VASUDHA FOUNDATION
Green ways for a good earth!

INDIA ENERGY TRANSITION STORY

JANUARY 2026

RISK IMPLICATION

SYSTEM IMPLICATION

COST & MARKET IMPLICATION

POLICY IMPLICATION

About the Series

The India Power Outlook Series by Vasudha Foundation is an ongoing endeavour to chronicle and analyse the evolving dynamics of India's power and energy sector. Through its editions, the series has sought to foster informed dialogues among policymakers, researchers, industry experts, and civil society on key transitions shaping India's clean energy future.

Over the years, the series has evolved into a credible knowledge product for data-driven insights and contextual understanding of India's energy transformation. From its early focus on capacity expansion and policy frameworks to today's multidimensional exploration of risk, cost, and system integration, the series offers a panoramic view of the nation's clean energy narrative.

India's Power Outlook | Volume 11 | January 2026

The eleventh edition — India's Energy Transition Story — marks a milestone in the Power Outlook Series. It goes beyond conventional reporting to weave a holistic picture of India's transition toward a sustainable and inclusive energy future.

This edition captures how India has turned its clean energy ambitions into action achieving its non-fossil fuel capacity targets five years ahead of schedule. It showcases how states, industries, and citizens are collectively shaping the nation's energy story through innovation, policy reform, and behavioural change.

Readers will find this edition especially engaging because it blends rigorous analysis with visual storytelling, turning complex data into accessible narratives. Above all, India's Energy Transition Story offers a compelling reflection on the human and institutional effort behind the numbers, a story of resilience, inclusivity, collaboration, and forward-thinking leadership as India steps confidently into a clean energy future.

Disclaimer

The analyses, projections, and interpretations presented in this publication are based on publicly available information, independent research, and secondary data sources deemed reliable at the time of compilation. However, Vasudha Foundation makes no representations or warranties regarding the accuracy, completeness, or suitability of the information for any specific purpose.

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01

Introduction

01 Introduction

The world stands at the cusp of an unprecedented transformation. The energy transition is not a choice but a necessity, and its scale is daunting. The transition is shaped by hard physical realities — from the need to build vast amounts of infrastructure in compressed timelines, to securing critical minerals, managing land and water constraints, ensuring affordability, and safeguarding reliability. At the same time, there is a need to build institutional capacities, develop skillsets, conduct consumer awareness and sensitisation and align with local aspirations and livelihoods to ensure that the transition is just and orderly.

For India, this challenge is magnified by the sheer size of its economy, the pace of growth, and the diversity of its energy consumers. Yet, it also presents an unparalleled opportunity — to leapfrog legacy systems, drive green growth, create millions of jobs, and position India as a global leader in clean energy innovation. India has already achieved remarkable progress: it met its Nationally Determined Contribution (NDC) target of 50% non-fossil fuel–based capacity five years ahead of schedule[1], and today it is among the fastest-growing renewable energy markets in the world.

But the transition cannot be seen through a single lens. It is multi-dimensional. Beyond technology and capacity additions, it requires navigating complex questions around:

- **Policy implications:** aligning regulations, incentives, and international cooperation to accelerate the shift while ensuring inclusivity and resilience.
- **Cost and market implications:** affordability for households and Micro, Small and Medium

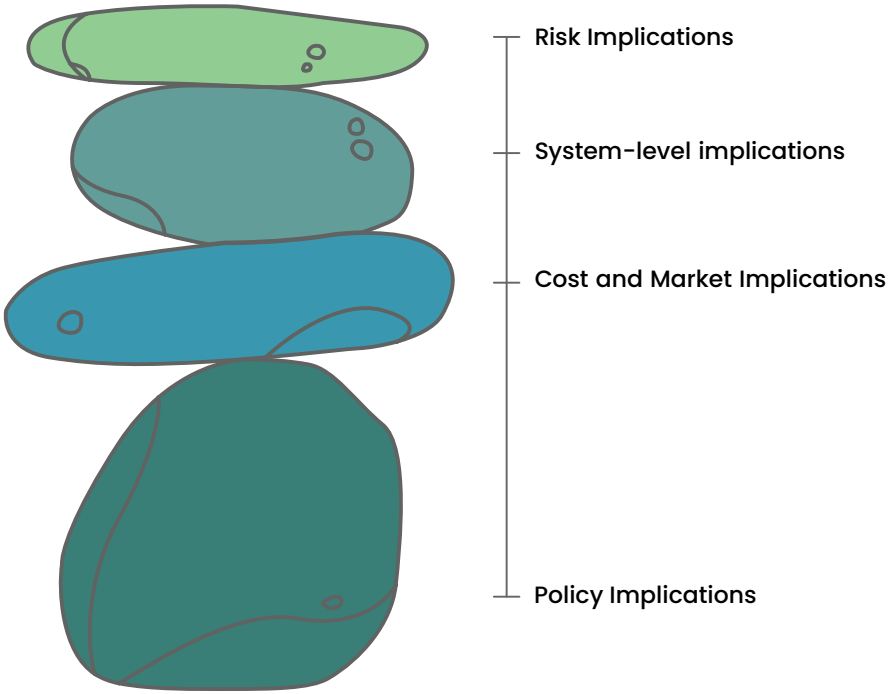


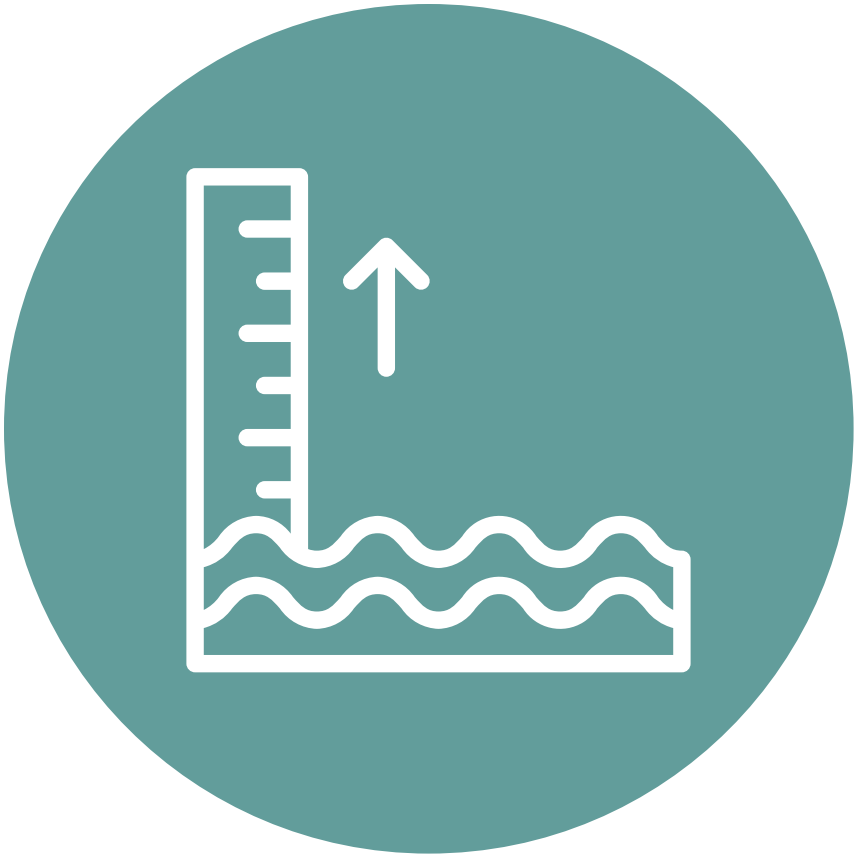
Figure 1: Navigating the complexities of energy transition

Enterprises (MSMEs), tariff structures, and evolving electrification economics.

- **System-level implications**: How a rapidly changing power mix affects stability, transmission, and storage needs.
- **Risk implications:** From safety concerns and climate-induced disasters to resource variability, workforce transformation and cybersecurity.

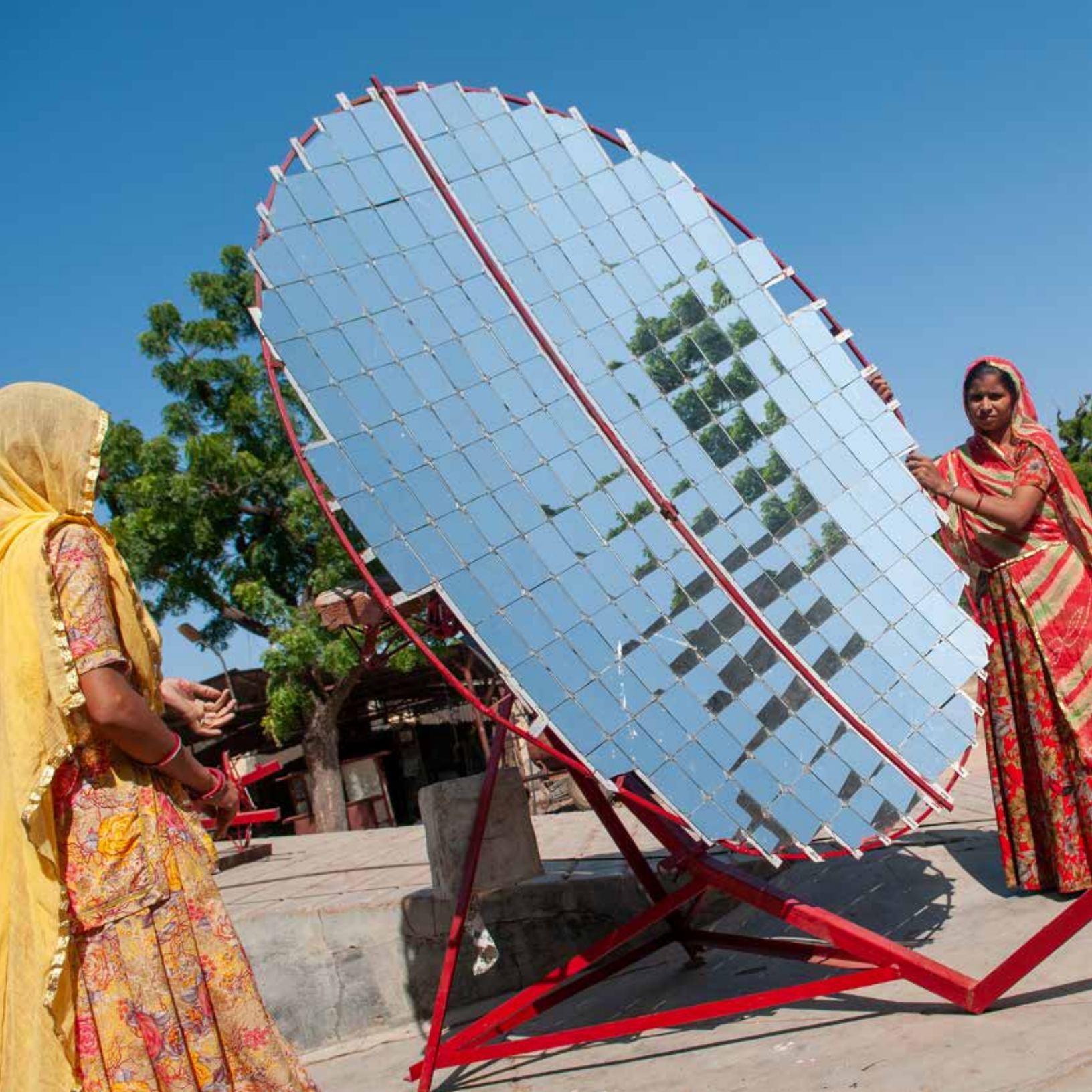
This report is structured to examine these dimensions in depth. More importantly, it seeks to go beyond the run-of-the-mill analysis that often dominate the conversation. By connecting India's transition to systemic risks, socio-economic impacts, and policy trade-offs, this volume aims to shed light on aspects that stakeholders have not fully reckoned with.

India's story is not only one of ambition but of pragmatism — a recognition that delivering on climate goals requires grappling with multiple realities simultaneously. This Volume is a step toward that candid conversation.



02

India’s Climate Progress in the Global Context



02 India's Climate Progress in the Global Context

India's climate journey stands out globally, with rapid strides in clean energy deployment and sectoral decarbonisation. This section tracks progress on COP28's ambitious goal to triple renewable energy capacity by 2030 and benchmarks India's progress against global peers, highlighting how emerging economies like India are advancing toward their 2030 clean energy targets, while several developed nations struggle to stay on course. It also underscores the importance of climate finance commitments from developed countries to accelerate global mitigation efforts.

1. Global Status: Tripling Renewable Energy Capacity as per COP28

- At COP28 in Dubai, the global community committed to one of the most ambitious clean energy goals in history: to triple the world's installed renewable energy capacity to at least 11,000 GW by 2030[2]. This declaration reflects the urgency of accelerating decarbonisation in line with limiting global warming to 1.5°C and marks a milestone in collective international climate action.
- By 2024, the world had reached ~4,770 GW of installed renewable capacity, up from ~4,030 GW in 2023 — an addition of about 740 GW in a single year. While this growth is significant, the pathway ahead is even more demanding. To reach the 2030 goal, the world must add at least 1,040 GW of renewable capacity every year, nearly 40% higher than the current pace.
- Achieving this target requires not only scaling up investments but also fostering unprecedented levels of international collaboration, particularly between developed and emerging economies.

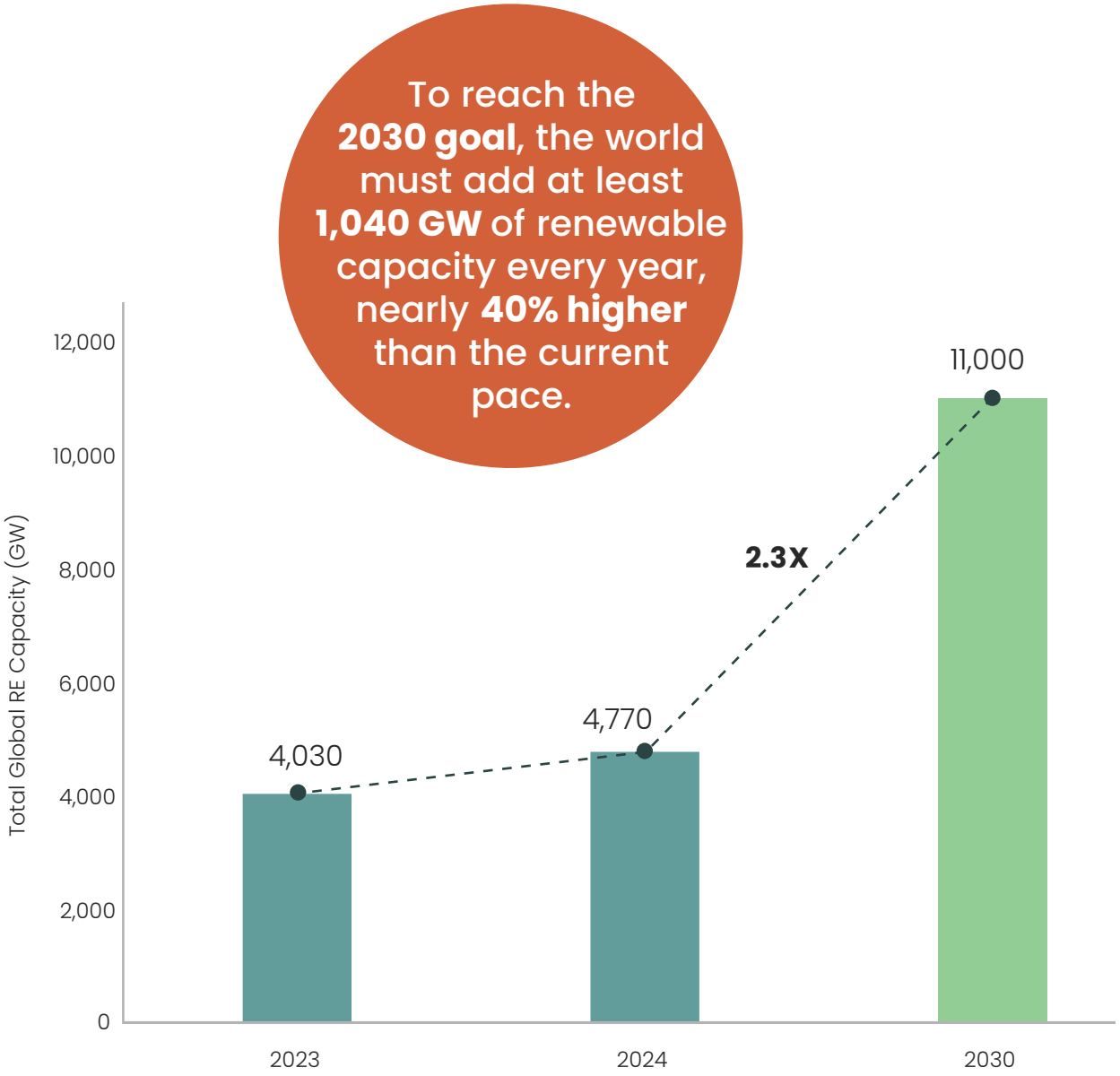


Figure 2: Global renewable energy capacity: current vs. 2030 target[3]

2. Renewable Capacity vs. Generation: Bridging the Gap

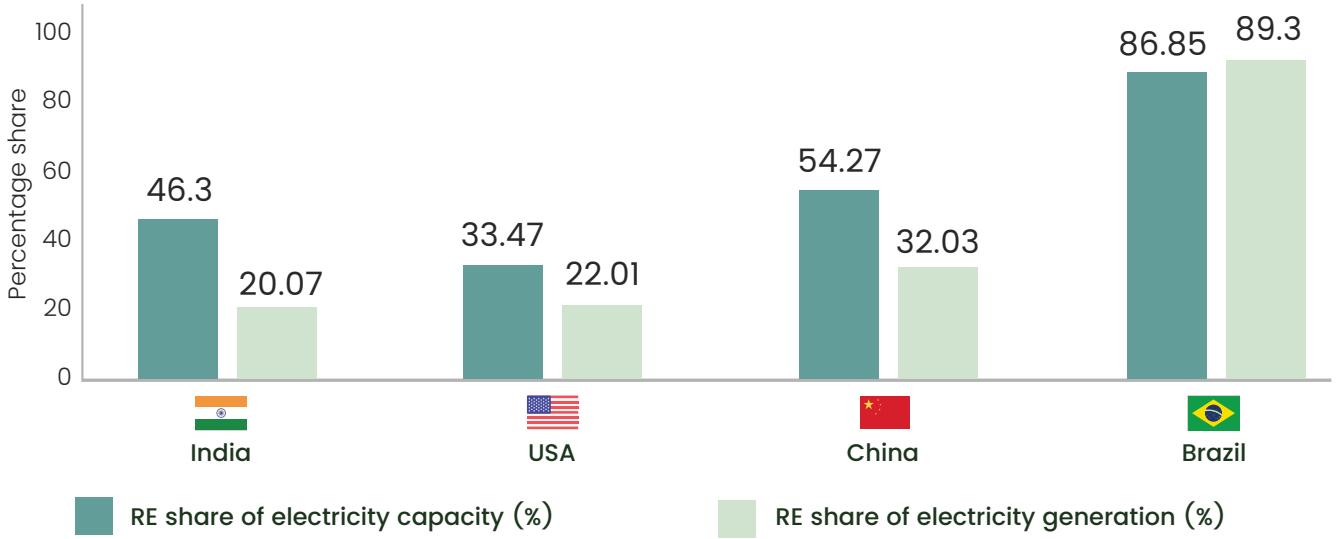


Figure 3: % RE capacity and % RE generation for a few countries (2024)[4]

- While countries have made remarkable progress in scaling up RE installations, there remains a critical distinction between installed capacity and actual generation. Renewable capacity additions often appear impressive on paper, but the contribution to total electricity generation is comparatively lower.
- This gap is primarily due to the Capacity Utilisation Factor (CUF) of renewables. For example, thermal power plants typically operate at CUFs of 60–80%, while solar and wind projects usually operate at 15–25% and 25–35%, respectively. This means that to generate the same amount of electricity as a 1 GW coal-based plant, India would require roughly 3–4 GW of solar capacity or 2–3 GW of wind capacity.

Electricity from 1 GW coal ~ electricity from 3–4 GW solar ~ 2–3 GW wind

- This reality underscores a vital point: scaling renewable capacity must far outpace the current trend. It is the displacement of fossil-fuel-based generation that drives real emission reductions.

03

Deep Dive: India’s Energy Transition Pathway

03 Deep Dive: India's Energy Transition Pathway

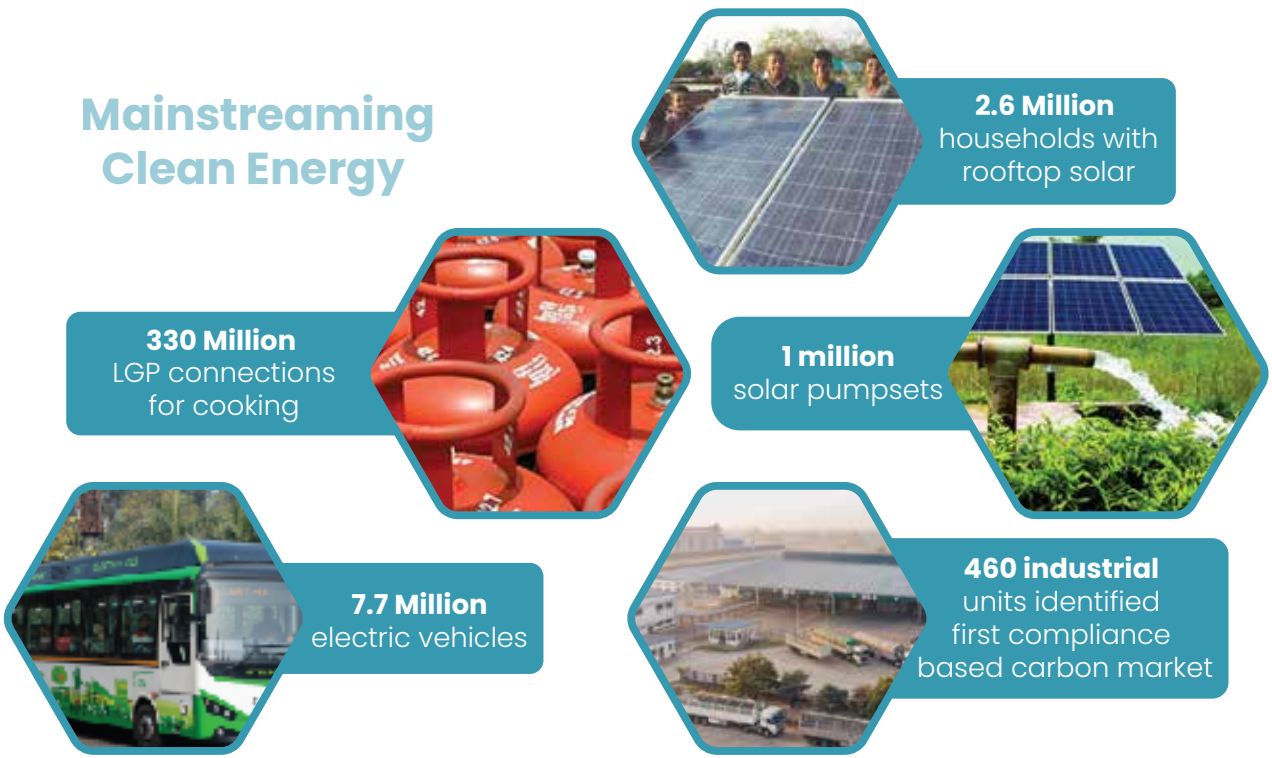
India's energy transition is central to its overall decarbonisation strategy, given that the energy sector accounts for over half of the country's total GHG emissions. In 2020, India's total GHG emissions were approximately 2,959 $MtCO_2e$ excluding Land Use, Land-Use Change, and Forestry (LULUCF), and about 2,437 $MtCO_2e$ when LULUCF is included.[5] The energy sector emerges as the largest contributor, followed by the agriculture and IPPU (Industrial Processes and Product Use) sector. Within energy, the dominant sources are electricity generation, industry, transport, and buildings, each with distinct pathways, opportunities, and challenges for deep decarbonisation.

Understanding the relative contribution of these sectors and their decarbonisation trajectories is critical to shaping India's long-term climate strategy. This strategy rests on three pillars. It requires making every citizen responsible for mainstreaming clean electricity through behavioural change and demand-side participation, advancing sector coupling to integrate energy systems across power, transport, industry, and buildings for a truly green economy, and empowering states to lead the transition through subnational policies and locally tailored solutions.

1. Making Every Citizen Responsible for Main-streaming Clean Energy

- **Clean Electricity:** PM Suryaghar: Muft Bijli Yojna (PMSGY) is advancing rooftop solar for residential households at an unprecedented pace with installations across 2.6 million homes[6] within just 22 months of its launch, towards its goal of 10 million households by March 2027.

- **Clean Cooking:** PM Ujjwala Scheme led to an exponential rise in the use of Liquid Petroleum Gas (LPG) for cleaner cooking, displacing firewood, increasing its share of residential consumption from 69% in 2013-14 to 99% in 2023-24[7]. This has led to 65% increase in LPG connections from 200 million connections in 2015-16 to 330 million connections in 2024-25.
- **Transport:** Notable shift to EVs with EV ownership in new vehicle sales rising from 0.1% in 2015-16 to ~8% in 2025-26 (up to December 25). In the last decade, India registered a total of 7.7 million EVs with 1.6 million added between April 2025 and December 2025[8].
- **Agriculture:** PM Kusum scheme installed/ solarised over 1 million solar pumpsets by April 2025. This has led to reducing the dependence on diesel in the agricultural sector.[9]
- **Industry:** India announced 'Greenhouse Gas Emission Intensity Target Rules, 2025' to reduce emission intensity across 460 industries by 2027 and a massive ₹10 billion (~USD 110 million) - ADEETIE[10] scheme to promote energy efficiency across Micro, Small and Medium Enterprises (MSME).



2. From a Greener Grid to a Greener Economy – Sector Coupling a New Way Forward

- India has achieved its non-fossil fuel capacity target five years ahead of schedule, marking a major milestone in its clean energy journey. Today, over 50% of the nation's installed power capacity comes from non-fossil sources, reflecting a significant shift toward a greener grid.

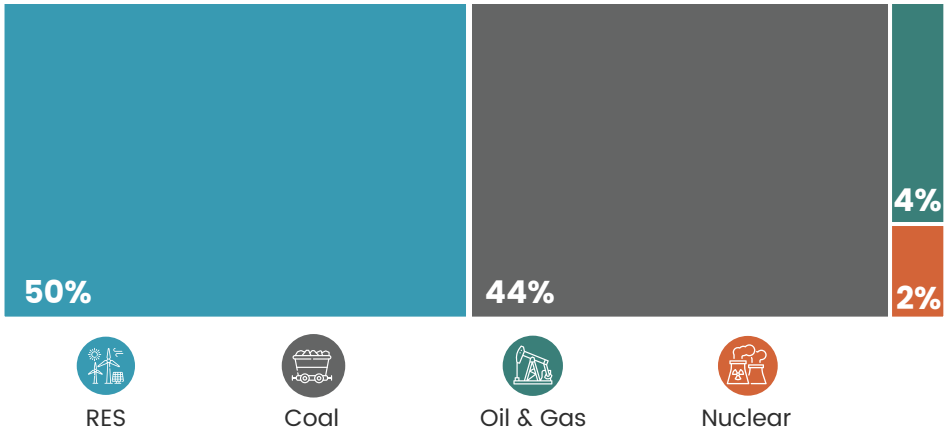


Figure 4: Installed Electricity Capacity Mix - 2025-26 (upto Dec'25)[11]

- India is at a watershed moment when it comes to energy transition. It is committed to not just greening its grid but actively pursuing sectoral coupling where it is integrating its increasingly renewable-powered grid with other sectors- agriculture, industry and transportation.

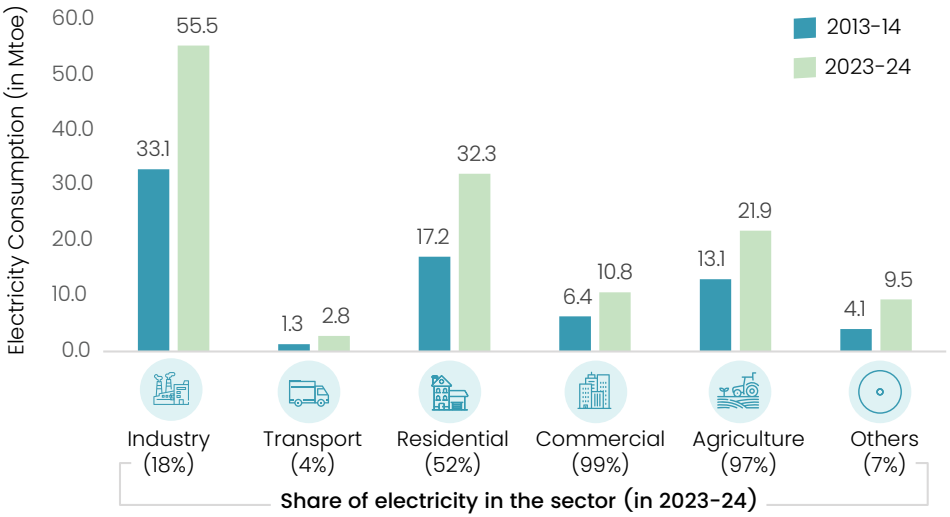


Figure 5: Share of electricity in total fuel consumption across sectors[12]

- During the 2014-2024 decade, India's total electricity consumption nearly doubled across demand sectors.
  - » Electricity use in industry rose at 68% while coal use in industry grew at 31% offering deep sector coupling opportunity.
  - » While electricity consumption in the transport sector has doubled over the decade, its share in the energy mix remains at 4%, as overall energy use has also doubled. Still, oil's dominance is gradually declining and gas is gaining ground, showing diversification of the sector's fuel mix. The sector presents a strong opportunity for sector coupling between electricity and transportation, with substantial potential for scaling up EVs.
  - » The irrigation pump electrification demonstrated a steady coupling with the power sector. However, diesel pumps continue to be present in some regions. Distributed solar pump sets mark the next paradigm change by integrating renewable electricity at the point of use. Further opportunities lie in electrifying farm machinery and processing equipment, deploying renewable-powered cold chains to reduce waste, converting agricultural residues into biogas and biomass energy, and more.

3. Industrial Energy Landscape and its Decarbonisation Imperative

- The industry sector is the largest consumer of both energy and electricity with a 49.5% and 42% share in the mix respectively in 2023-24. Over the last decade, the sector has shown a gradual shift towards cleaner fuels, with coal's share in total energy consumption declining from 70% in 2013–14 to 65% in 2023–24.
- While a lot of this can be attributed to large industries, studies suggest a large share of the global industrial emissions are derived from their respective supply chains.[13] Crucially, MSMEs not only drive economic growth, but they exert a substantial environmental footprint, consuming 20-25 percent of India's industrial energy consumption.[14] Given the size of the business segment that MSME holds and its emission intensity, it will be critical for them as well to decarbonise and propel towards a sustainable future.
- The sectors such as metals, chemicals, food and beverages, glass and ceramics, pulp & paper, rubber and plastics, textiles and apparel etc. are found to be highly energy-intensive among other industry clusters. Most of them remain heavily reliant on fossil fuels such as coal, oil and gas for industrial heat and steam generation across varied high and low temperature processes.

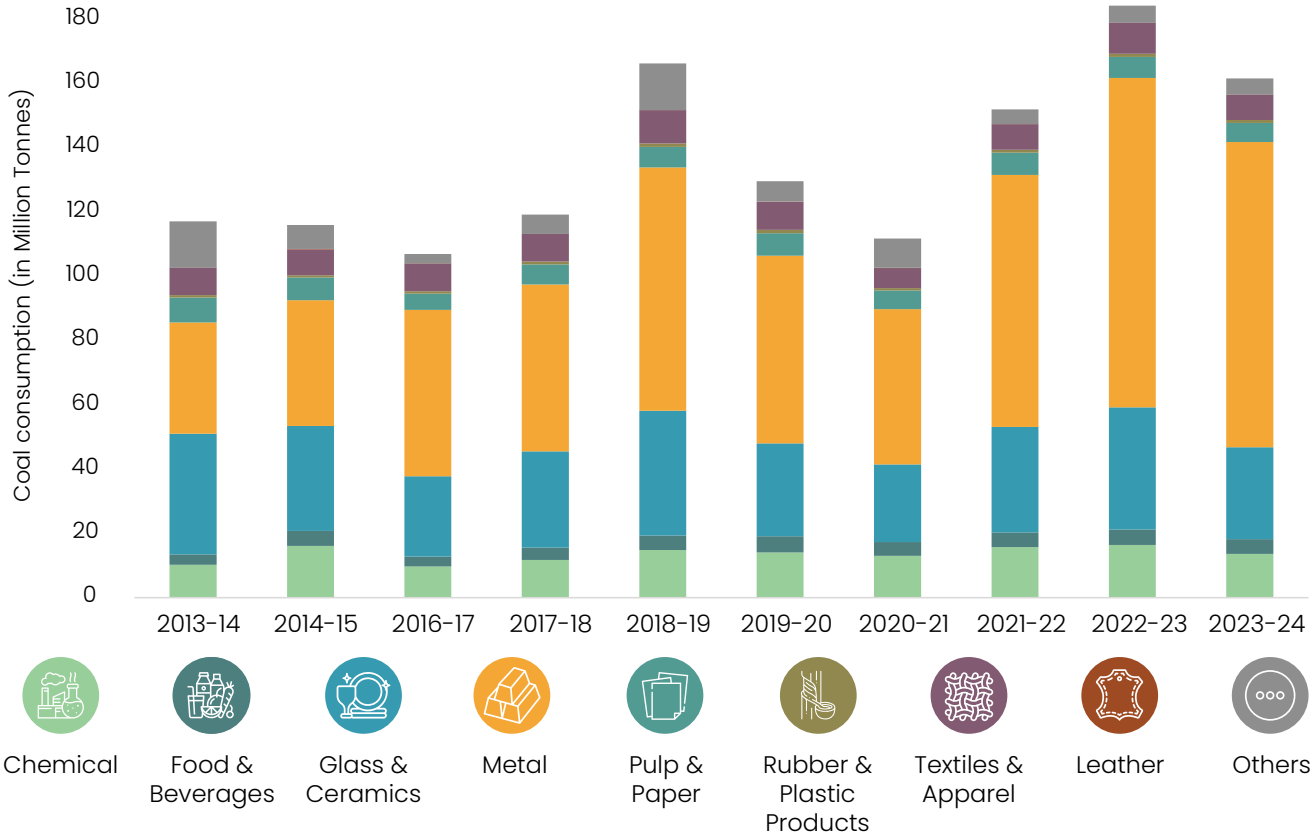


Figure 6: Decadal coal consumption trends across industries[15]

- Between 2013 and 2023, the coal consumption in industries increased by 38% primarily lead by the production of metals such as iron and steel and their products.
- Metals, followed by glass and ceramics industries together take up more than three-fourths of the total coal consumption required to meet their energy demands for processes like smelting, melting, and firing.

04

Policy and Regulatory Implications

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04 Policy and Regulatory Implications

India's energy transition is being driven by robust policy initiatives, progressive regulatory reforms, and ambitious targets set at both the national and state-levels. Over the last decade, the governments, at the central and state-levels, have introduced targeted schemes, fiscal incentives, and regulatory frameworks to accelerate clean energy adoption while also creating a conducive environment for private sector investment. These interventions are critical in reducing capital risks, catalysing domestic manufacturing, and ensuring India develops a resilient and self-reliant clean energy ecosystem. This section first highlights the diverse policy approaches across Indian states in advancing clean technologies, then turns to major national-level schemes and actions that anchor and accelerate the country's energy transition.

In India, almost all states have robust and clean energy policies. Many states are now announcing their own Net Zero targets. Flagship schemes like Saubhagya (universal household electrification), Ujwala (clean cooking fuel access) and now Suryaghar (scaling rooftop solar adoption) are actively delivering the transition at the grassroots level.

1. Renewable Energy Policy Landscape Across Indian States: A Snapshot

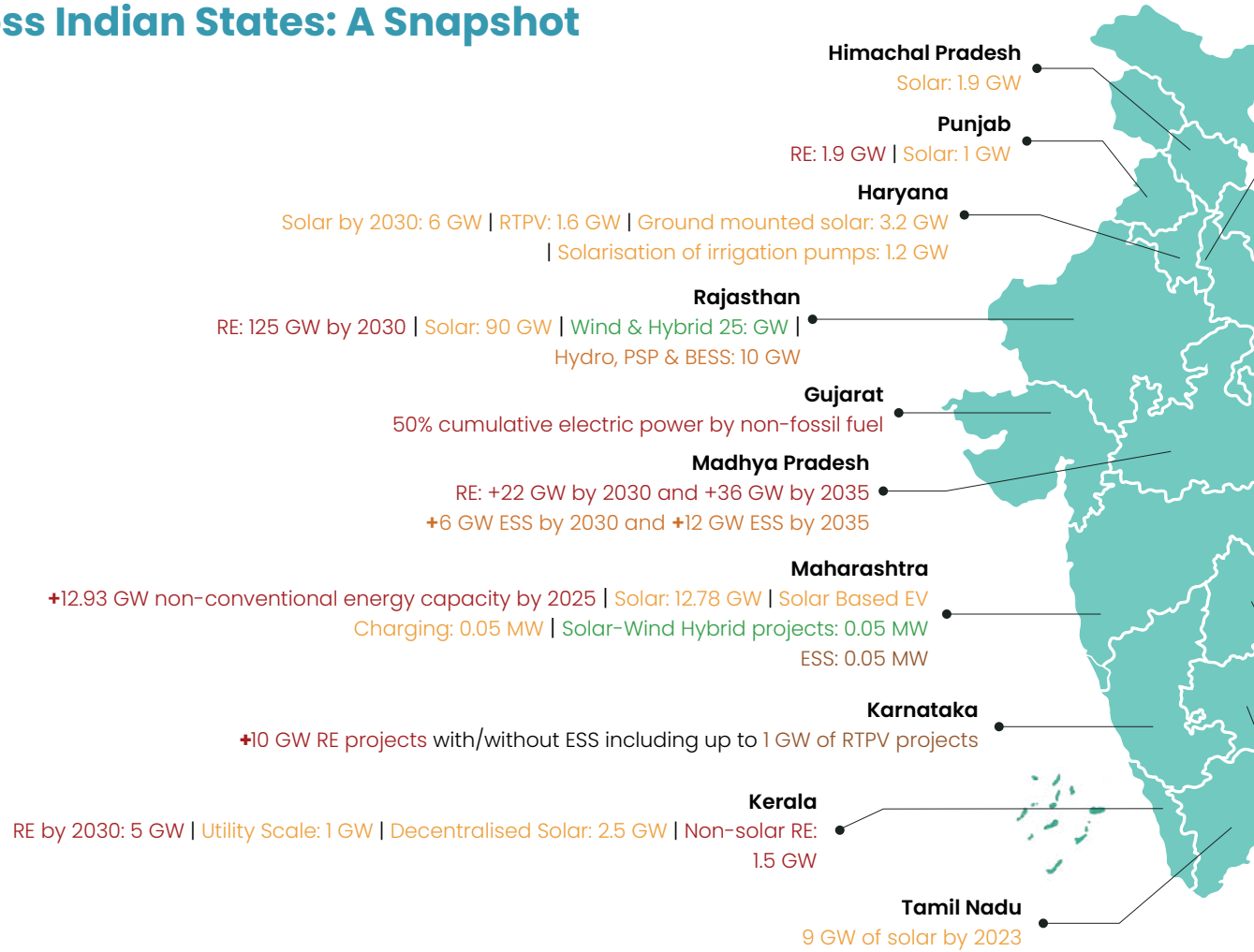
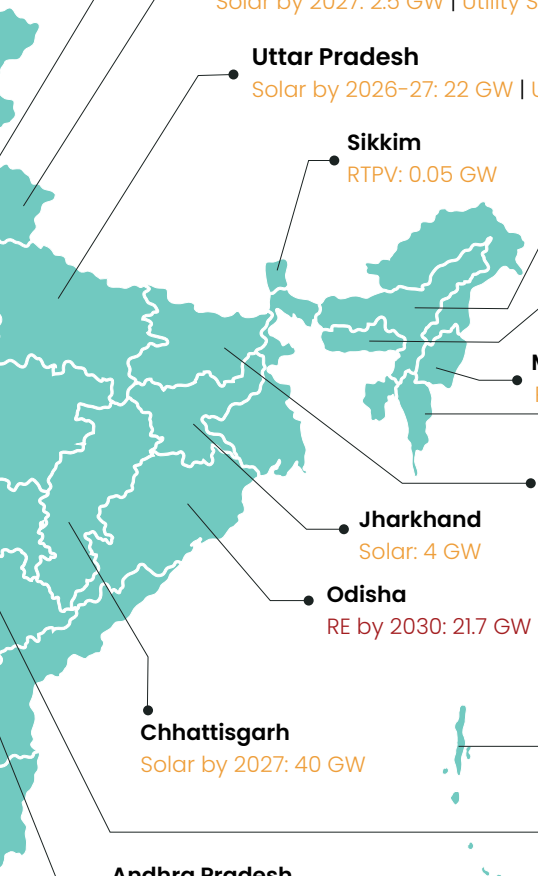


Figure 7: State-level renewable energy targets and policy initiatives



Delhi
Solar by 2026-27: 4.5 GW | RTPV: 0.75 GW | Utility Scale: 3.7 GW

Uttarakhand
Solar by 2027: 2.5 GW | Utility Scale: 1.1 GW | Distributed Solar: 1.4 GW

Uttar Pradesh
Solar by 2026-27: 22 GW | Utility Scale: 14 GW | RTPV: 6 GW | Distributed Solar: 2 GW

Sikkim
RTPV: 0.05 GW

Assam
RE by 2030: 11.7 GW | Grid Connected Solar Power Plant: 3.3 GW | Grid Connected RTPV: 1.9 GW | Off-grid Solar: 0.1 GW | Wind: 0.2 MW | Bio-mass & Waste to Energy: 0.1 GW | ESS: 3 GW

Meghalaya
RE by 2030: 0.2 GW | 0.1 GW Solar | 0.1 GW Wind

Manipur
RTPV: 0.05 GW

Mizoram
RTPV: 0.08 GW

Bihar
RE by 2030: 23.9 GW | Utility Scale: 21.9 GW | RTPV: 0.5 GW | Wind: 0.05 GW | Biomass & Waste to Energy: 0.4 GW | Energy Storage: 6.1 GWh (PSP: 1.6 GWh & BESS: 4.5 GWh)

Jharkhand
Solar: 4 GW

Odisha
RE by 2030: 21.7 GW | Wind: 3.5 GW | Hydro: 1.2 GW | Other: 17 GW

Chhattisgarh
Solar by 2027: 40 GW

A&N island
Achieve 100% RE

Telanganna
RE by 2030: 26.7 GW (Solar 19.8 GW, DRE 4.3 GW and Wind 2.5 GW) | ESS by 2030: 3.8 GW (BESS 3.3 GW, PSP 0.4 MW) | RE by 2035: 39.1 GW | (Solar 26.3 GW, DRE 8.2 GW and Wind 4.5 GW) | ESS by 2035: 7.9 GW (BESS 5.4 GW, PSP 2.4 GW)

Andhra Pradesh
+160 GW by 2029 | Solar: 78.5 GWp | Wind: 35 GW | PSP: 22 GW | BESS: 25 GWh | Ethanol: 1,500 KPLD | Bio-CNG/CBG: 10,000 TPD

Total RE | Solar | Wind | Energy Storage Systems | Hydro | Bio-fuels | Additional capacity

- India's energy transition is being driven by ambitious and diverse initiatives at the state-level. States have emerged as critical laboratories of innovation, each tailoring RE strategies to their unique resource endowments, economic priorities, and developmental contexts.
- The policy landscape reflects varying levels of ambition and sectoral focus. Leading states like Andhra Pradesh (160 GW RE by 2029), Rajasthan (125 GW RE by 2030) and Gujarat (100 GW RE by 2030) have set bold capacity targets. Technology-specific interventions are evident in Haryana's solarisation of 1,200 MW of irrigation pumps and Maharashtra's focus on solar-based EV charging and hybrid projects. Smaller states like Sikkim, Mizoram, and Manipur are prioritising distributed rooftop solar.

State-level diversity enables experimentation and context-specific solutions while fostering competitive federalism.

- This state-level diversity enables experimentation and context-specific solutions while fostering competitive federalism. However, it also necessitates careful coordination to ensure grid integration, avoid resource conflicts, and maintain policy consistency for investors.

2. Production-linked Incentives (PLI) in Clean Tech: Catalysing Private Investment

The Government of India has introduced PLI to catalyse domestic manufacturing in strategic clean technologies. This scheme is designed to reduce dependence on imports, attract private capital, and create globally competitive value chains in sectors critical for the energy transition. Two prominent focus areas are Advanced Chemistry Cell (ACC) batteries and solar PV modules.

Pre-PLI (2021)

- Solar module manufacturing capacity was about 15 GW.[16]
- Solar cell manufacturing capacity was roughly 5 GW.[16]
- ACC manufacturing capacity remained negligible.

Due to PLI (2021 onwards)

Solar Manufacturing[17]

- Fourteen companies selected under the scheme.
- 24 GW allocated, including 12.3 GW of fully integrated lines.
- Scheme-driven expansion has boosted solar module capacity to 118 GW in 2025.

ACC Manufacturing[18]

- Four winners selected.
- 40 GWh of manufacturing capacity allocated to date.
- Manufacturing capacity expected to reach 150 GWh by 2030.

Pre-PLI: State of Play

Before 2021, India's domestic manufacturing capacity in clean technologies was limited. By 2021, solar module capacity stood at ~15 GW and solar cell capacity at ~5 GW[16], while advanced battery manufacturing was negligible. The sector remained largely import-dependent, particularly for high-value components.

Due to PLI: Scale-Up

Under clean tech, two flagship PLIs were launched: ₹18,100 crore (~USD 2,048 million) for Advanced Chemistry Cell (ACC) batteries with a 50 GWh target, and ₹24,000 crore (USD 2,704 million)[18] for high-efficiency Solar PV modules. Due to these initiatives, by 2025, 40 GWh of ACC capacity has been allocated, and solar module manufacturing has surged past 118 GW under Approved List of Models and Manufacturers (ALMM), signaling a major shift toward self-reliance and supply-chain integration. The ALMM enlistment is critical for participation in government-linked tenders, thereby creating a strong demand-side pull for domestic manufacturers.

Trends and Outlook to 2030

Building on PLI momentum, India is transitioning from being a deployment-led renewable energy market to a manufacturing-driven ecosystem. Solar module capacity is projected to exceed 165 GW by 2027, while domestic battery production could reach around 150 GWh by 2030[19]. Together, these trends strengthen energy security, reduce import dependence, and position India as a credible global supplier in clean technologies.

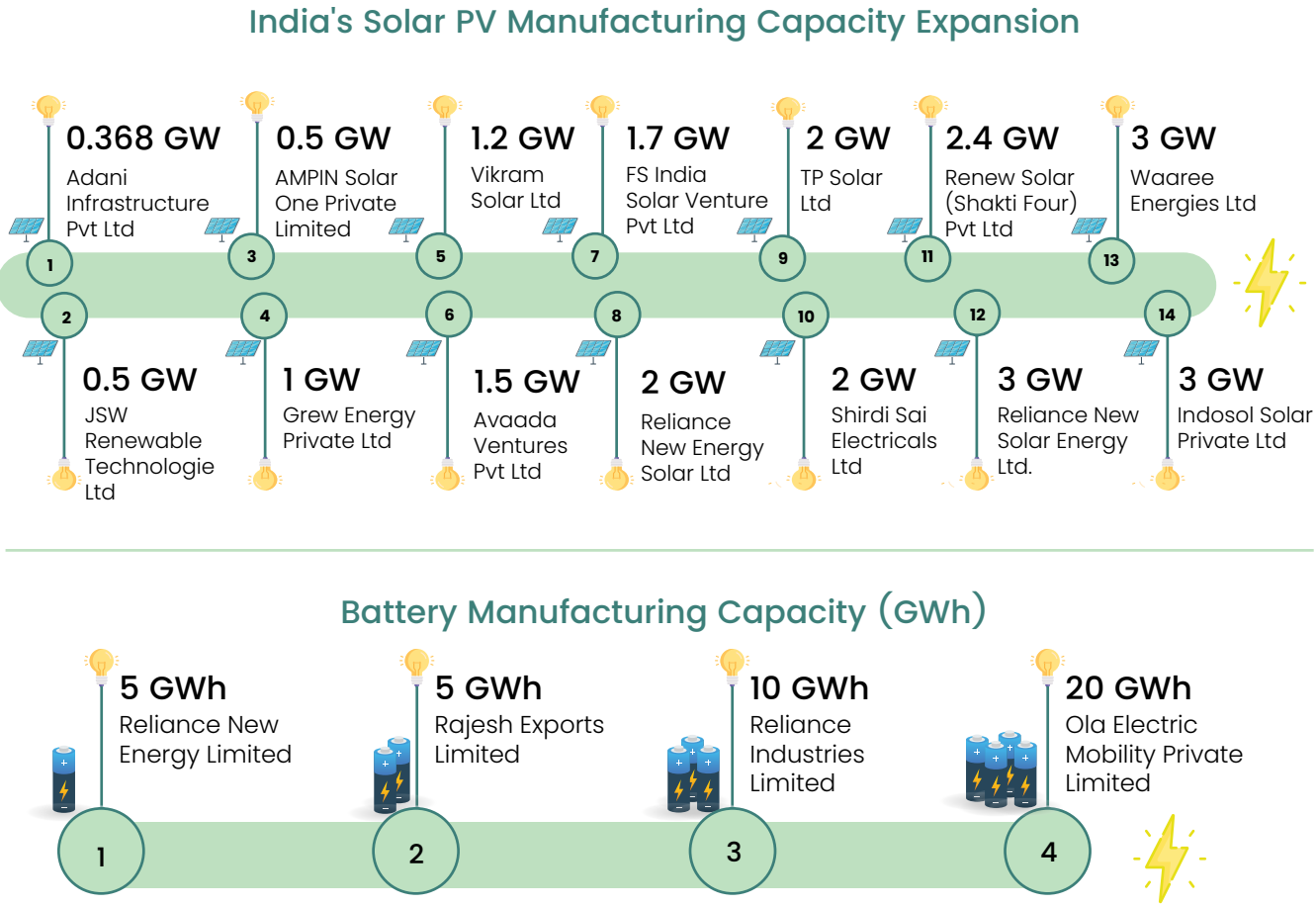


Figure 8: PLI winners for battery and solar PV manufacturing[17, 18]

Together, these PLI initiatives showcase India's shift from being a clean energy deployment market to a manufacturing hub. They not only enable faster RE integration but also strengthen energy security, generate employment, and position India as a credible global supplier in the clean tech value chain.

3. PM Surya Ghar: Driving Mass Adoption of Rooftop Solar

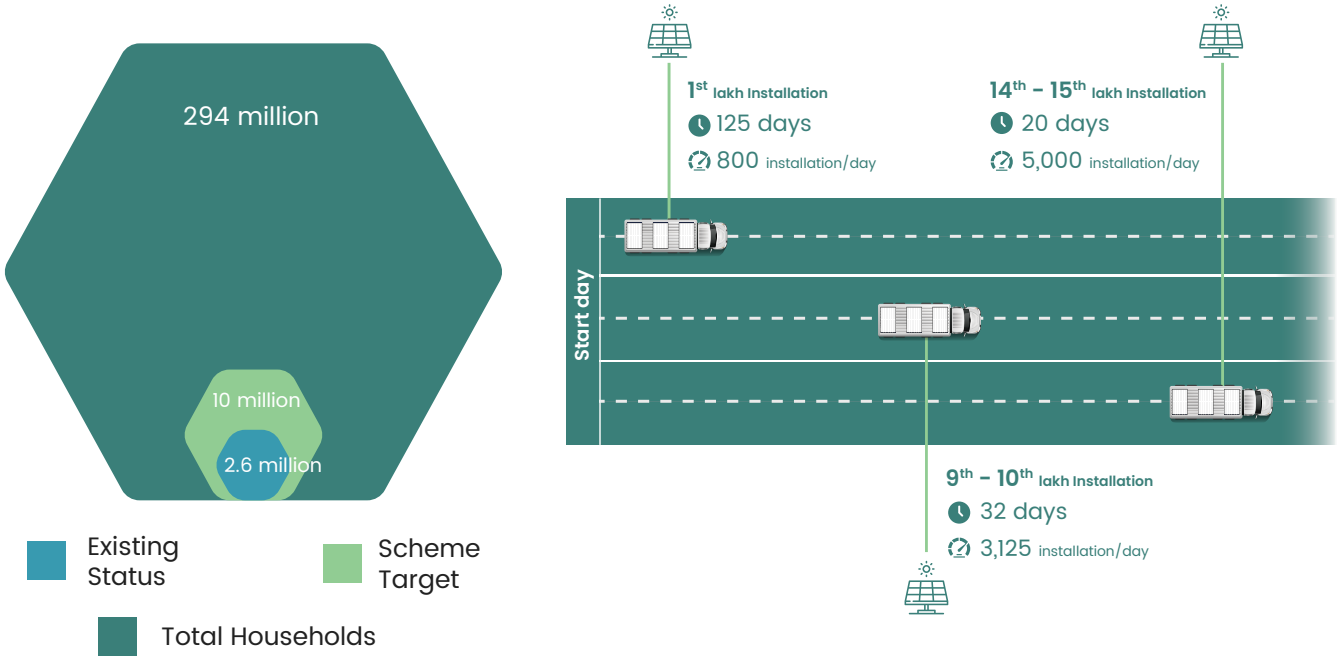


Figure 9: Status of PM-Surya Ghar Yojana[20]

The pace of installations under the PMSGY has accelerated sharply — while the first 1 lakh installations took 125 days, the 15th lakh was achieved in just 20 days.

- The PM Surya Ghar: Muft Bijli Yojana[21], launched in February 2024 with an ambitious outlay of ₹75,021 crore (USD 8.25 billion), is the world's largest rooftop solar program. Its vision is to democratise the clean energy transition by transforming households from passive consumers to active prosumers, generating their own electricity while contributing surplus energy back to the grid.
- The scheme has rapidly scaled rooftop solar adoption across the country. Within just 1.8 years of launch, rooftop capacity addition reached 7.8 GW[22], compared to a cumulative 11 GW deployed over the previous decade[23]. This marks a structural shift in the adoption

trajectory, positioning rooftop solar not as a niche choice but as a mainstream household solution.

- The programme has also evolved into a people's movement, with strong citizen participation driving its success. Subsidies of up to ₹30,000 (USD 330)/kW for the first 2 kW, ₹18,000(USD 198)/kW for the next 1 kW, and a cap of ₹78,000 (USD 858) per household have made rooftop solar affordable for residential users.
- The pace of installations under the PMSGY has accelerated sharply —while the first 1 lakh installations took 125 days, the 15th lakh was achieved in just 20 days.
- Beyond capacity addition, the scheme has generated significant social and behavioural impacts[24]:
  - » Households are becoming more energy-conscious, actively tracking consumption and savings.
  - » The programme has increased environmental awareness, with communities recognising their role in climate action.
  - » Importantly, children and youth are showing greater interest in clean technologies, nurturing a generation of future innovators and champions for sustainability.

4. Customs Duty Differentials for Solar: Driving Local Manufacturing

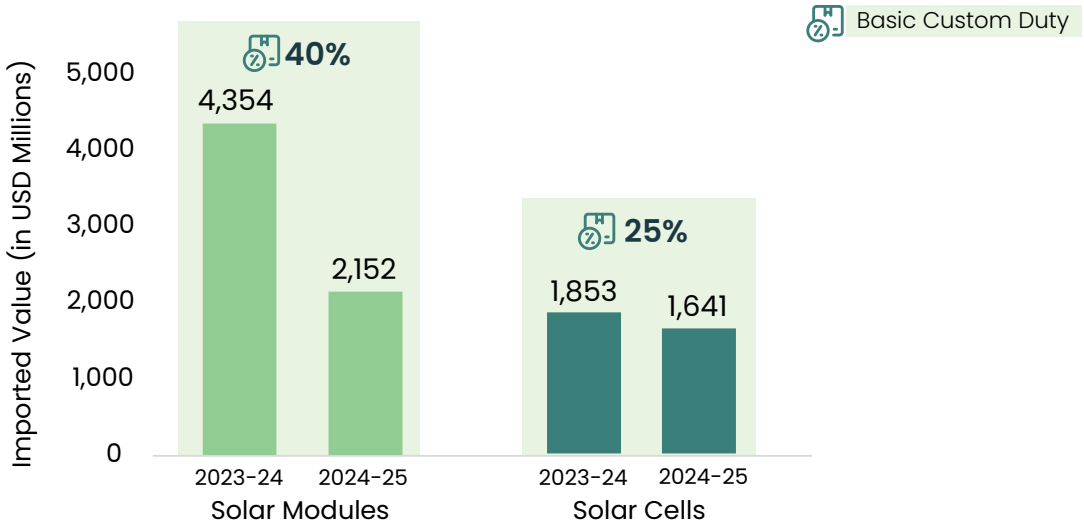


Figure 10: Impact of BCD on the import value for solar cells and modules[25]

The Government of India (GoI) has strategically employed Basic Customs Duty (BCD) as a policy lever to nurture domestic solar manufacturing and reduce reliance on imports.

- The GoI has strategically employed Basic Customs Duty (BCD) as a policy lever to nurture domestic solar manufacturing and reduce reliance on imports. Introduced in April 2022, this measure was designed not only to incentivise local capacity creation but also to shield the domestic market from low-cost, substandard imports that could undermine India's long-term clean energy ambitions.
- The BCD has been prudently structured to reflect the capital intensity of different parts of the solar value chain:
  - » Solar Modules: 40% BCD which was prioritised initially since module manufacturing is relatively less capital-intensive, requiring approximately ₹350 crore (USD 38.5 million) per GW of capacity[26].
  - » Solar Cells: 25% BCD which is levied at a lower rate given that solar cell production demands significantly higher investments, with capital expenditure of about ₹1,050 crore (USD 115.5 million) per GW[26]. Infrastructure for cell manufacturing is expected to follow in a phased manner, once the foundational base of module production is established.
- Customs duties are meant to be a temporary catalyst, giving domestic manufacturers the space to scale up before facing global competition. Once competitive, exposure to international markets drives innovation, R&D investments, and cost reductions, ultimately benefiting consumers. Excessive protectionism, however, risks inefficiency and stagnation. Reflecting this balanced approach, India revised the BCD in May 2025 to 20% for both solar cells and modules, signaling confidence in the growing strength of its local solar manufacturing sector[27].

5. Clean Heat - A low hanging opportunity for manufacturing sector

- A critical component of industrial decarbonisation lies in transforming industrial heating processes which remain heavily reliant on fossil fuels (as explained above) in the manufacturing industries. As we move towards a fundamentally more efficient system around electricity, there is dedicated need to look at electrifying heating not just in heavy industries but also its supply chains.
- In 2023-24, our analysis suggests that electricity makes up 26% of total final energy use in India's manufacturing sector. While this

Our analysis for 2023–24 indicates that electricity accounts for 26% of the total final energy consumption in India's manufacturing sector.

necessitates immense potential for electrification and reducing emissions across MSMEs; estimates suggests that this is much higher electricity penetration than in large industries.

- Despite a large potential for emission savings; the barriers to scale clean heat adoption are manifold. A key barrier is insufficient policy. According to IEA, more than 120 countries across the world have policies designed to promote renewable electricity, but only 40 have specific policies for clean heat, most of which are within European Union. In addition, renewable electricity solutions, including Power Purchase Agreements and utility offerings, have developed much more quickly and are enabling buyers to rapidly scale up the RE procurement market, while these options do not exist for renewable thermal energy.

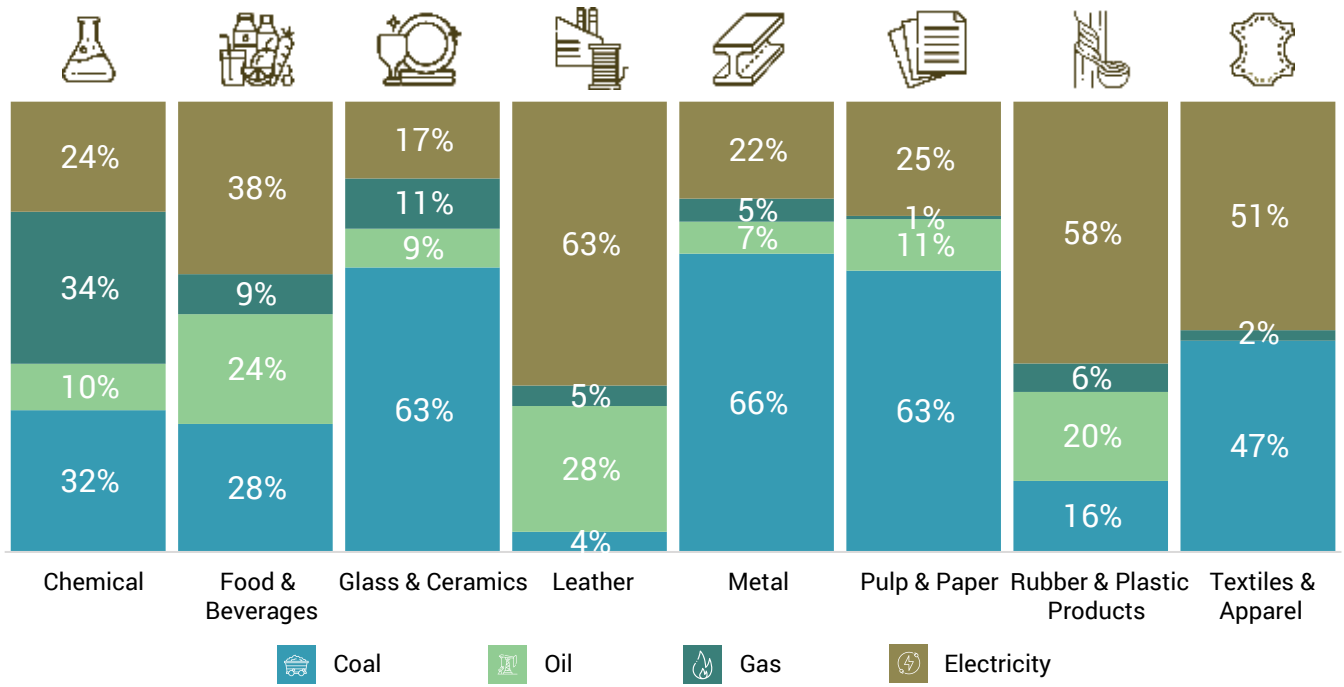


Figure 11: Fuel share across key energy intensive industries in India[28]

- Fortunately, industries can adopt an array of industrial technologies that are now commercially available which includes- heat pumps, electric boilers and other electrified technologies such as thermal batteries, electric arc or induction backed by renewable energy that can significantly and immediately reduce emissions. Notably, for low- (<100 °C) to mid-temperature (<500 °C) processes, electrification of process heat offers a low-hanging measure that can be rapidly scaled up via heat pumps and electric boilers than for high-temperature processes.
- Industry clusters across sectors such as food and beverage, textiles, pulp and paper, rubber and plastics, leather are excellent candidates for faster electrification of process heat due to their significant demand for low- to mid-temperature heat.

6. Strengthening Controls on Lithium-Ion Battery Black Mass Exports: Securing Strategic Resources

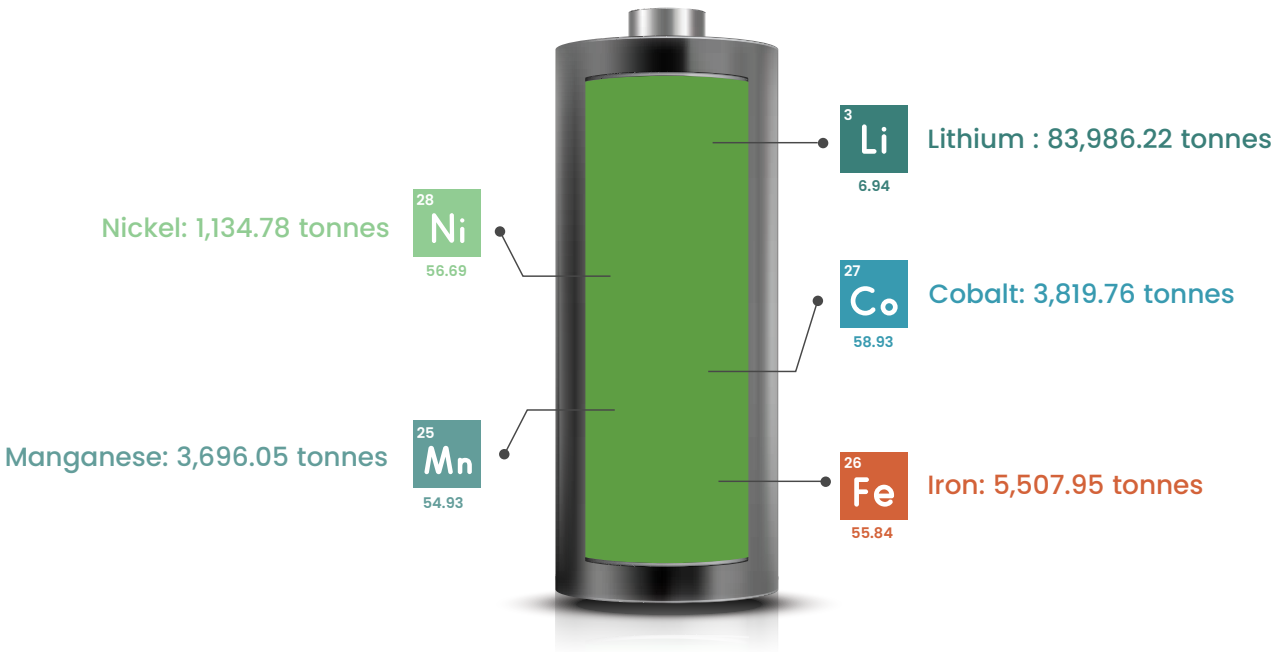


Figure 12: EPR targets for critical metals recovery from battery recycling[29]

India has already established black mass refining capacity of approximately 60,000 MT, capable of extracting critical minerals for which Extended Producer Responsibility (EPR) targets have been released by MoEFCC.

- The GoI has recognised black mass—the residual material from lithium-ion battery shredding—as a strategic resource critical to India's clean energy and manufacturing ambitions. In a significant policy intervention, the GoI has mandated that the export and import of black mass must be regulated under the Hazardous and Other Wastes (Management & Transboundary Movement) Rules, 2016, requiring prior permission from the Ministry of Environment, Forest and Climate Change (MoEFCC) for all such transactions[30].
- This decision reflects the strategic value of black mass in India's resource security framework:
  - » Strategic Resource Potential: Black mass contains valuable critical minerals including lithium, cobalt, nickel, and manganese. Through domestic refining, India can meet a significant portion of its mineral requirements for battery manu-facturing, reducing import depen-dence and enhancing supply chain resilience.
  - » Existing Domestic Capacity: India has already established black mass refining capacity of approximately 60,000 MT[31], capable of extracting critical minerals for which Extended Producer Responsibility (EPR) targets have been released by MoEFCC. This infrastructure represents substantial capital investment and technical capability that must be fully utilised.
- However, implementation gaps threaten to undermine these policy objectives. Certain entities continue to export black mass by misclassifying it under different Harmonised System (HS) codes, effectively circumventing regulatory oversight. This practice starves domestic refining facilities of essential raw materials while simultaneously allowing these same exporters to generate and sell EPR credits.
- The consequences of inaction are significant. Unchecked black mass exports inhibit India's emergence as a global leader in battery recycling, constrain job creation across recycling, manufacturing, metallurgy, and specialty chemicals sectors, and perpetuate mineral import dependence despite existing domestic processing capabilities. There is an urgent need to plug these regulatory loopholes.

05

Cost and Market Implications

05 Cost and Market Implications

The cost trajectory of clean technologies is one of the most important determinants of their adoption pace and market penetration. Falling technology costs not only improve affordability for consumers but also enhance the competitiveness of low-carbon solutions against fossil-fuel-based alternatives. Understanding these cost dynamics across mobility, industry, and residential sectors is essential to gauge the pace at which India can achieve large-scale electrification and decarbonisation.

1. Declining EV Costs Over Time

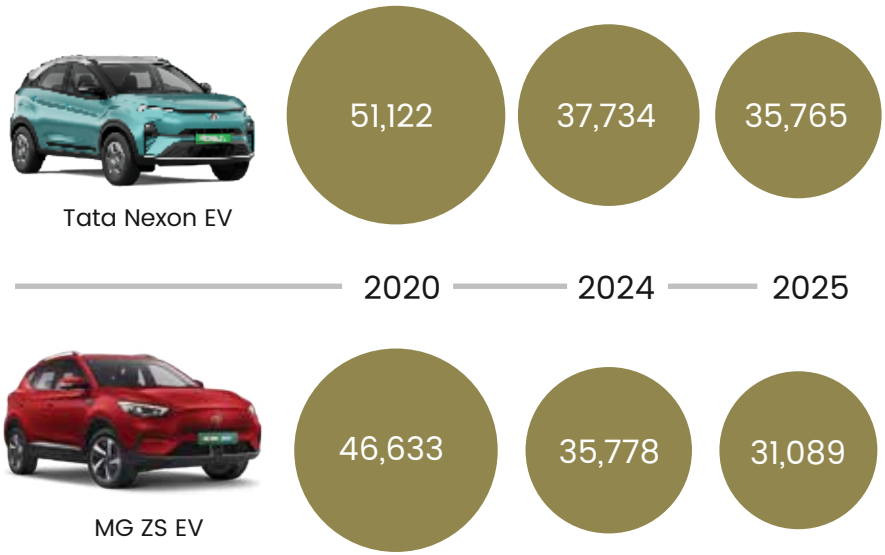


Figure 13: Ex-showroom EV cost per kWh of battery capacity[32]

- Here, EV (especially electric cars) costs were analysed based on ex-showroom prices of base models, normalised by their battery capacity (₹/kWh). The analysis considers the years 2020, 2024, and 2025 to highlight both medium-term (four-year) cost declines and sharper near-term (one-year) reductions.
- Between 2020 and 2025, normalised EV costs show a significant decline, reflecting the maturing market and improving affordability.
- Drivers of cost decline:
  - » Falling lithium-ion battery prices — batteries account for 30–40% of an EV's total cost, making their price trajectory the single biggest cost lever.
  - » Economies of scale from large-scale battery manufacturing capacity expansion across Asia, Europe, and North America.
  - » Advances in manufacturing processes that improve yield, reduce waste, and optimise energy inputs.
  - » R&D investments in next-generation chemistries and improved cell-to-pack integration, which further lower costs and enhance performance.
- As EV costs continue to converge with internal combustion engine (ICE) vehicles, consumer adoption is expected to accelerate.

2. EV Tariffs Across States: Affordability and Variability

- To enable the smooth adoption of EVs, the Bureau of Energy Efficiency (BEE) directed states to notify single-part EV tariffs. These tariffs form the base cost of charging, upon which charge point operators (CPOs) add components such as GST, service charges, and operational margins. Together, these charges define the effective electricity price faced by EV owners across different states.
- The tariff structures vary widely across states, ranging from ₹3.8 (USD 0.042)/kWh to nearly ₹10 (USD 0.11)/kWh, as shown in the map. This disparity has direct implications for EV economics:

Vehicle categories with higher annual kilometer run (e.g., intra-state buses, long-haul trucks, and commercial fleets) are more sensitive to tariff changes since electricity costs account for 15–25% of their Total Cost of Ownership (TCO).

» Vehicle categories with higher annual kilometer run (e.g., intra-state buses, long-haul trucks, and commercial fleets) are more sensitive to tariff changes since electricity costs account for 15–25% of their Total Cost of Ownership (TCO).

» Conversely, segments with lower utilisation (e.g., private two-wheelers and four-wheelers) are relatively less affected, though affordability still plays a role in adoption decisions.

- To ensure that EV adoption is not constrained by high charging costs, states should:
  - » Optimise tariff design to make EV charging affordable and predictable, particularly in regions with high commercial vehicle density.
  - » Introduce differentiated EV tariffs for commercial vehicles, providing relief to segments where electricity cost is a critical driver of operating economics.

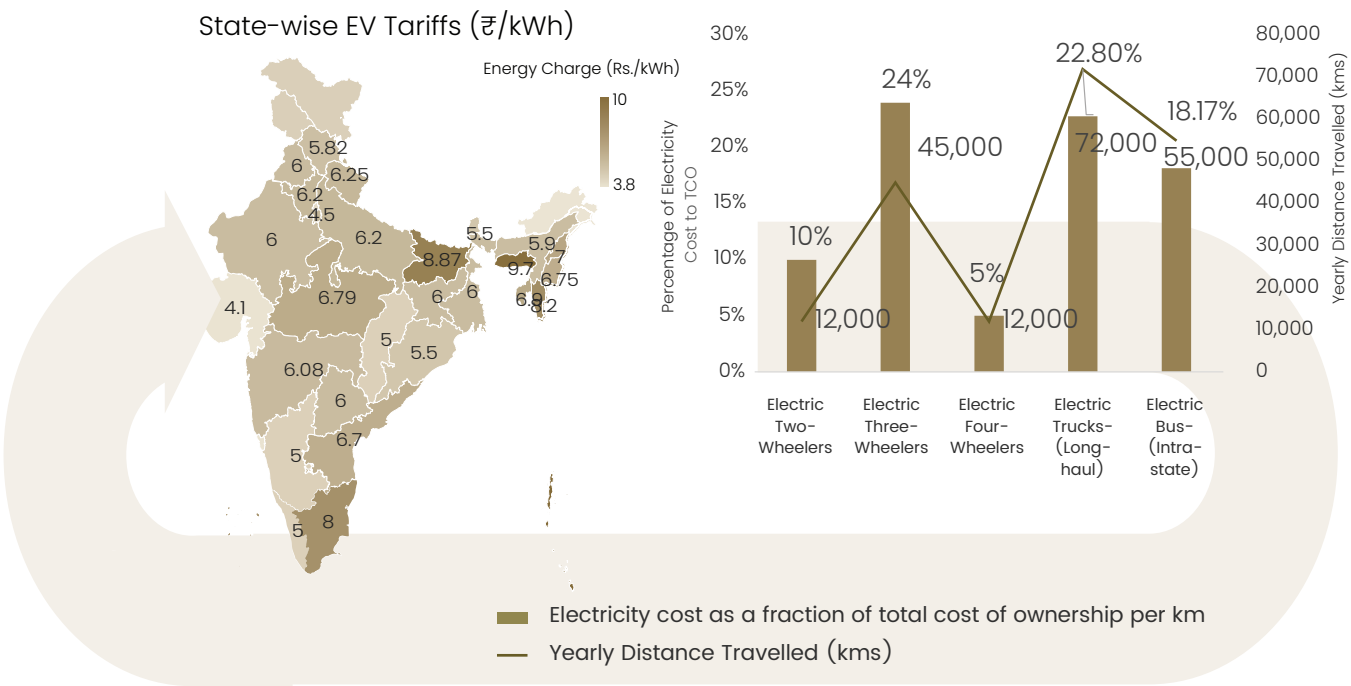


Figure 14: State-wise EV tariffs and their impact on electricity costs across vehicle segments[33]

The TCO calculation is based on the EV tariff applicable in New Delhi, as specified on the EV Yatra platform.

3. Mapping Varying Affordability Levels for Electricity Across States

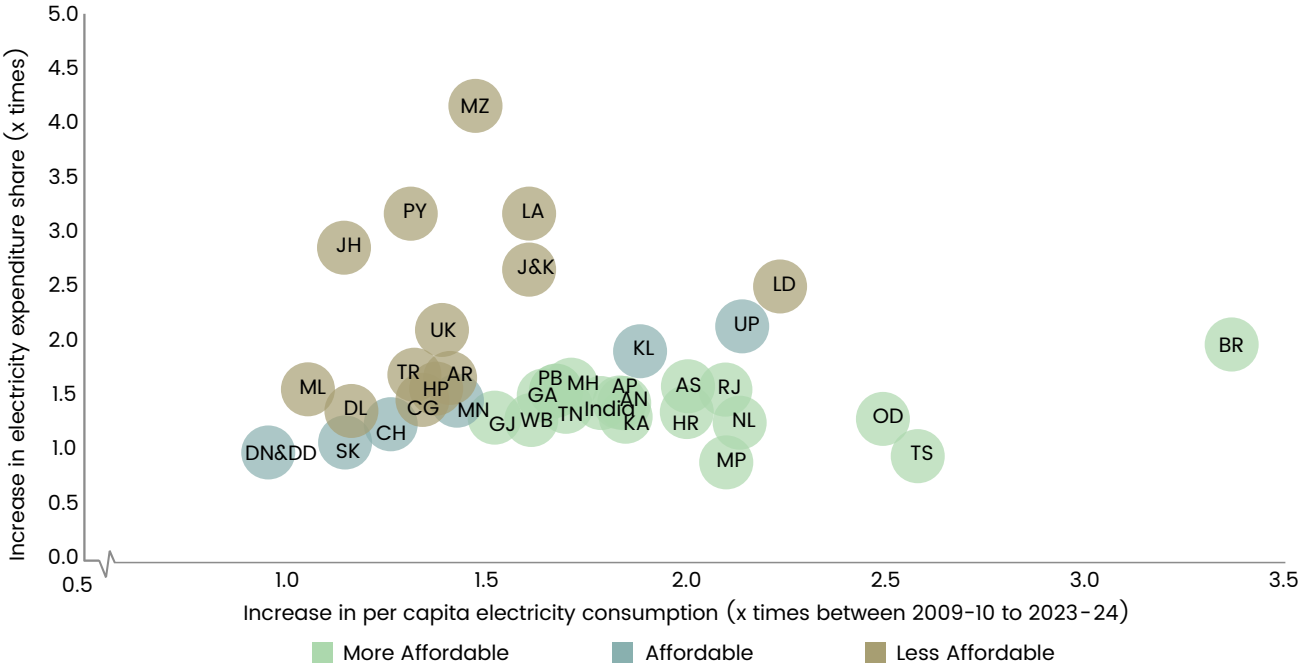


Figure 15: Per capita electricity consumption vs share of electricity expenditure in states (2009-10 to 2023-24)[34]

- Every state/UT shows a rise in per capita electricity consumption, reflecting rising shares of electrification, appliance use, and income growth. States such as Bihar, Odisha Madhya Pradesh, Rajasthan and Uttar Pradesh demonstrated an exceptional per capita electricity consumption growth by more than 100% showcasing greater economic prosperity of these states. This growth is especially significant given that these states were once considered lagging in electricity consumption, yet they have now demonstrated strong upward momentum in electricity usage.
- Despite the highest per capita electricity growth rate amongst all states, Bihar records one of the least per capita electricity consumption of 413 units in 2023-24.
- While both consumption and expenses rose, the expense share grew faster in 13 states/ UTs, implying electricity costs grew faster than incomes- thus widening the energy

While both consumption and expenses rose, the expense share grew faster in 13 states/UTs, implying electricity costs grew faster than incomes- thus widening the energy affordability gap.

affordability gap.

- Madhya Pradesh set a remarkable example by becoming the only state where electricity became highly affordable. The per capita electricity consumption doubled from 602 kWh to 1,272 kWh but had no impact on the expense share.
- Punjab followed by Delhi has a highest share of monthly expenditure on electricity - 7.8% and 6.5% respectively.
- Since 2009-10, the per capita electricity consumption in Puducherry increased marginally by ~32% but he share of its expenses rose by 221%.

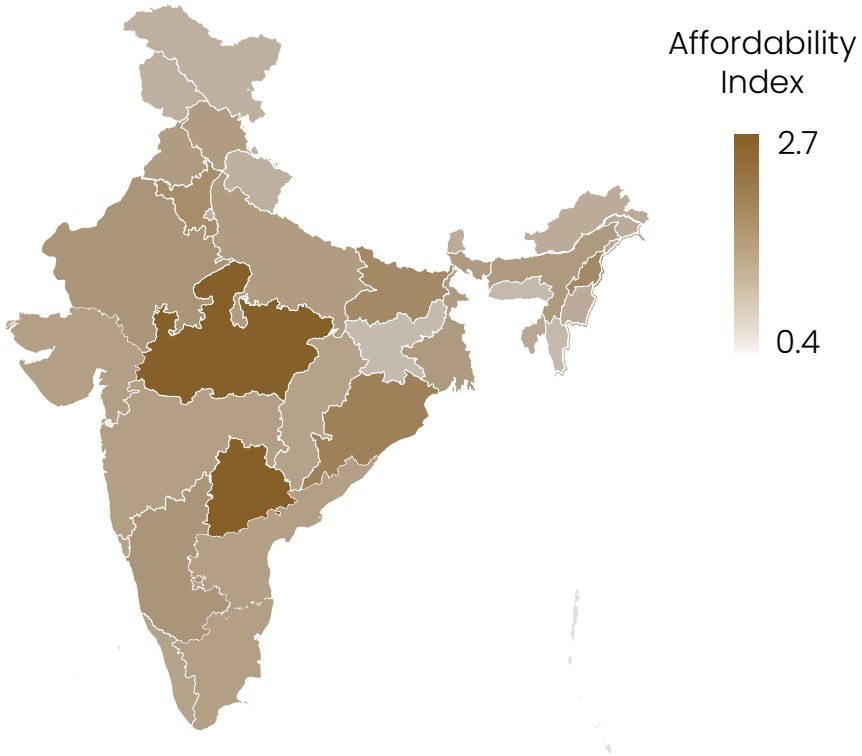


Figure 16: Affordability Index across states (between 2009-10 to 2023-24)[35]

06

System-Level Implications

06 System-level Implications

India has demonstrated remarkable leadership in RE deployment. Over the past decade, it has added significant capacity across solar, wind, biomass, and hydropower technologies.

However, the rapid growth of RE—particularly intermittent sources like solar and wind—demands proactive measures to maintain grid stability and ensure seamless integration. This section highlights key trends in generation capacity and their implications for future grid management.

1. India's Evolving Peak Demand Trends and Shifts

- Over the last two decades, India's power demand and peak electricity demand have sustained an average growth of 5-6% every year.
- On 12th June 2025, India achieved its national peak of 243 GW; recording a first-time decline in year-on-year peak demand since 1985[36]. This has been primarily weather related due to an early onset of monsoon, large spells of heavy rainfall and relatively cooler temperatures in most parts of India. Further, this peak demand is almost 11% lower than Grid-India projection of ~273 GW[37]; underscoring the need for more sophisticated forecasting methodologies that integrate weather parameters into physics-based demand models.
- Typically, we see the national peak shifting to 3 or 4 pm in the summer, driven largely by space cooling. This shift is beneficial, as the afternoon peak aligns better with solar energy generation, enabling greater use of solar power to meet peak demand. Interestingly, there has been a rise in solar generation share in meeting peak demand from 6% in 2019 to 17% in 2025.

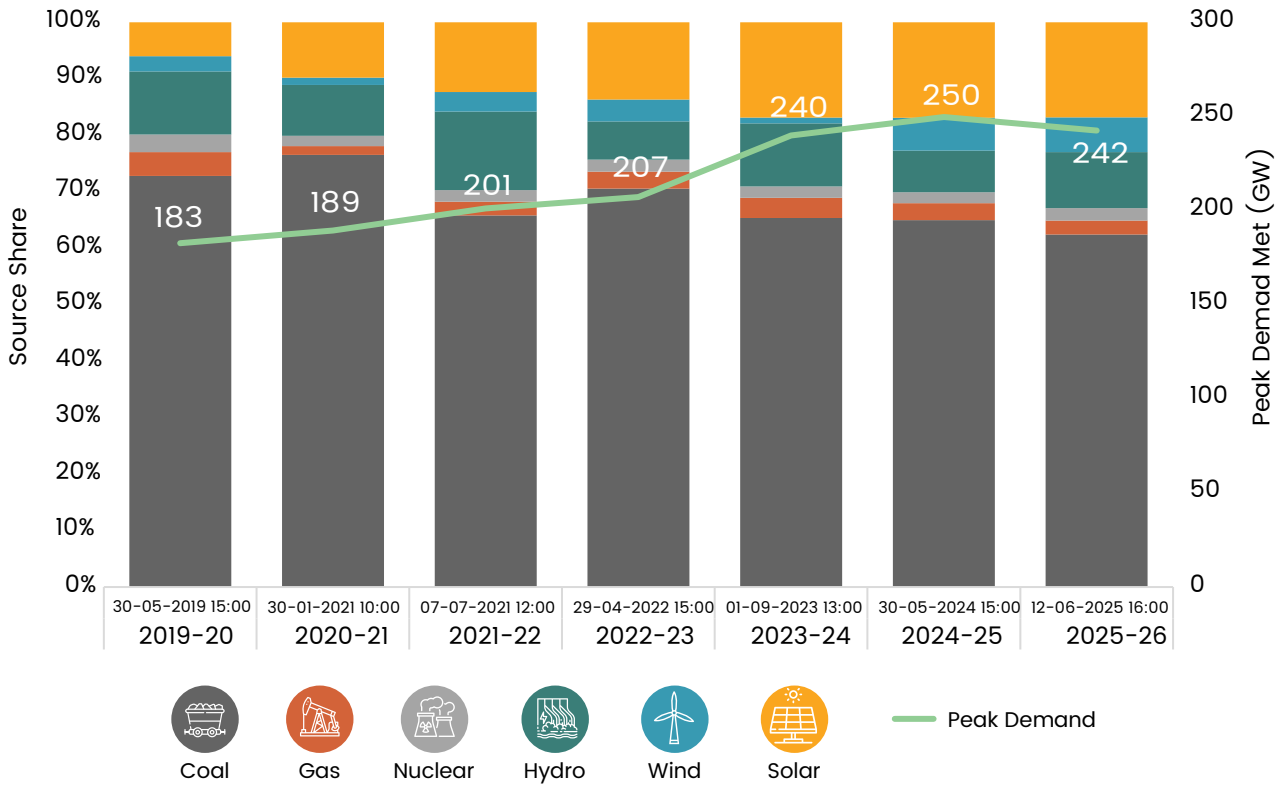


Figure 17: Share of generation sources at peak hour of Annual Peak Demand Day[38]

2. Large Scale Integration of Renewable Energy turns Into a Reality

- In the year 2025 (Between January to December), India's power system integrated substantial volumes of clean energy – reflecting a consonance between capacity addition and actual generation.
- In 2025, around two-thirds of the demand that was met had a RE share between 20-50%.
- Nearly one in ten blocks exceeded 40% RE penetration; indicating higher shares of renewable energy meeting real-time demand.
- India achieved record RE integration, with a total of nine 15-minute intervals during which renewable energy supplied more than

50% of the total demand. This implies India is already operating its grid at around 50% renewable penetration for some time blocks and hence proving that large scale RE integration is a possibility.

Figure 19: Frequency distribution of the solar generation in 2025 as a share of total system demand[39]

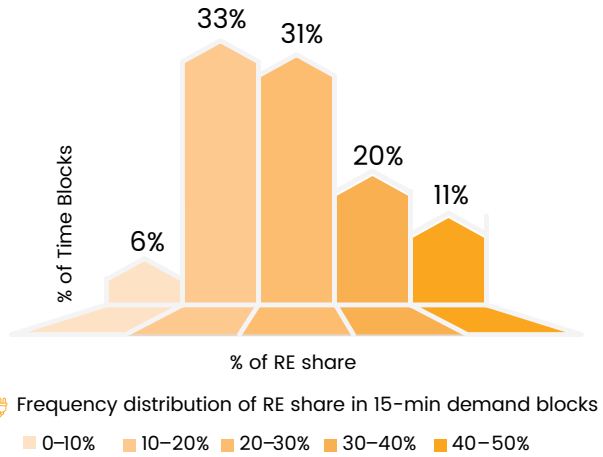
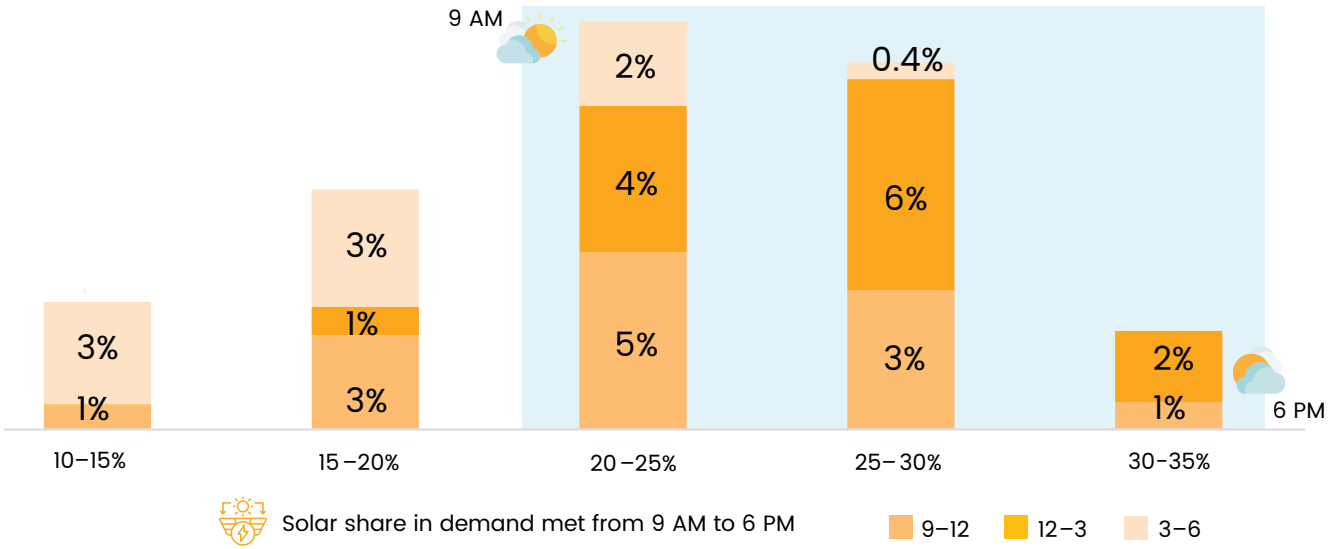


Figure 18: Frequency distribution of RE share in 15-min demand blocks
(Between 1st January 2025 and 31st December 2025)

India is already operating its grid at around 50% renewable penetration, and hence proving that large scale RE integration is no more a projection but a reality.



- As per Figure 19, between January to December 2025, solar power contributed more than 20% of the demand in 24% of all 15-min time blocks. Most of these high-solar periods occurred during the daytime hours when solar is at its peak between 9am and 3pm.
- On 10th Nov 2025, India's solar generation consistently remained above 33% for fourteen consecutive intervals between 10:45 and 14:00 hours, reaching a peak penetration of 37% for 45 minutes during this period. This showcasing the grid's ability of managing higher integration of inverter-based resources.

3. Growth of Inverter-Based Resources (IBRs) in the Power System

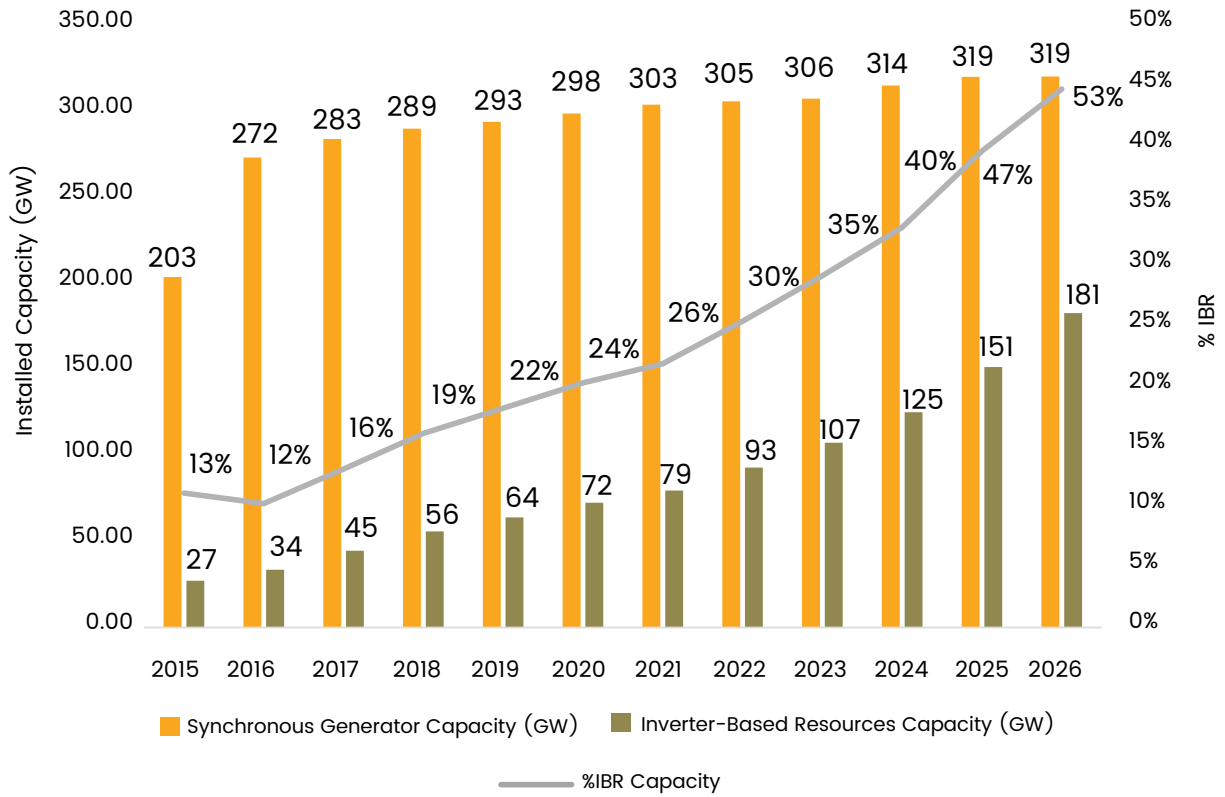


Figure 20: Growth in synchronous generator capacity and inverter-based resource capacity (2015–2026) with increasing share of IBRs in India's generation mix[40].

- While synchronous generators (traditional capacity) continue to expand gradually, inverter-based resources (IBRs) such as solar and wind show a sharp upward trajectory.
- The percentage of IBR capacity has increased from 12% in 2015 to over 53% as of September 2025, underscoring a structural shift in India's power mix.
- With higher IBR penetration, system operators need to explore ways to ensure grid stability and reliability. Investments in grid-forming inverters, storage solutions, and demand response will be critical to enhance stability and enable seamless integration of higher RE shares.

4. Transmission Capacity: From Expansion to Optimisation

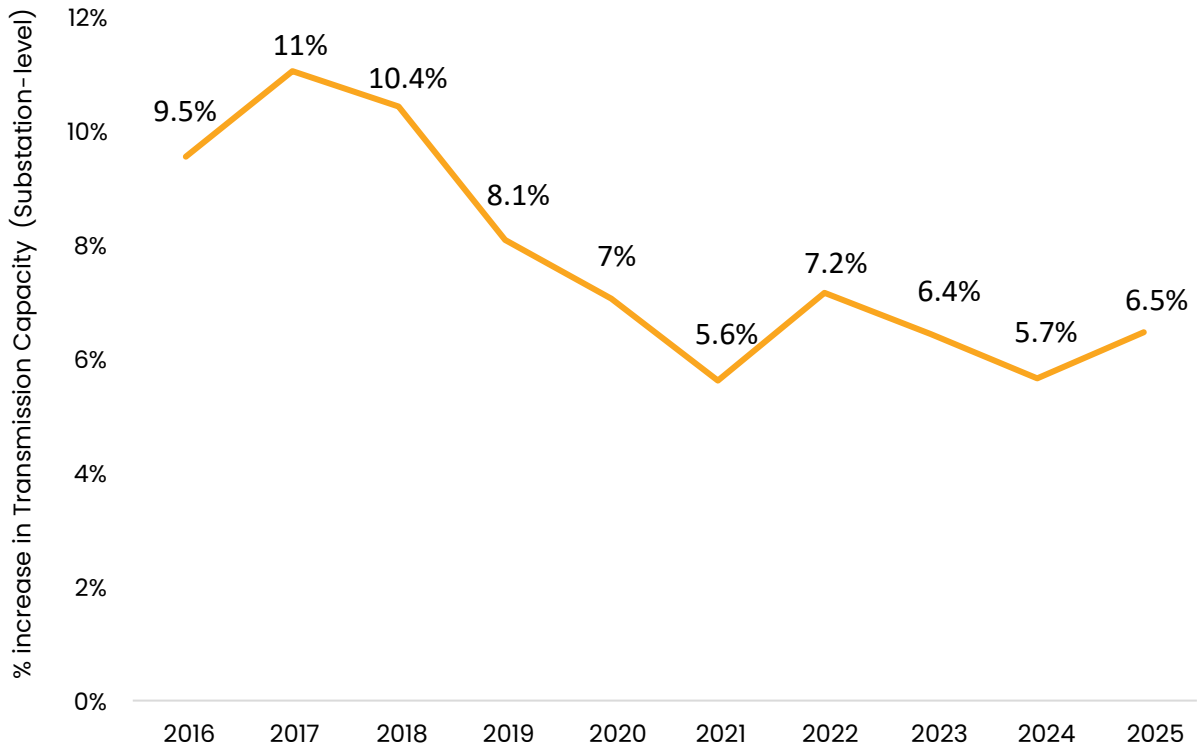


Figure 21: Transmission growth trends

- Transmission capacity increased rapidly, peaking above 10% in 2017, indicating aggressive strengthening or expansion of substation-level capabilities.
- According to the Central Electricity Authority (CEA), to integrate over 500 GW of RE by 2030, India requires:
  - » 50,890 ckms
  - » 433,575 MVA of substation capacity beyond the substation capacity in 2022-23.
  - » This translates to sustained annual transmission growth of 6% through 2030.
- Advanced conductors can increase existing line ampacity by 2–2.5 times without new towers or rights-of-way.
- Since new transmission lines have long gestation periods (7–8 years) due to clearances and land acquisition challenges, accelerated reconductoring of existing corridors with advanced conductors (like HTLS—High-Temperature Low-Sag) is essential. This can expand line capacity without requiring new land and in shorter project timelines.
- With aging infrastructure and higher renewable penetration, grid reliability requires a two-pronged strategy: (i) expanding new corridors in RE-rich regions (western, southern India for solar/wind, northeast for hydro) while (ii) modernising existing transmission assets through reconductoring, digital monitoring, and deployment of flexible AC transmission systems (FACTS) for stability.

5. Spare Transmission Capacities: Current Status and Emerging Constraints

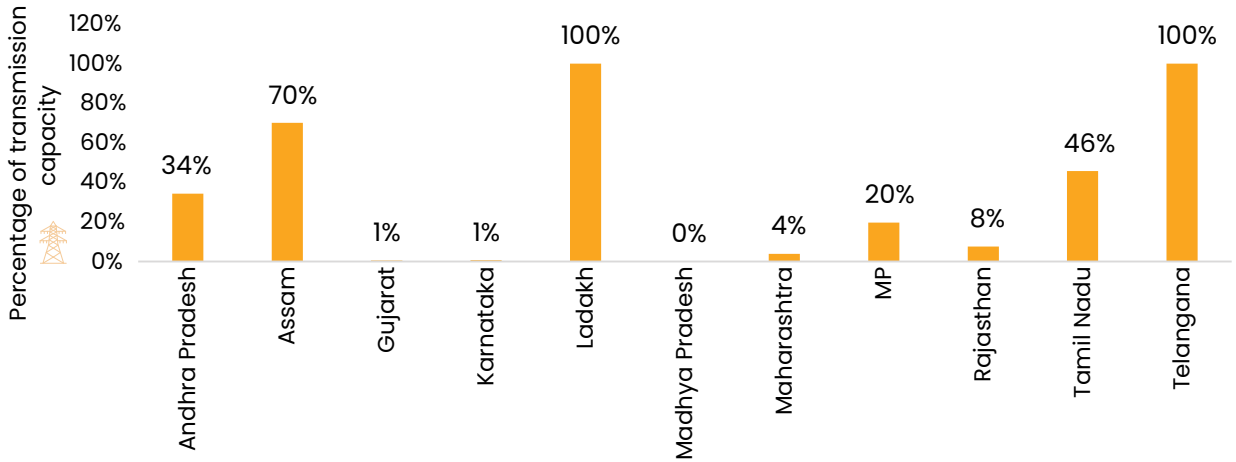


Figure 22: Proportion of transmission capacity available for new interconnections[41]

Spare capacity comprises both the existing margin and the additional capacity that can be realized through upgrades.

- India's transmission grid does possess some spare capacity that can be leveraged to integrate renewable projects. However, this available margin is insufficient to meet the fast-rising RE integration requirements, indicating the need for urgent augmentation and optimisation.
- Ladakh and Telangana exhibit large spare margins that can be operationalised with modest upgrades.
- Gujarat, Karnataka, Maharashtra and Rajasthan need significant new transmission expansion to unlock the next tranche of renewable capacity.

6. System Inertia: Current Status and Future Trajectory

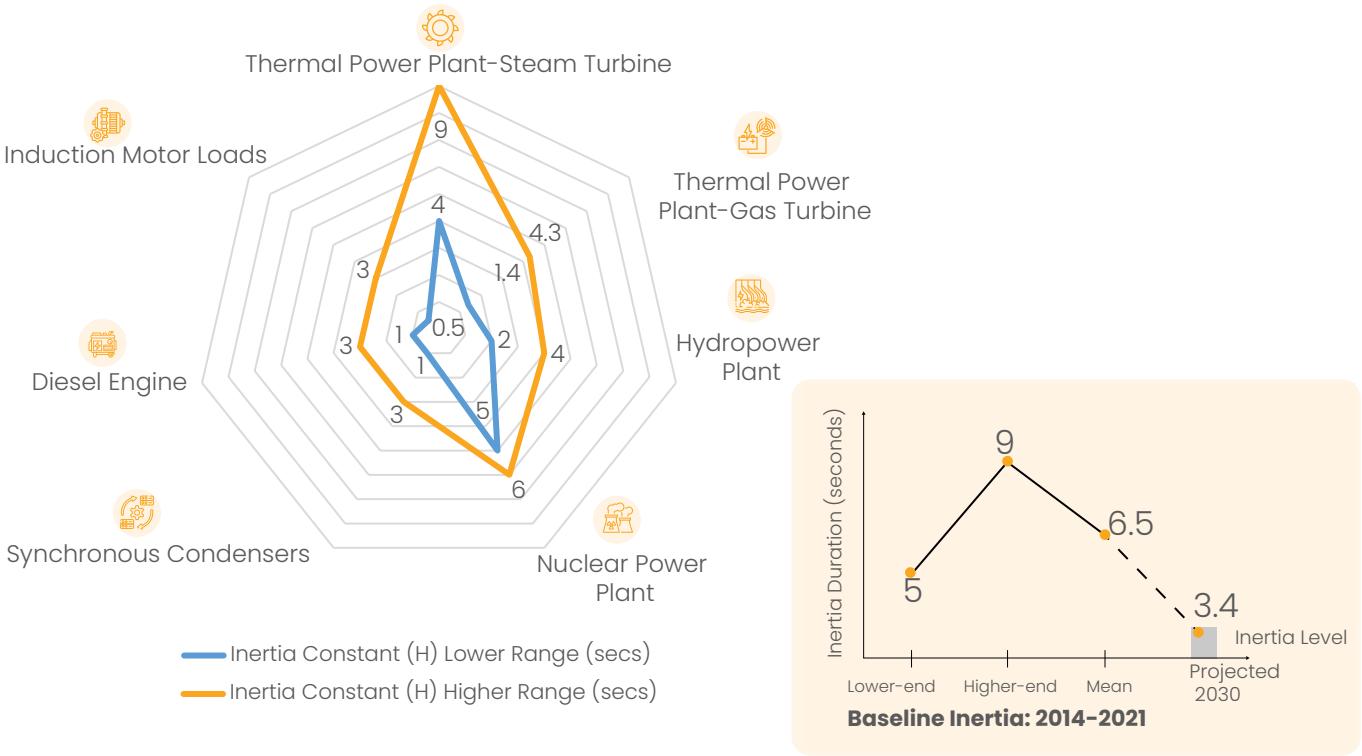
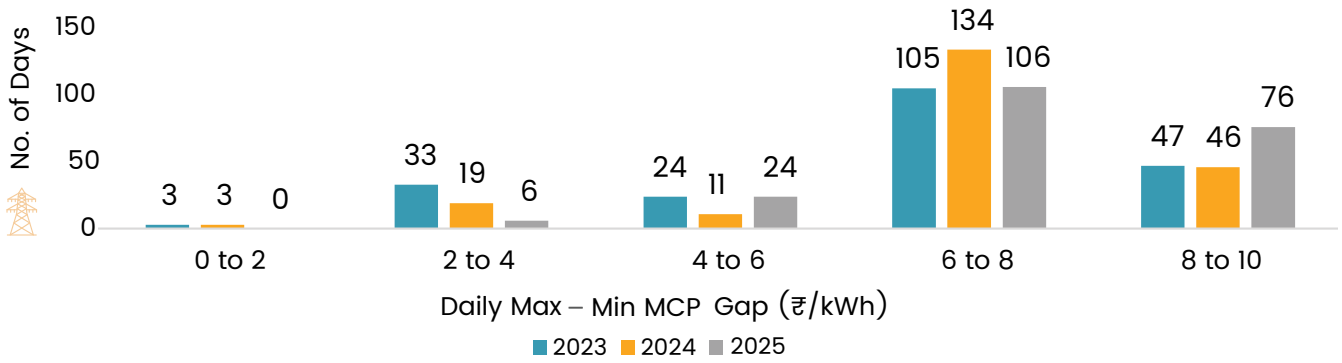


Figure 23: Current inertia estimates and projected declines with higher IBR shares[42]

- Grid India estimates show India's current system inertia at 5–9 seconds (mean ~6.3s), provided largely by synchronous machines (thermal, hydro, nuclear). With IBRs, projections for 2030 drop to just 3–4 seconds, leaving far less response time for governors, batteries, and demand response to stabilise the grid.
- By 2030, renewables may contribute ~500 GW (≈62.5% of 800 GW total), with instantaneous RE shares exceeding 60–70% during peak hours. This decommits synchronous machines and sharply reduces rotational inertia, raising risks of frequency instability and cascading outages.
- To maintain a healthy 5–9 second inertia window, the grid must leverage synthetic inertia from IBRs, deploy grid-forming inverters, and mandate battery energy storage systems (BESS) to provide fast frequency response. The Ministry of Power's recommendation—BESS integration with all solar/wind plants (≥10% of capacity with 2-hour storage)—should be implemented rigorously.
- Complementary measures include installing synchronous condensers at critical nodes, promoting community-level inertia support, and integrating advanced demand response. Together, these actions can offset lost synchronous inertia, prevent instability, and prepare India's grid for high renewable integration by 2030.

6. Battery Energy Storage Systems (BESS): Arbitrage and Grid Integration Potential



Data for each year covers 1st Jan to 31st July to allow a consistent comparison with 2025.

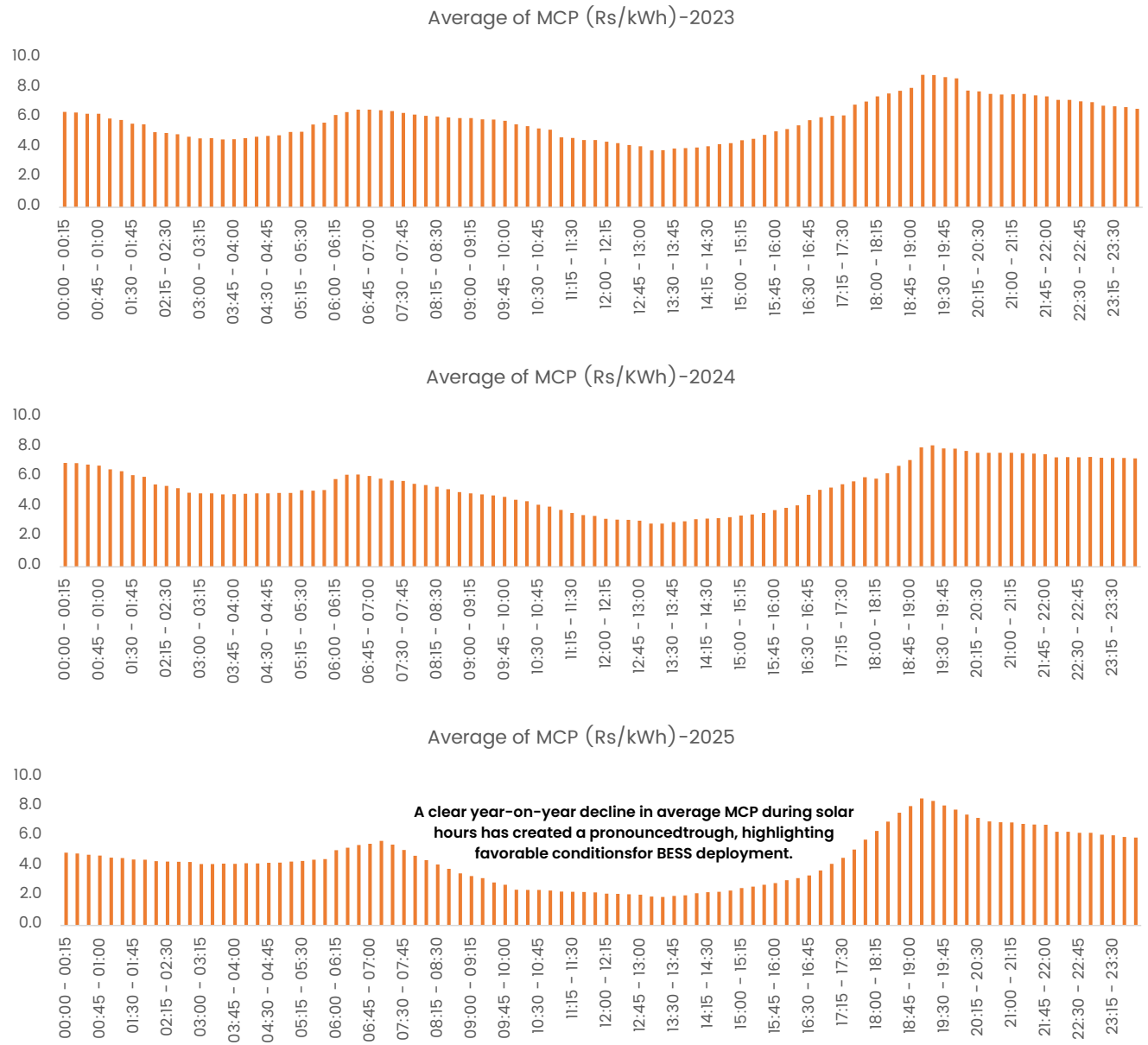


Figure 24: Market price volatility and storage opportunity

Over the past three years, electricity prices in the market have been swinging more widely between low and high points during the day. This growing gap means there are now many more hours when power is very cheap, mainly because of high solar generation, and many more hours when prices rise sharply due to higher demand. Battery storage can take advantage of this pattern by charging when electricity is inexpensive and releasing it when prices peak. This not only allows storage owners to earn more but also helps the grid by reducing stress during peak hours and making better use of renewable energy.

- The analysis of the difference between maximum and minimum Market Clearing Prices (MCPs) over the period 2023–2025 highlights a clear shift in the energy arbitrage window toward higher values for a greater number of days.
- In 2023, most of the arbitrage opportunities were concentrated in the ₹2-6 (USD 0.022–0.066)/kWh range, with 158 instances of higher spreads. By 2024, the number of days with ₹6-8 (USD 0.066–0.088)/kWh spreads rose significantly, with over 219 days witnessing such levels. And in 2025, the market saw a marked shift, with 134 days recording the arbitrage window in the ₹8-10 (USD 0.088–0.11)/kWh for the entire year. This trend clearly indicates that energy price volatility is increasing, opening larger arbitrage opportunities for flexible assets like storage.
- During daytime solar hours, an influx of renewable energy leads to abundant supply and consequent price reductions as seen in the figure above. These "low-price windows" are ideal for charging storage systems with low-cost renewable energy.
  - » Merchant BESS can leverage this growing arbitrage window by:
  - » Charging during solar hours when MCPs are low due to high renewable penetration.
  - » Discharging during peak demand hours when MCPs surge, capturing the value of price spreads.
- This not only enhances project revenues but also provides critical grid support by:
  - » Reducing peak demand stress,
  - » Improving system reliability,
  - » Supporting renewable integration and minimising curtailment.

07

Risk Dimensions in the Transition

07 Risk Dimensions in the Transition

The energy transition, while unlocking immense opportunities for decarbonisation and sustainable growth, also brings with it a diverse set of risk dimensions that must be carefully managed. These risks span across multiple dimensions and effectively addressing these dimensions requires robust risk assessment frameworks, adaptive regulatory mechanisms, comprehensive skilling and workforce development programmes, resilient financing structures, and technological innovation to ensure that the transition remains both sustainable and equitable.

1. Solar Resource Uncertainty: Role of Irradiance Variability

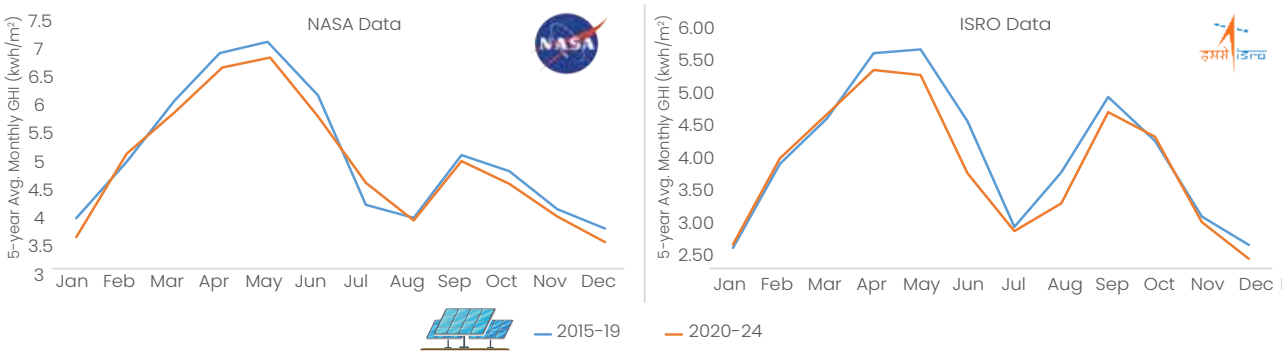


Figure 25: Solar irradiance for a district in Rajasthan: NASA vs. ISRO data (2015–19 vs. 2020–24)

- One of the emerging risks for solar PV generation is the long-term reduction in Global Horizontal Irradiance (GHI), which directly impacts the amount of solar energy available for conversion into electricity.
- In recent years, multiple factors — including rising air pollution levels (particularly across northern India) and changes in monsoon patterns — have contributed to a decline in irradiance levels.
- As illustrated in the figure, a clear downward trend is visible in GHI values for the period 2020–2024 compared with 2015–2019, corroborated by both NASA and ISRO datasets for a district in Rajasthan, India.
  - » The March to June period, typically the peak generation season for solar projects, has witnessed the most significant declines.
  - » Monthly half-decadal averages reveal consistent reductions in GHI across multiple months, confirming that this is not a short-term anomaly but a structural trend.
- This persistent reduction in irradiance has far-reaching implications:
  - » Solar projects deliver less generation than initially projected, widening the gap between expected and actual performance.
  - » Reduced output impacts cash flows and debt servicing, creating risks for developers, investors, and lenders.
  - » Operators may struggle to meet power purchase agreement (PPA) obligations, leading to potential penalties or renegotiations.
- Addressing solar resource uncertainty requires a multi-pronged approach, including:
  - » Incorporating irradiance variability trends into project feasibility studies and yield forecasts.
  - » Leveraging climate models and granular locations specific data for continuous monitoring and forward-looking planning.

2. Impact of Hailstorms on the Solar Infrastructure

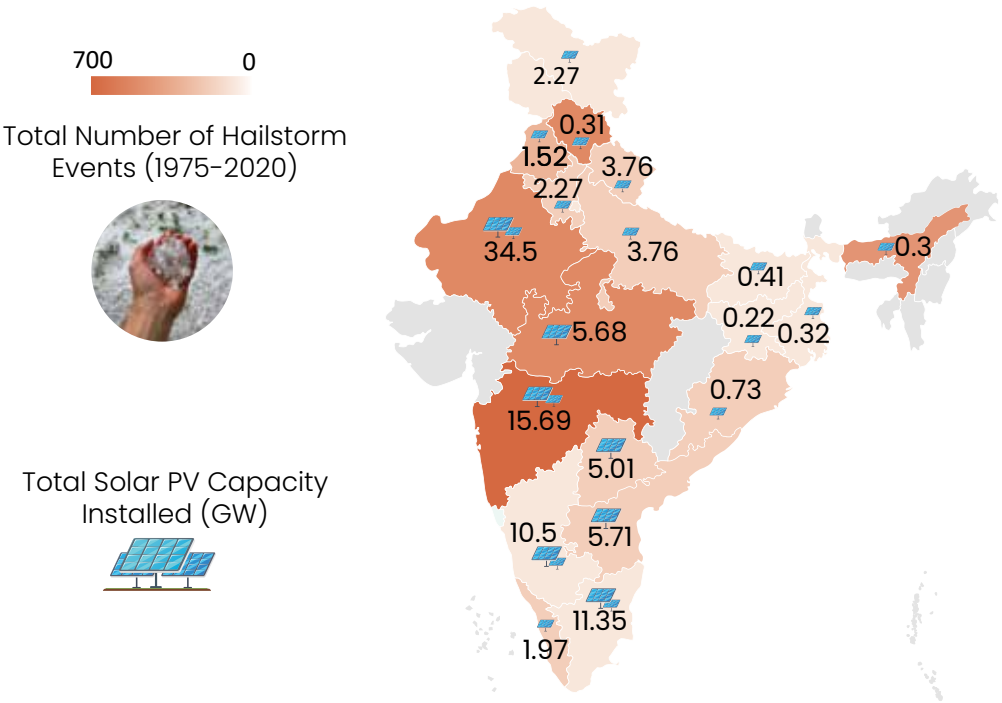


Figure 26: Hailstorm events vs. solar capacity across states[43]

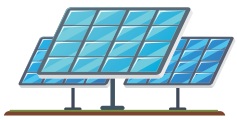
- While solar PV installations are critical to achieving India's RE ambitions, they are increasingly vulnerable to climate-induced extreme weather events, particularly hailstorms. Unlike other natural risks, hail damage is highly localised but can cause catastrophic losses for project owners, developers, operators, and insurers.
- According to Insurance Insider, the average loss per hail claim is around USD 58 million[44] at the global level. Although hail accounts for less than 2% of solar insurance claims by volume, it contributes to over 50% of total monetary losses — underscoring its disproportionate financial impact.
- India's climatic profile makes it particularly prone to hailstorms, especially during the pre-monsoon season (February–April). Around 62% of districts in the country have experienced at least one hail event, with a

statistically significant positive trend in the frequency of inter-annual events. The year 2014 recorded the highest hailstorm activity, with 330 events across 104 districts in 14 states.

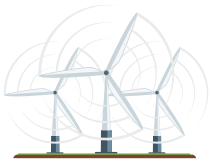
- Maharashtra leads with 614 recorded hailstorm events (1975–2020), followed by Madhya Pradesh (339) and Rajasthan (303). Together, these three states account for 1,256 hailstorm events, representing the densest concentration of hail activity in the country. These same states also host around 51.2 GW of solar capacity, highlighting the scale of infrastructure at risk.
- While hail risks cannot be eliminated entirely, project developers and operators can take proactive measures to reduce vulnerability:
  - » Module Design: Use thicker front glass (≥3.5 mm) and modules that go beyond IEC 61215 type approval, including certifications like hail durability tests or hail characterisation from RETC.
  - » Plant-level Measures: Implement stowing functionality for trackers to tilt modules at safer angles during hail events.
  - » Predictive Analytics: Invest in advanced hailstorm prediction modeling and real-time weather monitoring systems to enable timely alerts, providing operators with sufficient lead time to execute preventive stowing protocols before hailstorms arrive.

3. Cybersecurity in Interconnected and Digitalised Power Systems

Approximate number of endpoints



Solar PV Utility Scale Plant (100 MW); **480–600+**



Wind power Plant (100 MW); **415–500+**

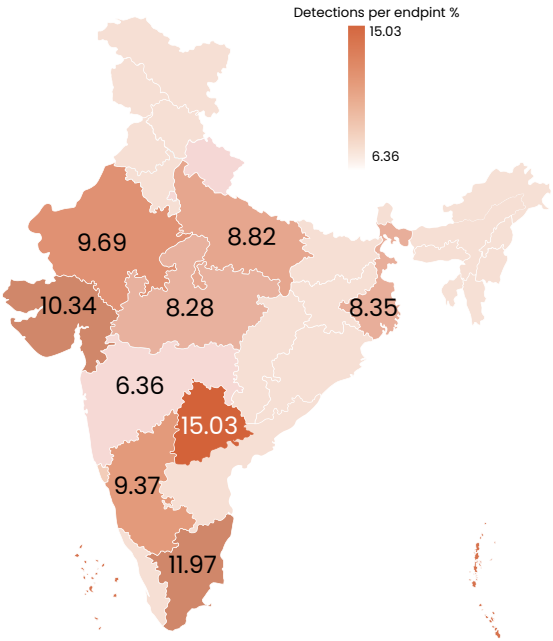
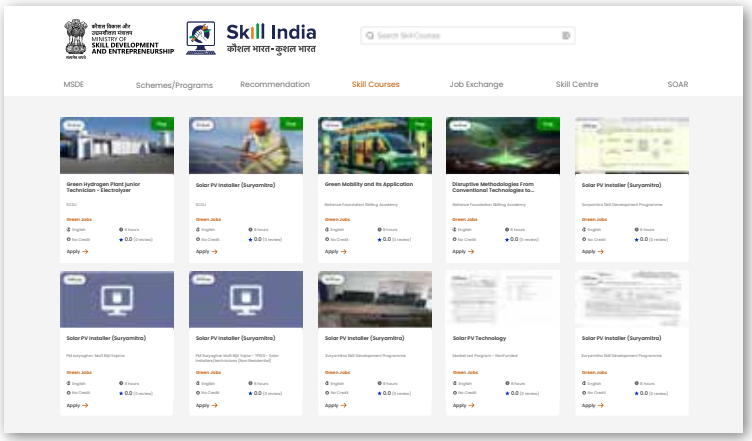


Figure 27: Cyber risks in renewables[45], [46]

- The sheer scale of cyberattacks is staggering across India. Between October 2023 and September 2024, over 369 million security incidents were detected across 8.44 million endpoints, equivalent to nearly 11 cyber threats every second nationwide[47].
- Around 51% of total detections were concentrated in just 10 states[47]. States with stronger digital infrastructure are often better at identifying threats, while those with rapidly expanding power infrastructure also face higher exposure due to growing attack surfaces.
- The power and energy sector spanning power generation, electricity distribution, petroleum, and fuel industries reported 15,355+ detections across 2,132 endpoints[47]. The sector's critical role makes it a high-value target for cyber attackers.
- To put things into perspective, for a 100 MW solar plant, endpoints typically range from 480–600, while a 100 MW wind plant involves 415–500 endpoints. These include inverters, string combiner boxes (SCBs), SCADA/IT systems, sensors, network hardware, turbine PLCs, and subsystems, each serving as a potential entry point for malicious activity.
- To safeguard interconnected and digitalised power systems, a multi-layered cybersecurity framework is essential:
  - » Embed cybersecurity from hardware to software; ensure every component is built with threat modelling in mind.
  - » Secure identities for all entities; use mutual authentication, secure tokens.
  - » Encrypt communication in transit; use integrity checks so tampering is detected; isolate and alert on tampering.
  - » Only accept updates that are signed from trusted sources; maintain chain-of-trust.
  - » Monitor baseline behaviour; detect deviations in energy flows, access patterns, etc.
  - » Assume no device/node is inherently trusted; use least-privilege access; micro-segmentation to limit lateral movement.
  - » Adopt and enforce strong standards; regulatory frameworks; coordination among OEMs, utilities, cybersecurity firms.

4. Human Capital Risks: Workforce Transition and Skilling Readiness



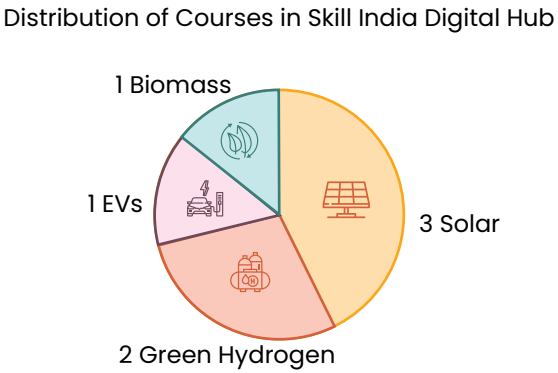


Figure 28: Skill India Digital Hub (SIDH): Course landscape for clean technology skilling

- The energy transition demands not only physical infrastructure but also a rapid evolution in workforce capabilities. While India has built foundational training ecosystems, gaps remain in coordination and localisation of clean-tech skilling initiatives.
- National portals such as BharatSkills[47] and Skill India Digital Hub[48] provide a repository of clean-tech and allied sector courses, yet state-level linkage to industry demands remains weak.
- There is a limited mapping of skill requirements across the clean-tech value chain, spanning manufacturing, installation, operation, and maintenance restricting, effective course alignment.
- Courses often lack direct co-development with industry partners, limiting on-job applicability and placement outcomes.
- Central programmes are robust, but many states lack the institutional capacity to roll out, accredit, and monitor localised training delivery.
- Further, a key aspect that needs to be addressed is the need for local community capacity building and training to support livelihoods and enable a rural economy reform.

5. Safeguarding Grid Stability through Inclusive Digital Momentum

India's Digital Backbone

- UPI - 20 billion transactions a month, powers 85% of India's digital payments and replicated by 8 other countries.[49]
- Aadhar – Created 1.44 billion identities[50]
- Jan Dhan accounts now have 573 million beneficiaries with deposits of ₹2.82 trillion (~USD 31 billion)[51]

India's Social Backbone

- Over 315 million informal workers registered to access social security benefits (E-Shram portal)[52]
- Two-thirds of Jan Dhan accounts in rural and semi-urban areas; 55% held by women[53]
- 26.2% of unincorporated establishments are female-headed; this rises to 58.4% in manufacturing (ASUSE 2023-24)[53]
- Net additions to EPFO subscriptions have more than doubled from FY19 to FY24[54]

- India's power sector is now taking a page from its digital successes. With the launch of the India Energy Stack (IES), a task-force-led roadmap to build a unified digital public infrastructure (DPI) for energy, the goal is to create a secure, interoperable backbone that brings together generation, transmission, distribution, assets and consumers into a data-rich ecosystem.
- Building on India's proven digital model — Aadhaar (1.38 billion identities) , UPI (≈ 20 billion transactions monthly) , and Jan Dhan (561 million accounts, ₹2.68 trillion/USD 29.48 billion deposits) — the IES aims to replicate this scale by introducing unique asset IDs, open APIs, and real-time data exchange across the energy system. Crucially, these digital ecosystems have already brought marginalised populations into the formal financial system, thus, democratising access to essential services like banking, healthcare, employment and affordable mobile data (over 800 million internet users).
- Every node must go digital: Substations, feeders, transformers, smart meters, and distributed renewables need integration to enable real-time grid balancing, demand forecasting, and asset optimisation.

- Notably, a DPI for energy just does not connect assets- it connects people. By bringing visibility and operability to every node, it enables all small, distributed actors like households, women entrepreneurs, rural communities, farmers etc. to participate in energy generation, storage and trading. With this, each consumer transforms itself into a prosumer where inclusivity automatically feeds into grid stability and resilience.
- Delays in building this inclusive digital infrastructure could destabilise the grid. Limited data visibility and fragmented systems risk weakening grid resilience, slowing fault detection, and complicating renewable integration as inverter-based resources rise. Sustained momentum is vital to ensure a smart, stable, and inclusive energy future for India.

08

The Road Ahead

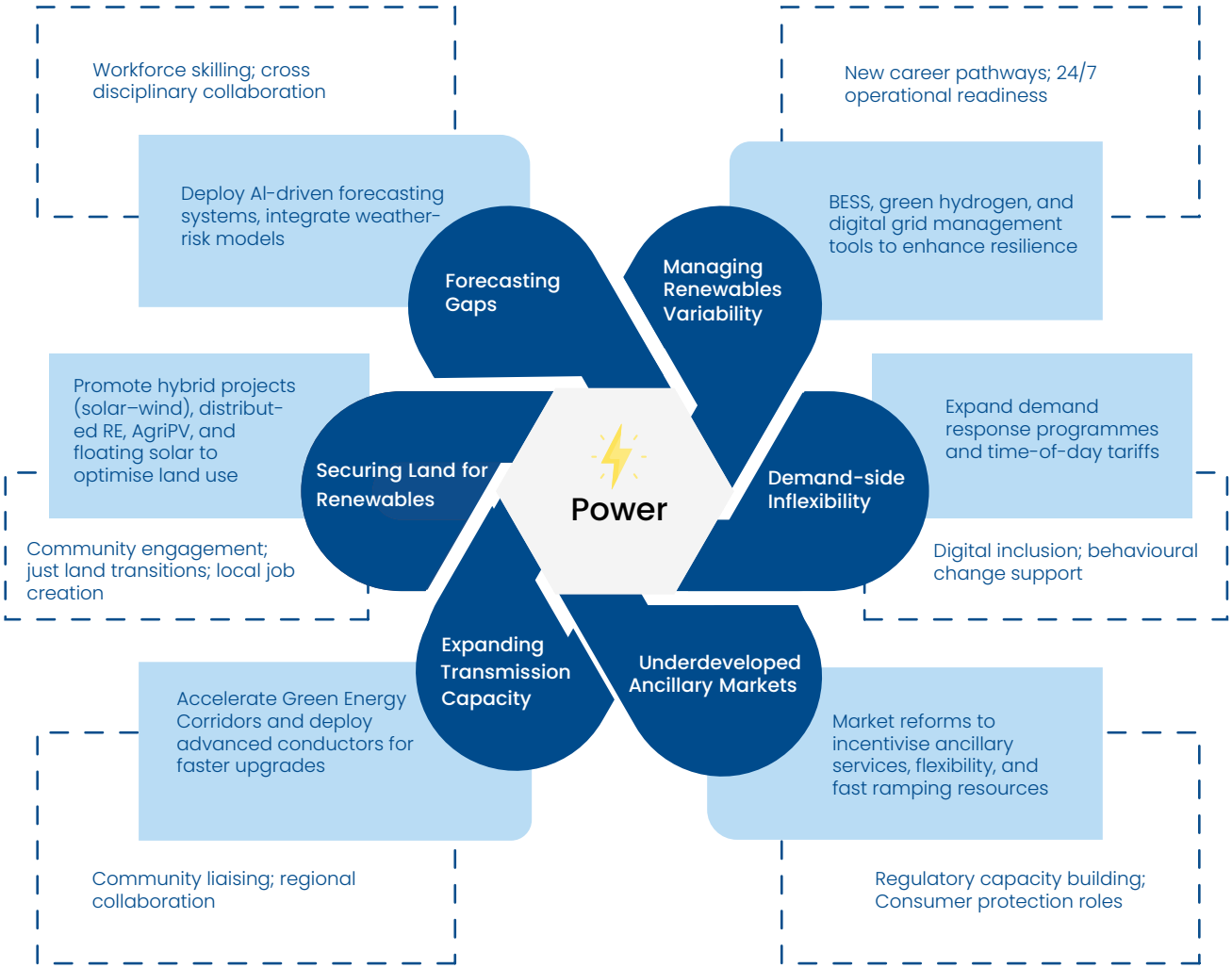
INDUSTRY
5.0
FULL

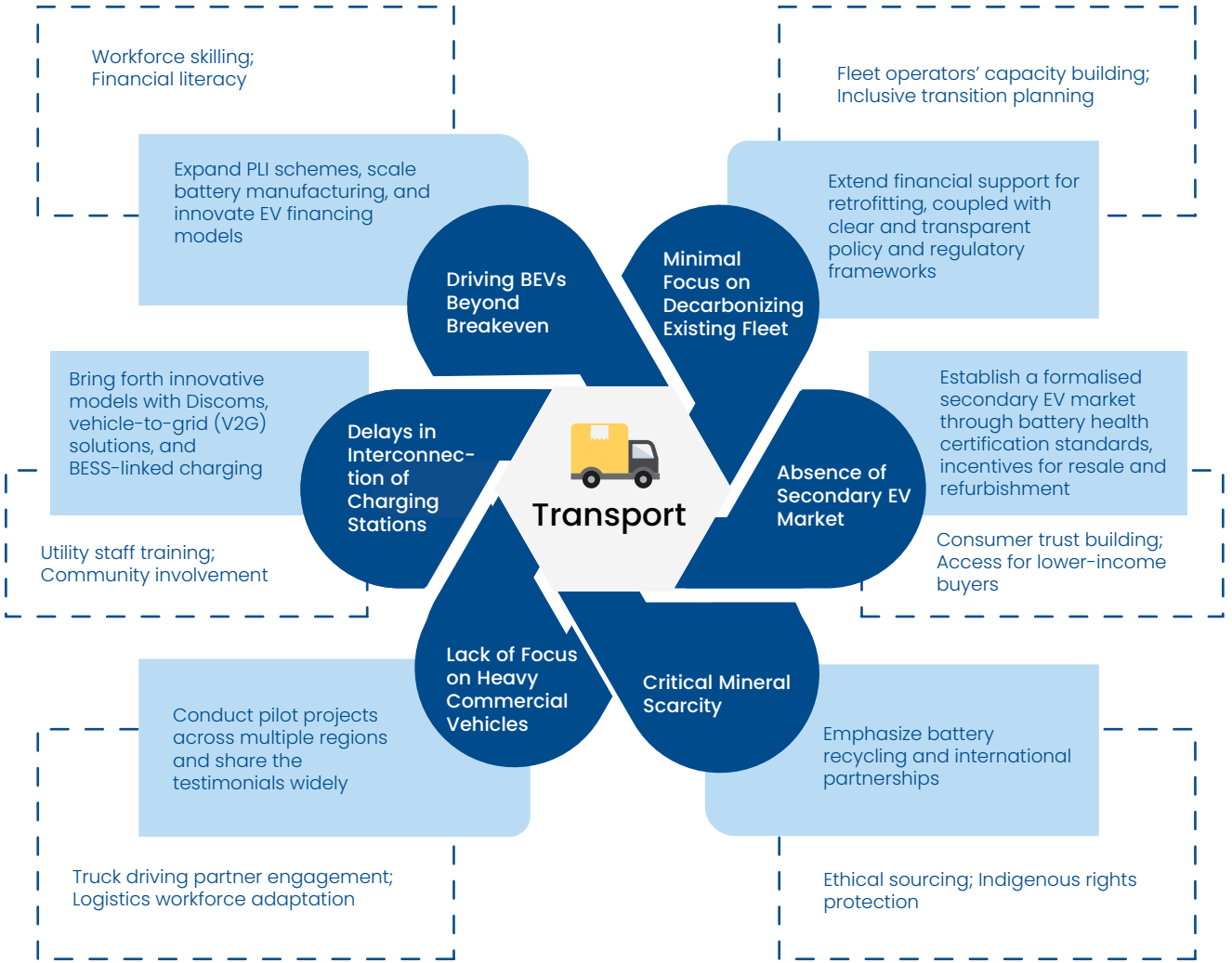
08 The Road Ahead

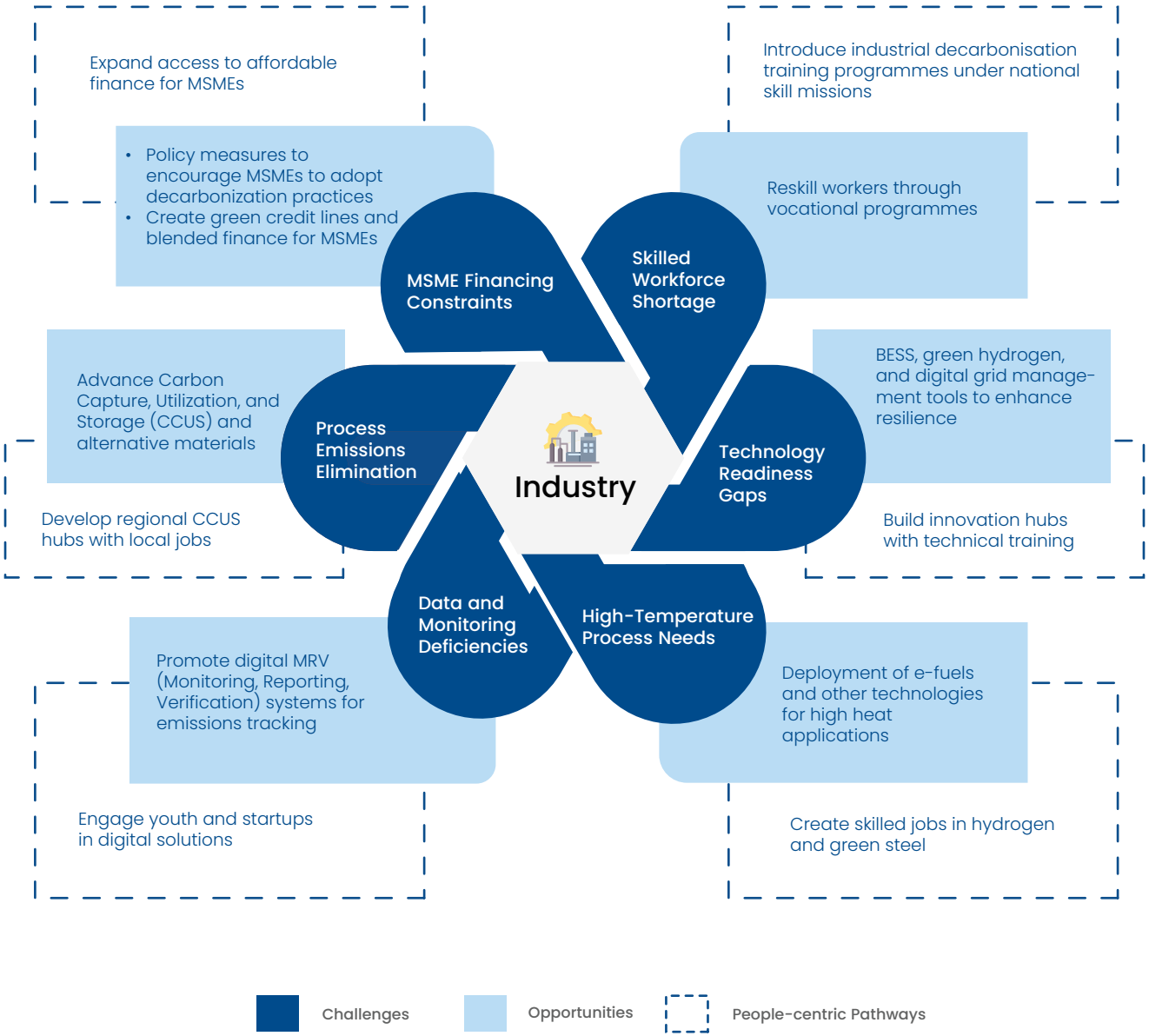
India's energy transition is at a defining juncture marked by rapid renewable deployment, electrification of mobility, and the first steps toward industrial decarbonisation. While the pace of progress has been impressive, the next decade will test the country's ability to integrate renewables at scale, decarbonise hard-to-abate sectors, and ensure that the transition remains affordable, inclusive, and resilient.

Key Challenges, Opportunities and People-centric Pathways

In this section, we outline the major challenges, key opportunities, and people-centric dimensions across the power, transport, and industry sectors. Moving forward, a coordinated effort will be essential to effectively address these challenges and ensure the success of the energy transition.


Workforce skilling; cross disciplinary collaboration
Deploy AI-driven forecasting systems, integrate weather-risk models
Forecasting Gaps
New career pathways; 24/7 operational readiness
BESS, green hydrogen, and digital grid management tools to enhance resilience
Managing Renewables Variability
Promote hybrid projects (solar–wind), distributed RE, AgriPV, and floating solar to optimise land use
Securing Land for Renewables
Power
Expand demand response programmes and time-of-day tariffs
Demand-side Inflexibility
Community engagement; just land transitions; local job creation
Digital inclusion; behavioural change support
Expanding Transmission Capacity
Underdeveloped Ancillary Markets
Accelerate Green Energy Corridors and deploy advanced conductors for faster upgrades
Market reforms to incentivise ancillary services, flexibility, and fast ramping resources
Community liaising; regional collaboration
Regulatory capacity building; Consumer protection roles
Challenges
Opportunities
People-centric Pathways


Workforce skilling; Financial literacy
Expand PLI schemes, scale battery manufacturing, and innovate EV financing models
Driving BEVs Beyond Breakeven
Fleet operators' capacity building; Inclusive transition planning
Extend financial support for retrofitting, coupled with clear and transparent policy and regulatory frameworks
Minimal Focus on Decarbonizing Existing Fleet
Bring forth innovative models with Discoms, vehicle-to-grid (V2G) solutions, and BESS-linked charging
Utility staff training; Community involvement
Delays in Interconnec-tion of Charging Stations
Transport
Establish a formalised secondary EV market through battery health certification standards, incentives for resale and refurbishment
Consumer trust building; Access for lower-income buyers
Absence of Secondary EV Market
Conduct pilot projects across multiple regions and share the testimonials widely
Truck driving partner engagement; Logistics workforce adaptation
Lack of Focus on Heavy Commercial Vehicles
Critical Mineral Scarcity
Emphasize battery recycling and international partnerships
Ethical sourcing; Indigenous rights protection
Challenges
Opportunities
People-centric Pathways


Expand access to affordable finance for MSMEs
Policy measures to encourage MSMEs to adopt decarbonization practices
Create green credit lines and blended finance for MSMEs
MSME Financing Constraints
Introduce industrial decarbonisation training programmes under national skill missions
Reskill workers through vocational programmes
Skilled Workforce Shortage
Advance Carbon Capture, Utilization, and Storage (CCUS) and alternative materials
Develop regional CCUS hubs with local jobs
Process Emissions Elimination
Industry
BESS, green hydrogen, and digital grid management tools to enhance resilience
Build innovation hubs with technical training
Technology Readiness Gaps
Promote digital MRV (Monitoring, Reporting, Verification) systems for emissions tracking
Engage youth and startups in digital solutions
Data and Monitoring Deficiencies
High-Temperature Process Needs
Deployment of e-fuels and other technologies for high heat applications
Create skilled jobs in hydrogen and green steel
Challenges
Opportunities
People-centric Pathways

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Our mission is to promote environment-friendly, socially just and sustainable models of energy by focusing on renewable energy and energy-efficient technologies as well as sustainable lifestyle solutions. Through an innovative approach and data-driven analysis, creation of data repositories with cross-sectoral analysis, along with outreach to ensure resource conservation, we aim to help create a sustainable and inclusive future for India and Mother Earth.

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