 1.3-GW Hornsea 2 project in the UK. However, India's government recently launched a tender for a 500-MW offshore wind farm off the coast of Gujarat.

Growth rates for solar and wind

The rate of solar PV deployment overshadows that of onshore wind. Solar grew by between 12.6% and 28.2% a year between 2019 and 2023, while wind had growth rates between 2.8% and 6.7% in the same timeframe (Table 1).

Deployment of both technologies will have to increase rapidly if the 2030 target is to be achieved. There is some evidence that deployment rates are rising: between April 2023 and April 2024, solar capacity increased by 17.6% and wind by 42.9% compared with the previous year. However, it is not clear whether this trend will be maintained in future. Clean energy consultancy Mercom India reports that wind capacity additions in the second quarter of 2024 were down by 33% compared with the first quarter.

Table 1: Renewables capacity and growth, 2018-2023

Technology	2018	2019	2020	2021	2022	2023
Solar (GW)	27.48	35.25	39.71	49.95	63.39	73.11
annual % increase		28.28	12.65	25.79	26.91	15.33
Wind (GW)	35.29	37.51	38.56	40.07	41.93	44.74
annual % increase		6.29	2.80	3.92	4.64	6.70
Total renewables (GW)	118.07	128.31	134.60	147.17	162.95	175.64
annual % increase		8.67	4.90	9.34	10.72	7.79

Source: Ember

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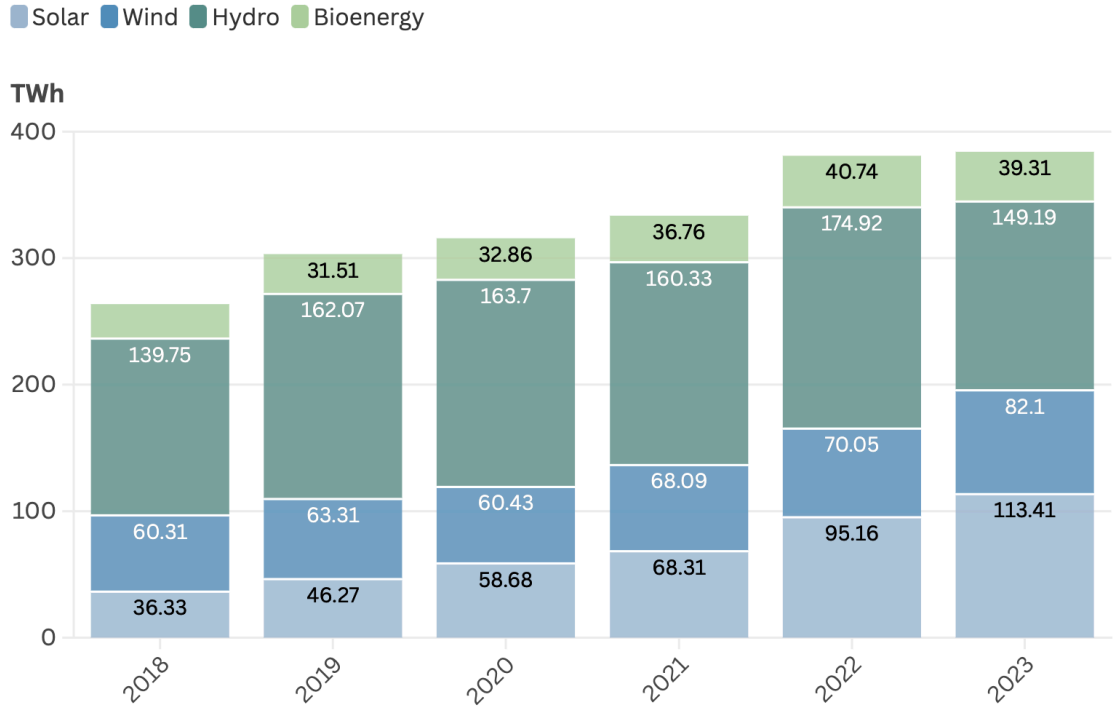
Despite the growth of solar and wind, renewables generation remained more or less stable between 2022 and 2023 as a result of reduced hydro output (Figure 3). This stagnation, combined with increased generation from other sources, led to the contribution of renewables to overall electricity generation falling slightly in 2023 to 19.5%, compared with 20.5% in 2022 (Figure 4). This is well short of the 2030 target for 50% renewables generation.

Fig. 3: Renewables generation by type, 2018-2023



Source: Ember

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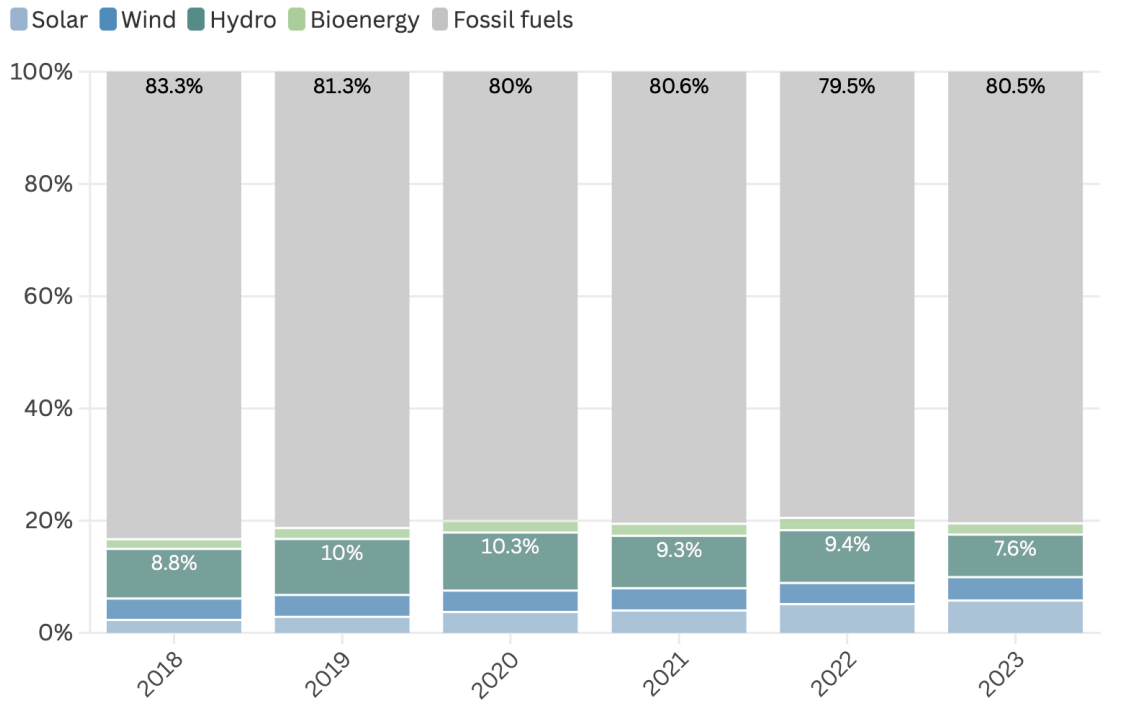
Fig. 4: Renewables share of electricity generation, 2018-2023 (%)



Source: Ember

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Growing capacity via ultra mega solar projects

A significant proportion of India's political effort on renewables has been directed towards constructing solar parks known as UMREPPs (ultra mega renewable energy power parks).

The government established the scheme to encourage the development of large-scale solar parks by providing developers with financial support. The rationale was that large-scale projects can exploit economies of scale as well as being more efficient to deliver in short timescales. Ultra mega solar parks were originally defined as having a capacity of more than 500 MW, although some parks are well below 50 MW in size.[4]

The scheme was originally intended to deliver 20 GW of solar capacity by 2019-20, but the target was doubled in 2017 to 40 GW of capacity by 2025-26. As of 30 June 2024, nearly 40 GW has been agreed in 13 states. However, more than 40% of the capacity target is yet to be awarded contracts, raising the possibility that the new capacity target will not be achieved by 2025-26 (Table 2).

Table 2: Status of solar parks/UMREPPs (June 2024)

Project pipeline	GW	% total
Commissioned	11.42	28.7%
Under construction	11.07	27.8%
In award/tendering process	17.30	43.5%
Total	39.79	100%

Source: Central Electricity Authority • Totals may vary due to rounding

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How does India's large-scale solar development compare with other countries?

Several extremely large solar farms have been announced or are in the pre-construction phase around the world. The largest announced projects are two 25-GW solar farms in Libya (Topeka) and Australia (Western Green Energy Hub), while Greece has announced an 11-GW project (Vardali Domokou). The largest announced project in India is the 10-GW Ladakh Solar Park, which ranks as the joint fourth-largest proposed project in the world.[5] Given the early stage of development of these projects, it is unlikely that all of them will be built.

Most of the largest operational projects are in China. The biggest is the Qinghai Golmud Wutumeiren (Luneng) complex, with 3 GW of capacity, and there are several projects with 2-GW capacity in operation.

The largest non-Chinese operating solar farm is the 2-GW Al Dhafra project in the United Arab Emirates. This is followed by the 816-MW Kurnool Ultra Mega Solar Park in Andhra Pradesh, India.

[4] Vankal Solar Park in Mizoram which is 20 MW, and Odisha Solar Park is 40 MW.
[5] The park was originally intended to be 7.5 GW but was upgraded to 10 GW in 2021.

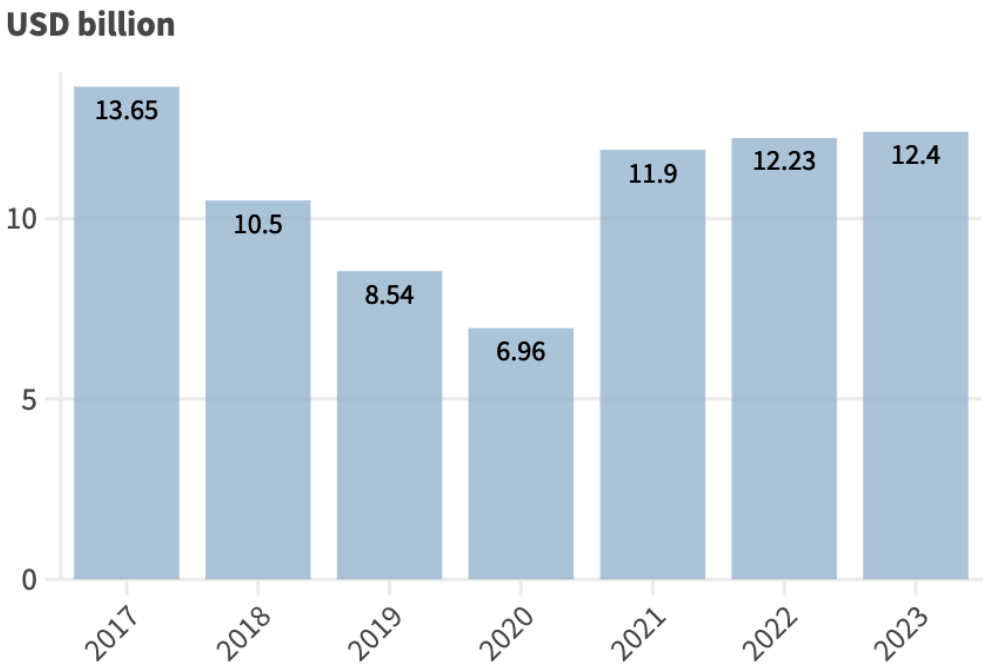
Overall, India has two projects in the top 100 largest solar projects at any stage of development (Ladakh and the 4.5-GW ArcelorMittal solar park). The majority of these large solar projects, including those in India, have been announced or are in pre-construction, but have not yet been built.

As of June 2024, there were seven announced projects greater than 500 MW in India. Globally, 661 projects of 500 MW or more have been announced, are in pre-construction or in operation, according to data from Global Energy Monitor. The majority of these are in China, but there are also several projects in Morocco, Australia, Oman and Saudi Arabia, among others.

Is there enough investment to meet renewables targets?

Around USD 12.4 billion was invested in renewable energy in India in 2023, a slight increase from 2022 levels (Figure 5). Renewable energy investment more than halved between 2017 and 2020. Wind investment was particularly hard hit following the change in support mechanism from a feed-in tariff to an auction-based system for power sold to the grid for wind sources in 2017. Investment recovered after 2021 for both solar and wind (Figure 6) but has overall remained stable rather than returning to 2017 levels.

Fig. 5: Renewable energy investment has increased since a low in 2020



Source: ZCA analysis, BNEF Energy Transition Investment Data
• Renewable energy includes: wind (on- and offshore), solar (large and small-scale), biofuels, biomass & waste, marine, geothermal and small hydro.

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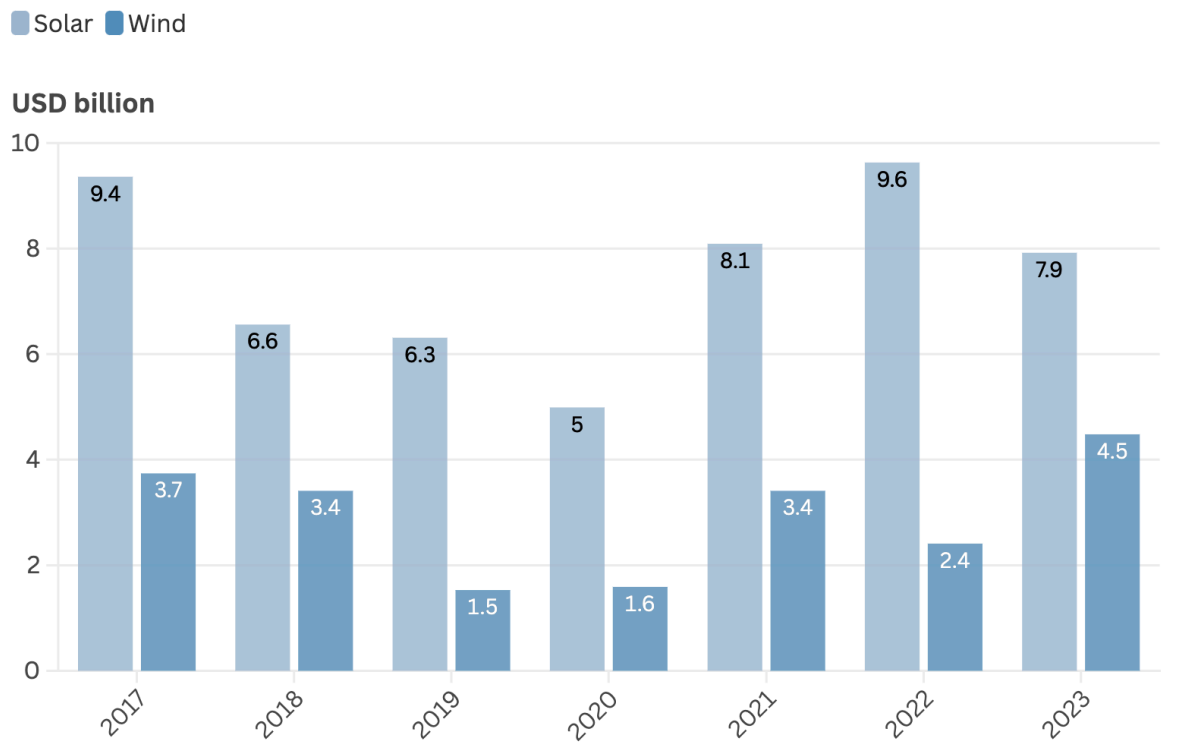
Investment figures by segment

Solar PV dominates investment, with nearly USD 8 billion invested in 2023. However, this was a 17% fall from the 2022 level. Wind lags behind solar at nearly USD 4.5 billion in 2023, although this is up by more than 85% from 2022 (Figure 6). Investment rates in both solar and wind are volatile, and there is no clear trend for individual technologies from year to year.

Fig. 6: Solar tops wind investment in 2017-2023



Source: ZCA analysis, BNEF Energy Transition Investment data

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Expectations fall short of targets

The government expects investment to reach USD 16.5 billion in 2024. If sustained, this level will not reach the USD 200 billion that financial service company Nomura estimates is necessary for renewables investments to deliver India's 500 GW of non-fossil fuel electricity capacity by 2030.