



THE CHINKS IN INDIA'S SOLAR ARMOUR

To meet its ambitious renewable energy goals, India needs to fix multiple snags first

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When Bell Laboratories developed the first silicon solar cell in 1954, a technological breakthrough that converted sunlight into electricity, the invention made headlines. "It may mark the beginning of a new era," went a story in *The New York Times*, "leading eventually to the realization of one of mankind's most cherished dreams—the harnessing of the almost limitless energies of the sun."

That hope was born out of a humbling statistic: the amount of sunlight that strikes the earth's surface in an hour and a half is enough to meet the world's energy demand for a year.

Over the next several decades, solar technologies made huge progress, to the point that by 2020, solar electricity turned cheaper compared to polluting sources of energy like coal and fossil fuels. In November last year, India achieved a major milestone when its renewable energy capacity surged past 200 gigawatts (GW). By 2030, it hopes to scale up renewables to 500 GW. India's renewable energy targets are also critical to its stated goal of reaching net zero carbon emissions by 2070.

Data from the Central Electricity Authority show that by end-January 2025, renewables comprised 45% of installed power capacity. Solar capacity crossed 100 GW and now accounts for over a fifth of India's installed power capacity. Considering that solar was a paltry 3.7 GW in March 2015, the sector witnessed a remarkable 27-fold growth in less than a decade.

In 2023, India spent \$30 billion on green capital expenditure, which is expected to grow to more than \$400 billion cumulatively in the decade spanning 2022-32, as per a Morgan Stanley report (April 2024).

It now costs electricity distribution companies (discoms) anywhere between ₹2.5 and ₹4.8 to purchase a unit of renewable power, depending on whether the project involves a mix of solar, wind, hydro and includes some battery storage. This is comparable or less than the cost of thermal power (using coal) which hovers between ₹5-6 per unit.

Now the question is, if solar is cheaper than thermal, why are we not producing more electricity from this endless resource? Why is the share of solar in overall power generation still less than 10%?

THE ROUGH EDGES

Despite the progress India made so far in its energy transition journey, some recent state of the sector reports flag multiple gaps which include inadequate transmission infrastructure (renewable power generated in one state has to be transported to another) and projects failing to take off.

India issued a record 73 GW of renewable energy (RE) tenders in 2024, far exceeding its annual target of 50 GW. But, 8.5 GW of capacity was under subscribed, five times higher than the previous year, said a report from the Institute of Energy Economics and Financial Analysis (IEEFA), released earlier this month.

Worryingly, the cumulative unsigned power sale agreement (PSA) capacity now exceeds 40 GW. This means while companies are willing to set up renewable energy (RE) projects, there aren't enough buyers.

Another report by the Delhi-based Centre for Science and Environment (CSE), released in January, underlined the sluggish pace of commissioning of RE projects. For 34.5 GW of solar, wind, and hybrid projects, power purchase agreements (PPA) have been signed but projects are yet to be commissioned. PPA's are signed between project developers, or companies which produce solar power, and agencies which issue tenders like the Solar Energy Corporation of India (SECI). This implies a lack of interest from state-owned discoms to purchase renewable power.

India's fledgling solar sector also received a blow after it was marred by allegations of bribery. In November last year, the US' Securities and Exchange Commission (SEC) began investigating top executives at Adani Green Energy and Azure Power for their role in allegedly paying \$250 million in bribes to Indian state government officials to secure solar contracts. As per the SEC, Adani Green Energy raised \$2 billion from American and for-



A file photo of workers carrying a solar panel for installation at an under-construction renewable energy project in Gujarat's Kutch district.

AP

eign investors based on false and misleading statements about the firm's anti-corruption and anti-bribery efforts. Adani Green Energy has denied the allegations.

"Without getting into the legal arguments or the merits of the case, the question that arises here is why should there be a need to 'bribe' officials to accept solar energy contracts?" asks the CSE report. "When delivered solar energy costs are cheaper than coal-based thermal power, why is solar not the preferred option?"

Mint spoke with energy researchers and industry insiders to understand if solar purchases are slowing down and what can be done to resolve the problem. They spoke of steep targets set by the Centre, inadequate transmission infrastructure, and the reluctance of states. Some questioned the auction process itself. The ministry of new and renewable energy (MNRE) did not respond to queries from Mint.

A lot of RE is being pushed to states without consulting them, said a former MNRE secretary who did not want to be named. "The renewable purchase obligation, which mandates

Project implementation delays and mounting unsold power inventory pose a major challenge to India's renewable energy target for 2030. This could deter investors.

states to source a certain share of energy from renewables, is shoddily designed and cannot be enforced legally. It needs consensus between the Centre and states. The target to push 50 GW renewables every year does not take into account whether we

have the capacity to implement it," the former bureaucrat added.

Not everyone agrees. The Centre is doing the right thing by pushing an ambitious target and aligning states with India's clean energy goals, argued Sumant Sinha, chairman and chief executive officer of ReNew, among the largest renewable energy companies in India.

Sinha added that the main operational challenge over the last few years was availability of imported equipment due to disrupted supply chains during the covid-19 pandemic. But the situation has vastly improved due to a policy push to promote domestic equipment manufacturing. "We are proud to share that our solar project in Rajasthan of about 1,300-megawatt peak capacity is commissioned using modules manufactured at our own facility in Jaipur, Rajasthan, which is an industry milestone," he said.

SUNNY SIDE DOWN

A drawback of solar is its intermittency. Solar power cannot be produced after sunset, even though power

demand often peaks during evening hours. This means electricity providers have to arrange for back-up power from other sources, be it thermal or hydro. Even during the day, solar generation can fluctuate due to cloud cover or varying levels of sunshine. This intermittency can disrupt the stability of the grid—a complex network of power plants and transmission lines which matches demand with supply.

A possible solution lies in storing solar power generated during the day in batteries for use later but this raises the cost of power. For discoms in financial distress, solar can turn out to be difficult-to-manage proposition—one where they have to pay for backup power and fixed charges imposed by thermal power plants even when they are not drawing power.

Another flipside of solar is that capacity utilization, or plant load factor (PLF), usually hovers between 20-25%, leading to lower average power output (again because solar panels do not produce power during night time). In comparison, thermal power plants operate at a PLF of 60-80%. This means, larger capacities need to be set up for solar to increase its share in generation. Of course, intermittency and low PLF are not glitches; they are intrinsic to solar.

RACE TO THE BOTTOM?

After reverse auctions were introduced in 2016 into the renewable energy sector, the quoted tariffs went aggressively low (with solar tariffs tumbling down to as low as ₹2.4 per unit), without considering whether it is feasible to put projects on ground at those prices, said a senior executive of a renewable energy firm who spoke on condition of anonymity. In reverse auctions, sellers (project developers) compete with each other by offering the lowest price to deliver power.

The person added that while auctions are centralized (tenders floated by central agencies like SECI), power is purchased by state-owned discoms who are often reluctant. Further, projects have to come up in land owned by states. These are points of friction.

In addition, power evacuation systems are not in place. The timeline to develop transmission lines was aligned to the thermal era when it took 4-5 years to build the infra. It takes between 2-3 years now.

"While my solar projects would take just a year and a half to start generation, transmission lines take much longer. We have done wonders when it comes to energy transition, but somewhere in this journey we forgot that the backbone (of power supply) still remains conventional

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WHAT

Solar electricity is now cheaper compared to polluting sources of energy. It costs discoms ₹2.5-4.8 to buy a unit of renewable power, comparable or less than the cost of thermal power.

BUT

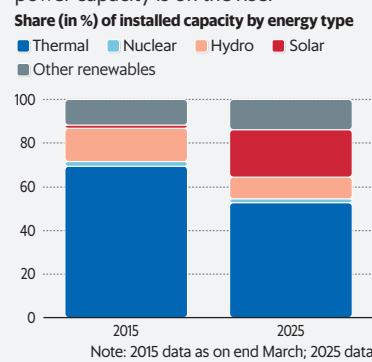
India is making more electricity from solar than a decade ago but the share of solar in overall power generation is still less than 10%. Many discoms are reluctant to purchase RE power.

WHY

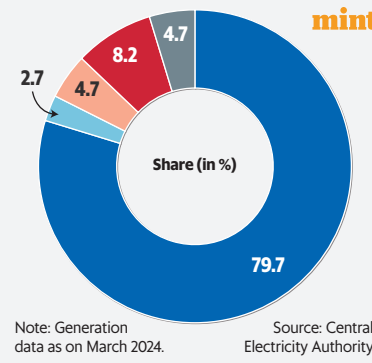
Multiple gaps exist. They include inadequate transmission infrastructure—renewable power generated in one state has to be transported to another—and projects failing to take off.

POWER TALES

The share of solar in India's installed power capacity is on the rise.



Solar's share in generation is still low



SATISH KUMAR/MINT

cially unviable, like in some state-level battery energy storage system tenders," said Vineet Mittal, chairman of Avaada Group, a renewable energy project developer and manufacturer of solar modules.

A 300-megawatt solar project needs over 900 acres. Acquiring such a large, contiguous land parcel, especially near

grid substations, is a significant hurdle, said Sumant Sinha of ReNew, quoted earlier.

"Land procurement is increasingly becoming a challenge due to the sector's rapid growth and the concentration in specific regions (like Gujarat and Rajasthan). Greater transparency and ease in the allocation of state and central government-controlled land would immensely benefit the sector," he added.

JUST TRANSITION

A reason why state discoms are reluctant to purchase renewable power is volatile and falling tariffs. They don't want to lock themselves into 25-year-long agreements when tariffs may fall due to low-cost energy storage technologies in future. Furthermore, domestically manu-

factured solar modules currently cost more than double the price in global markets, and prices may fall in future leading to lower tariffs.

Currently, companies generating power under government projects have to use domestically manufactured modules as per a mandate to promote local production and reduce dependence on China.

"The centre needs to work closely with states to ensure that RE tenders are aligned to their requirements. Also, it is time to rethink the waiver of transmission charges as these costs are often socialised (with the end consumer footing the bill). This will lead to a balanced development of new projects in states where RE generation is lagging," said Alok Kumar, a former power secretary.

Currently, green energy projects commissioned before end-June 2025 are exempted from paying inter-state transmission charges.

To resolve the current backlog of projects, both centre and state governments have to step up investments to modernize the grid infrastructure, said Nidhi Bali, director of energy and urban transition at iForest, a climate think tank.

"States will need to set ambitious renewable energy targets, particularly those in the eastern region which are coal-dependent and lags behind in RE generation. This is crucial for a just and equitable transition. The good thing is, states like Odisha and Assam are setting the right goals," she added.

A just transition ensures that communities which are dependent on polluting sources of energy to make a living do not lose out with greater adoption of clean energy.

Another cog in the wheel is to prioritize decentralized solutions, Bali said. If electricity can be produced by households adopting rooftop solar, it will reduce the need to transport power over long distances.

In February last year, the centre approved a ₹75,000 crore PM-Surya Ghar free electricity scheme targeting 10 million families with a subsidy of up to ₹78,000 per family. As the scheme picks up pace—so far, a million families have benefited—rooftop solar holds the promise to improve clean energy penetration and ease the load on overworked grids.

Despite the rough edges, India's journey in renewables offers hope that it can meet the ever-growing demand for energy without adding to carbon emissions, further polluting its air and worsening the climate crisis.



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