Beyond Tripling: India needs $101bn additional financing for the net-zero pathway

In the next 8 years, $293 billion will be needed to meet the NEP14 target while meeting the IEA Net-Zero Emission (NZE) Pathway would require $394 billion.

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About

This report is divided into two chapters. Chapter 1 compares India’s solar and wind targets set out in the 14th National Electricity Plan (NEP14) with the International Energy Agency (IEA) Net-Zero Emissions (NZE) pathway. The comparative analysis delves into the contribution of solar and wind in terms of generation, examining the requisite capacity for solar and wind to achieve the targeted generation levels.
Chapter 2 explores the necessary capacity in investment and financing required for India to deliver on the 14th National Electricity Plan (NEP14) and to even consider increasing its solar and wind ambition to align with a global target.

Highlights

+$101bn

Investment India needs to align with IEA NZE target as compared to NEP14 pathway

+35%

Annual solar generation required on top of India’s existing targets by 2030 to align with IEA NZE target

5X

Increase in total solar and wind annual capacity addition by 2027 to align with IEA NZE target

Executive Summary

India needs $101bn additional financing to meet IEA net-zero pathway

The COP28 Presidency is actively pursuing a commitment to triple total global renewables capacity by 2030. This is a crucial step towards limiting global warming to 1.5 °C.

With India managing to secure a G20 commitment in September 2023 supporting this initiative, there is growing anticipation of a global commitment at COP28. However, the specific actions each country, including India, must take to achieve this target is yet to be determined. Insights from the International Energy Agency's (IEA) Net Zero Roadmap report, published in October 2023, presents one pathway i.e., Net-Zero Emissions (NZE) pathway, which suggests that for India to contribute to the tripling target, around 32% of its electricity generation should come from solar and 10% from wind by 2030.

This analysis examines what this would mean for India in terms of the additional capacity additions and the investment needs compared to the targets published in the 14th National Electricity Plan (NEP14). Given the investment and financing risks associated with Renewable Energy (RE) investments in India, mobilising the required finances to achieve the NEP14 targets or to increase solar and wind targets could pose a significant challenge.

01 India needs 35% more solar and 8% more wind generation on top of the NEP14 targets to meet IEA NZE

If India achieves its renewables targets set in NEP14, its solar generation

will reach 602 TWh by 2030, from 102 TWh in FY 2023 while wind generation will grow to 237 TWh from 72 TWh. If India's electricity demand grows at the same rate as projected in NEP14, meeting the IEA NZE solar and wind share targets would mean India's solar and wind generation needs to reach to around 819 TWh and 259 TWh respectively by 2030.

02 Meeting IEA NZE targets will require India to push its combined wind and solar capacity to 571 GW by 2030

The NEP14 targets will take India's solar capacity to 332 GW and wind capacity to 113 GW by 2030. The country will need to add 115 GW more solar and 9 GW more wind capacity on top of this by 2030 to achieve the IEA NZE solar and wind generation share targets for India. This would also need an additional 14 GW/84GWh of storage and 47 GW of transmission capacity above India's existing plan for storage and transmission by 2030.

03 India's annual solar & wind additions would need about five-folds rise by 2027 to align with IEA NZE pathway

India added 12.8 GW of solar and 2.28 GW of wind in 2022. To achieve its NEP14 targets, India needs to increase these annual additions to 41 GW of solar and 11.8 GW of wind by 2027. However, achieving the IEA NZE wind and solar share targets for India would need its annual solar and wind additions to touch 64 GW and 13.6GW respectively by 2027.

04 India will need $101 bn in additional financing to achieve IEA NZE wind and solar share targets

Between 2023 and 2030, an investment of $293 billion (bn) would be necessary for India to meet the NEP14 solar and wind capacity targets including the storage and transmission. To move to the IEA NZE pathway, an additional investment of about $68 bn towards solar, $8 bn towards wind, $14 bn towards storage and $11 bn towards transmission capacity additions.

Despite investment risks, India needs financing to build capacity in renewables, storage and transmission to even meet the NEP14 targets. To further step up ambitions to match a global net-zero pathway, securing significantly more financing at competitive rates will be vital to ensure the viability for India to reach the goal. Access to this finance is critical for India to avoid building new coal capacity to meet its growing demand in this decade.

Neshwin Rodrigues
India Electricity Policy analyst, Ember

Unpacking “tripling renewables” for India

IEA Net Zero pathway requires India to set more ambitious solar targets

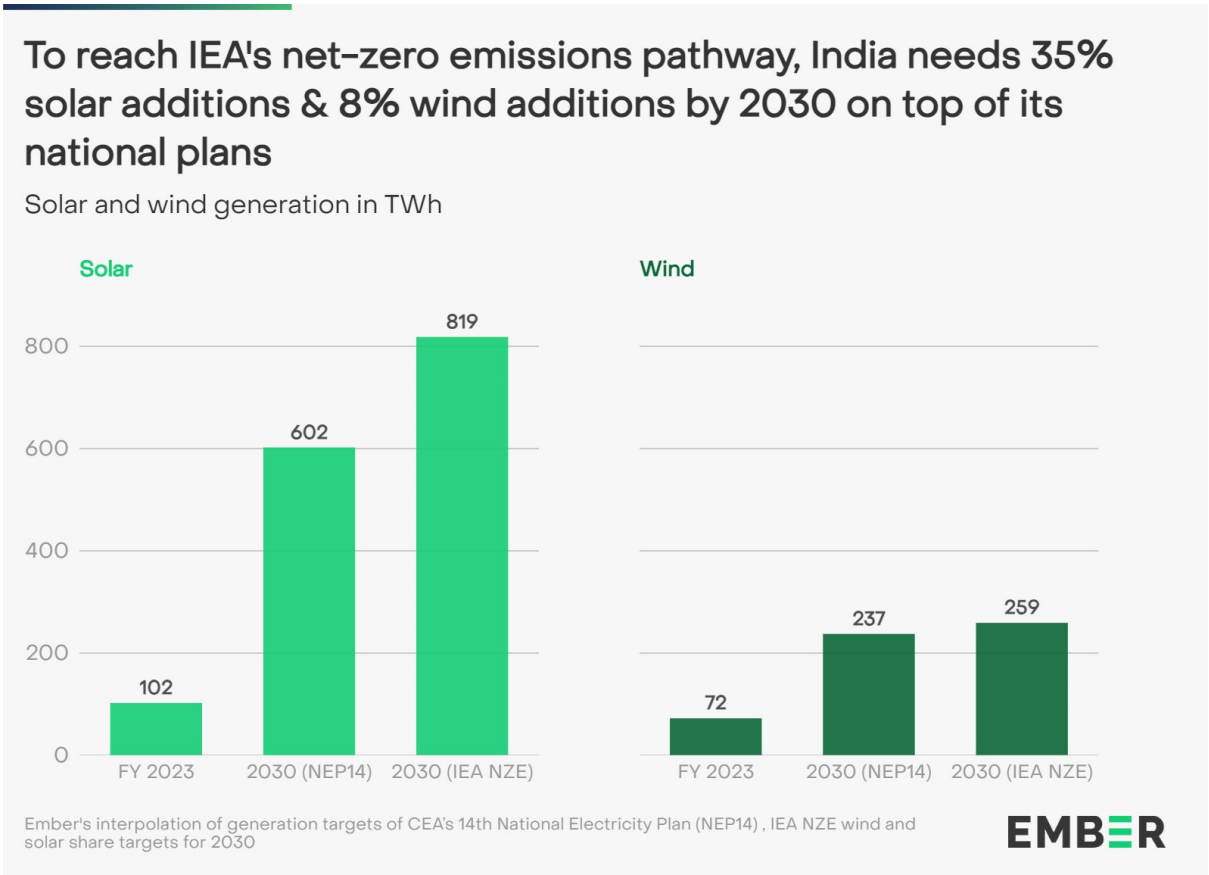
The COP28 Presidency is actively pursuing a global commitment to triple total global renewables capacity by 2030 (referred to as ‘the tripling target’ from here on. This is widely being regarded as the single biggest action at the policymakers' disposal in 2023 to help move the world towards a *1.5 degree*-aligned pathway.

With India securing a G20 commitment in September 2023 to “pursue and encourage efforts to triple renewable energy capacity globally through existing targets and policies,” there is an increasing anticipation to secure a global commitment at COP 28. However, what is still unclear is what each country including India would have to do to meet this global target.

One study which provides some insights into what India's contribution to the tripling target would need to be is the International Energy Agency’s (IEA) Net Zero Roadmap report published in October 2023. In its Net Zero Emissions (NZE) scenario, it laid out a key milestone for the electricity sector to triple the global renewables capacity, leading to a 60% share of renewables in global electricity generation by 2030.

While different renewable sources are important for different countries depending on resource availability and national circumstances, what is clear is that the solar and wind generation growth is central to the IEA NZE pathway. It requires a 40% share in total global electricity generation from combined wind and solar sources by 2030, while in India around 32% of generation would need to come from solar and 10% from wind.

In India, solar generated about 6% (102 TWh) of the country’s electricity in FY 2023, while wind constituted about 4% (72 TWh). If we interpolate the projections set out in India’s 14th National Electricity Plan (NEP14), the country’s solar and wind share in total electricity generation in FY 2030-31 would be 24% and 9% respectively.

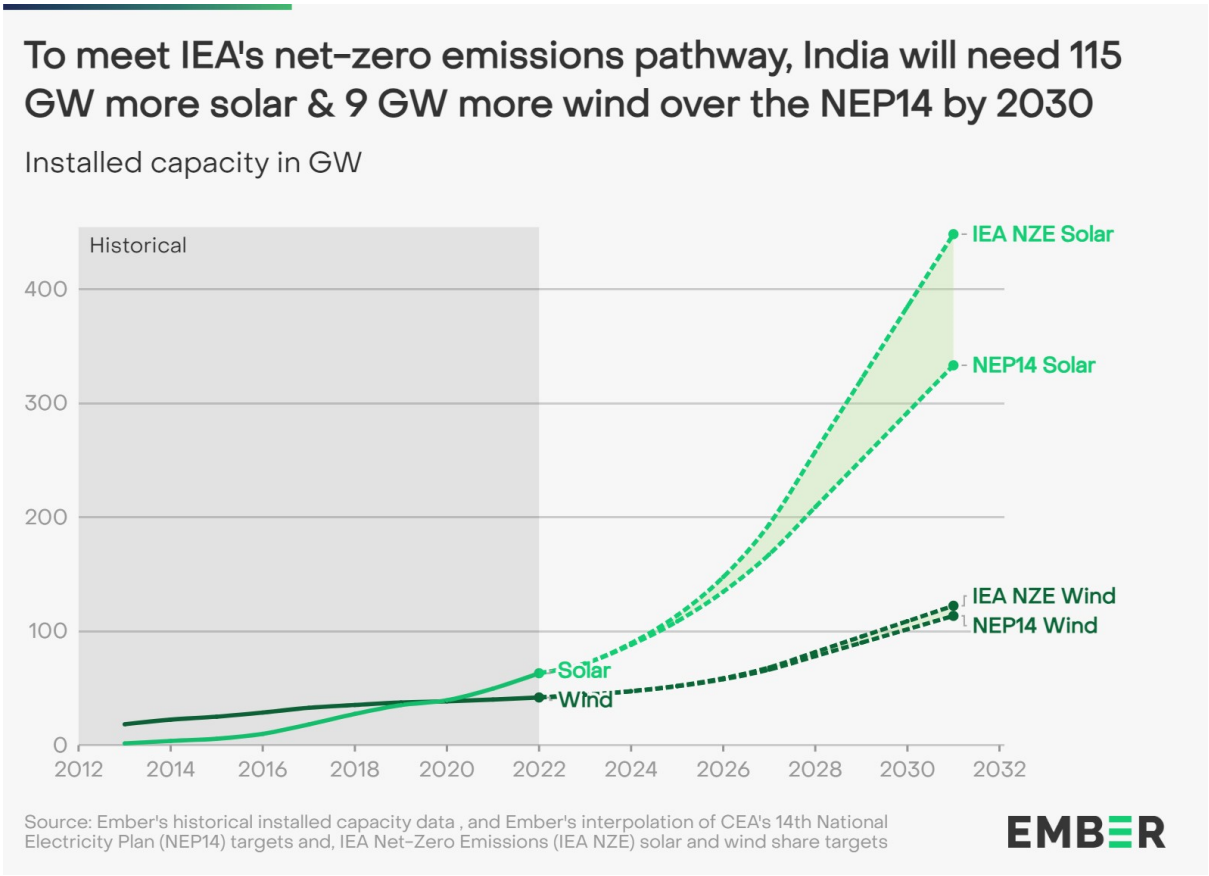


While India's existing targets are ambitious, given the annual capacity addition and financing required, aligning with the updated International Energy Agency Net Zero Emissions (IEA NZE) pathway necessitates an increase in these targets.

Specifically, India's solar generation would need to be about 819 TWh and wind generation 259 TWh by 2030 (assuming India's demand grows as per the recent 20th Electrical Power Survey of India). This means India would need to achieve 35% more generation from solar and 8% more generation from wind above the NEP14 interpolated projections for FY 2030-31.

To increase the contribution of solar generation in the overall energy mix as per NEP 14, India needs to increase solar capacity from 72 GW (as of October 2023) to around 332 GW by 2030-31. Simultaneously, wind capacity should rise from 44 GW to about 113 GW during the same period.

However, to align with the IEA NZE pathway, India must achieve around 32% of generation from solar and 10% from wind. If we assume capacity factors of 21% for solar power plants and 24% for wind power plants, this would necessitate a significant increase in solar capacity target to 448 GW and a relatively small increase in the wind capacity target to 122 GW by 2030.

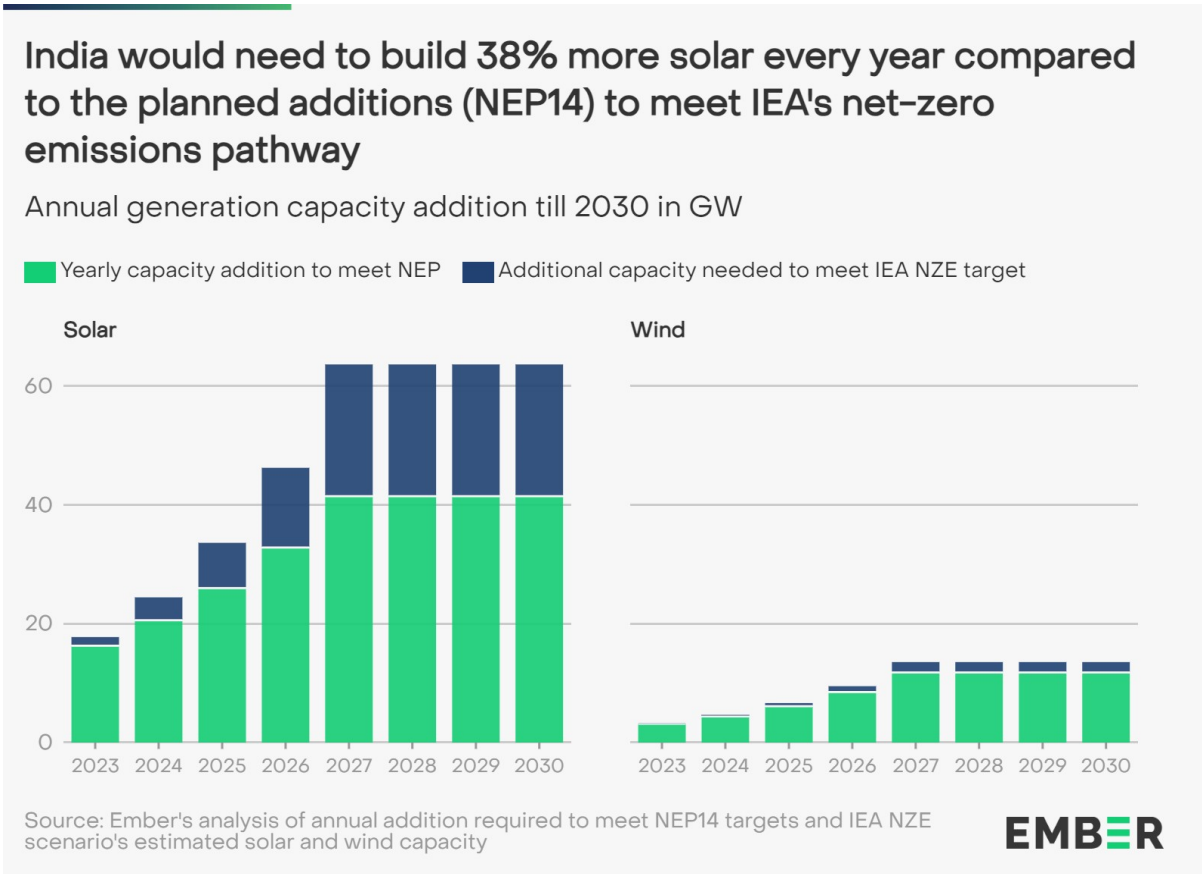


To achieve even the NEP14 target, India has to substantially increase the year on year addition of solar and wind.

The existing annual additions of solar and wind capacity need to be ramped up substantially to meet the targets set out in NEP14 for FY 2027 and FY 2032.

To meet even the NEP14 targets for solar, India needs to increase its annual solar capacity additions by 26% and annual wind capacity additions by 39% every year till FY 2028. For solar, this means going from an addition of 12.8 GW in FY 2023 to around 16.3 GW in FY 2024, and continuing this upward trajectory to touch 41.5 GW/ year by FY 2028. India would then need to consistently add 41.5 GW of solar capacity each year after FY2028 to successfully achieve the NEP14 target for 2032.

To meet the wind target outlined in NEP14, the annual addition of wind capacity needs to Increase by approximately 39% each year till FY 2028. This entails increasing from an addition of 2.28 GW in 2023 to around 3.2 GW in the financial year 2024, and rising to around 12 GW/ year by FY 2028. To successfully achieve the NEP14 target for FY 2032, India would need to consistently add 12 GW of wind capacity each year thereon.



Although the call to [triple global renewable generation capacity] by 2030 does not mention India's expected contribution, the IEA Net Zero Roadmap report presents one pathway i.e., IEA NZE pathway, which suggests that for India to contribute to the tripling target, around 32% of its electricity generation should come from solar and 10% from wind by 2030.

IEA NZE pathway requires India to substantially increase its planned annual solar build-rates.

To achieve 448 GW solar and 122GW wind capacity by 2030 and meet the IEA NZE share targets, the annual solar additions needs to increase almost five-folds from 12.8 GW/ year in FY 2023 to 64 GW/year by FY 2028, while wind additions need to increase from 2.28 GW/year in FY 2023 to 13.6 GW/year by FY 2028. This means that the combined annual solar and wind additions need to increase almost five folds by FY 2028.

Enhancing capacity in transmission and storage is also crucial for meeting the NEP14 target, and further scaling up is necessary to reach the IEA NZE pathway target for India.

The build-up of transmission and storage is essential to balance variable renewable energy (VRE) generation from sources like solar and wind with demand, both temporally and spatially. As solar and wind generation increases, so does the cost of balancing, known as grid integration costs, adding approximately 0.5-0.6 Rs/kWh to the generation cost of solar and wind.

India aims to add 227 GW of Interstate Transmission System (ISTS) and 37 GW of Intra-State Transmission System (IRTS) to integrate RE, following NEP14 targets for FY 2030-31[1]. Additionally, plans include 18 GW of pumped storage and 42 GW (5-hour) of battery storage.

To meet the IEA NZE pathway target, India will have to further increase storage and transmission capacity, requiring an additional 48 GW of ISTS and at least an additional 14 GW (6-hour) of battery storage. The additional storage was estimated using an optimization model, constrained to achieve the percentage share targets for solar and wind as outlined in the IEA NZE pathway for India with the capacity for other technologies and other technical assumptions as per the NEP14 assumptions. The transmission capacity was increased on a pro-rata basis for the additional renewables, utilizing the existing plan as a foundation.

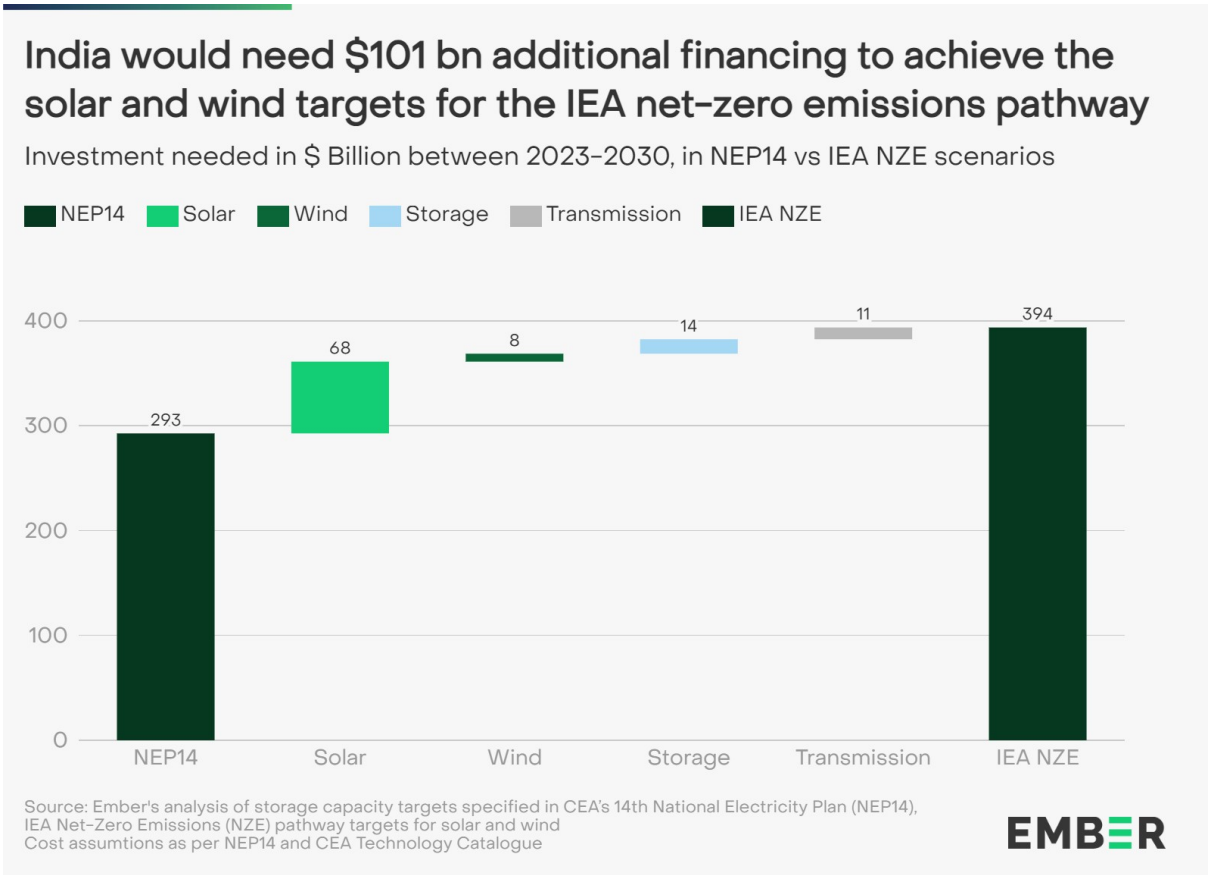
A significant year-on-year increase in capacity addition of storage would be required. India has installed around 4.7GW of pumped hydro storage and only around 37 MWh of BESS capacity as of FY 2023, which implies that battery storage capacity is far from the 210 GWh planned even as per the existing plans for FY 2030-31[2].The calculations for the same can be found here.

[1] Interpolated linearly from the FY 3032-32 target
[2] Interpolated linearly from the FY 3032-32 target

Investment requirement

India would need $101 bn additional financing to achieve IEA NZE solar and wind targets

India requires increased financing at competitive rates to set ambitious solar and wind targets aligned with the IEA NZE pathway, despite investment risks.



The financial requirements to achieve IEA NZE targets far exceed the current investment and funding capacities available today.

Our estimates indicate that India will require approximately $293 billion in investments till 2030 to achieve its solar and wind capacity targets set out in NEP14. This figure encompasses not only the development of solar and wind projects ($211 billion) but also accounts for the essential costs associated with storage and transmission required to integrate renewable energy at this expansive scale.

Now, if India were to build the required solar, wind, transmission and storage capacities to achieve the IEA NZE solar and wind share targets, this would push up the investment requirement by US $101 billion. This involves an extra investment of approximately $68 billion for solar, $8 billion for wind, $14 billion for storage, and $11 billion for transmission capacity additions. This brings the total investment in this scenario to around $394 billion. The calculations for the same can be found here.

Comparatively, the financial landscape for solar and wind in the preceding 8 years, commencing in 2021, witnessed an investment capacity of approximately $75 billion. To meet the upcoming demands, the financing capacity must increase nearly threefold on average during the next 7-8 years. This heightened level of financial commitment is imperative for facilitating essential capacity expansions in electricity generation, energy storage, and transmission infrastructure.

Renewable projects in India face investment risks, which may be a significant barrier to mobilise investment.

Despite the recent uptick in investments in solar and wind installations, individual renewable energy projects in India remain exposed to substantial risks; categorised into regulatory risks, project risks, and financing risks.

Some of these challenges include payment delays, renegotiation of Power Purchase Agreements (PPAs), and complexities related to land acquisition. Effectively addressing these risk factors and actively attracting investment, particularly from foreign sources despite these risks, is pivotal for ensuring the successful implementation of renewable energy projects.

Certain risks, such as payment delays and subsequent requests to renegotiate Power Purchase Agreements (PPAs), emerge from systemic challenges linked to prolonged cost recovery issues that demand extensive reforms over the span of decades to rectify. While

many Solar Energy Corporation of India Limited(SECI) projects incorporate a payment security mechanism, establishing this safeguard requires additional capital, often not factored into the overall investment estimate.

Despite persistent efforts to minimise investment risks, the reality is that investments are still imperative even in the presence of these challenges. Therefore, it is essential to explore and implement efficient mechanisms to effectively reduce or manage these risks, ensuring the resilience and success of renewable energy projects.

India will need to have access to substantially more financing capacity and at a competitive rate of financing, in a time bound manner to set solar and wind targets that are in line with the IEA NZE pathway.

India will need an additional $101 billion in financing to achieve the International Energy Agency's (IEA) Net-Zero Emissions (NZE) solar and wind targets. This financial requirement encompasses the supplementary costs associated with storage and transmission essential for integrating renewable energy at a more ambitious level.

It is imperative that this financing is secured at competitive rates to ensure the economic viability of the ambitious targets. NEP14 aligns with an optimal capacity generation mix, indicating that the plan represents a least-cost pathway, considering the economic aspects of each technology, including solar, wind, and various storage options. While pursuing goals beyond the NEP14 targets, it's crucial to recognize that deviating from this plan may not necessarily be the least-cost option. Therefore, to maintain the overall cost of generation in line with the least-cost pathway, the availability of financing at favourable rates becomes a critical factor.

Another thing to note here is that the estimates in this analysis do not include the costs of early decommissioning of coal power plants in India, a particularly pertinent consideration in a scenario where the anticipated increase in renewable energy is expected to displace generation from coal.

In this context, having additional coal capacity beyond what is strictly necessary to meet peak power requirements could result in a lock-in situation. This lock-in has the potential to diminish the cost-effectiveness of expanding renewable energy beyond the initially planned targets.To mitigate this risk and avoid unnecessary lock-ins, it becomes crucial to secure financing well in advance.

Overall, while India's existing national targets will triple its renewable capacity by 2030, aligning with the IEA NZE tripling pathway will require building additional solar, wind, storage and transmission capacities just on the supply side. It might well be that India will need international financing to increase the ambition to levels necessary to meet the IEA NZE pathway.

In the meantime, India cannot really afford to slip on the NEP14 targets for renewables, especially solar and wind to stay as close as possible to aligning with the global goal of tripling renewables by 2030.

Supporting Materials

Methodology

The analysis for the year 2030 is conducted based on the International Energy Agency's (IEA) Net-Zero Emissions (NZE) pathway's solar and wind generation targets. These targets are assumed while aligning the total generation with the National Energy Policy of 2014 (NEP14) projections.

The comparison is made against the NEP14 projections for technology-wise generation share for the financial year 2030-31. The generation share and capacity number for the financial year 2030-31 are estimated through linear interpolation between existing values of generation share (for FY2023) and installed capacity (as of September 2023) and the projected values per the NEP14 projection for FY 2031-32. Ember's 2030 Global Renewable Target Tracker estimates for the NEP14 target assume a compounded growth rate, leading to a target of 319 GW of solar and 110 GW of wind by 2030.

The generation capacity estimates are derived from the percentage share targets for solar and wind as outlined in the IEA NZE pathway for India. These estimates assume the total generation projection and solar and wind capacity utilization factor (CUF) as per the NEP14. The annual capacity addition required for each of the two cases, NEP14 and IEA Net-Zero Emissions (NZE), is calculated by taking into account the current fiscal year (FY 2023) annual capacity addition. The analysis incorporates a growth rate in the annual addition until 2027. Beyond 2027, it is assumed that the annual capacity addition saturates to prevent exceeding the necessary capacity additions required to meet future targets.

This approach helps balance the need for continued growth in capacity addition to align with evolving energy targets and demand projections until 2027. However, by assuming saturation beyond this point, the analysis recognizes a strategic shift or stabilization in capacity addition to avoid overcommitting resources to annual installation capacity that may exceed future requirements.

To estimate the investment required in the NEP14 scenario, we assume the capacities for each technology, including storage, in accordance with the NEP14 interpolated targets for the fiscal year 2030-31. Additionally, we incorporate the Central Electricity Authority's (CEA)

plan for the Transmission System, designed to accommodate the integration of 500 GW of Renewable Energy (RE) capacity by 2030.

In the context of the IEA Net-Zero Emissions (NZE) scenario, the methodology for estimating generation capacity is grounded in the percentage share targets for solar and wind outlined in the IEA NZE pathway for India, as previously mentioned. The calculation of storage capacity involves the use of an optimization model, constrained to achieve the percentage share targets for solar and wind as outlined in the IEA NZE pathway for India with the capacity for other technologies and other technical assumptions as per the NEP14 assumptions.

The estimation of transmission capacity is conducted on a pro-rata basis, utilizing the existing plan as a foundation. This pro-rata calculation specifically addresses the additional transmission capacity necessary to integrate the increased solar and wind capacity required to achieve the percentage share targets outlined in the International Energy Agency's Net-Zero Emissions (NZE) pathway for India. The capital cost assumptions to estimate the financing/investment required is as per the capital cost assumptions in the NEP14 and CEA's Indian Technology Catalogue for generation and storage.

The detailed calculations can be found here.

Acknowledgements

Contributors

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Cover image

Workers at a 1 MW solar power station run by Tata power on the roof of an electricity company in Delhi, India.

Credit: Ashley Cooper pics / Alamy Stock Photo