Odisha energy transition

Chariots of change

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Odisha has long powered India's industrial growth. Today, it stands ready to power India's clean energy future. The state's evolution — from being the country's mineral and manufacturing powerhouse to becoming a frontrunner in green energy and industrial decarbonization — reflects a new chapter in Eastern India's development journey.

The insights captured in this knowledge report, "Odisha energy transition – Chariots of change," reaffirm that Odisha is uniquely positioned to anchor India's energy transformation. With over 41 GW of renewable potential, expanding pumped storage capacity and a growing focus on green steel and hydrogen ecosystems, the state combines natural endowment with visionary policy direction. Its alignment with the National Electricity Plan (2023–32), the National Hydrogen Mission and the State Renewable Energy and Industrial Policies underscores a deep commitment to balancing growth with sustainability.

The transition to a low-carbon economy will not only redefine how we produce and use energy but also how industries compete, innovate and create value. For Odisha and Eastern India, this transformation presents the opportunity to evolve from resource-based economies to technology-driven, investment-ready energy hubs.

ASSOCHAM, in collaboration with EY, has prepared this knowledge report to highlight actionable pathways for accelerating clean energy adoption, industrial transition and regional competitiveness. It is both a roadmap and a vision document — one that translates India's net-zero aspiration into regional opportunity.

As India steers toward 500 GW of non-fossil capacity by 2030 and net-zero by 2070, Odisha's leadership will be instrumental in shaping a green, resilient and inclusive industrial future. The chariot of change has begun to move — and Odisha is firmly at its helm.

Shri Pankaj Lochan Mohanty

Chairman,
ASSOCHAM Odisha State Development Council

The global energy transition has entered an irreversible phase — one defined by innovation, policy clarity and regional leadership. Within this national and international context, Odisha and Eastern India hold a distinctive strategic position. With abundant natural resources, a robust industrial base and forward-looking policy frameworks, the region has the potential to evolve into India's clean energy growth engine.

This knowledge report by ASSOCHAM and EY — "Odisha energy transition – Chariots of change" — provides an incisive analysis of the opportunities and challenges shaping this transformation. It underlines how Odisha's expanding renewable capacity, strong industrial ecosystem and emerging green hydrogen and storage initiatives can together build a low-carbon, globally competitive industrial corridor.

The report's findings highlight that achieving energy resilience and industrial competitiveness must go hand in hand. Odisha's proactive measures — from implementing the Renewable Energy Policy 2022 and Pumped Storage Policy 2025 to the State Energy Efficiency Action Plan — demonstrate a pragmatic approach where sustainability strengthens productivity. These initiatives are complemented by the private sector's growing commitment to clean energy, digital innovation and carbon neutrality.

For India to meet its 500 GW non-fossil capacity target and advance toward its 2070 net-zero goal, the eastern region must play a catalytic role — unlocking investments, accelerating technology deployment and integrating new energy markets. Odisha is not just prepared for this transition; it is driving it.

This report, therefore, is more than an analysis—it is a statement of intent and capability. It charts how Odisha's energy ecosystem can lead by example, setting the benchmark for clean growth, circular manufacturing and sustainable industry in India and beyond.

Shri Ashesh Padhy

Chairman,
ASSOCHAM Odisha State Energy Council

FOREWARD

India's energy transition has entered a decisive decade. As the country accelerates towards its net zero goal by 2070, Odisha has emerged as a pivotal enabler of the national green growth agenda. The convergence of renewable energy expansion, green hydrogen deployment, industrial decarbonisation and innovative financing frameworks position Odisha to play a defining role in shaping India's clean energy future.

This report presents a comprehensive analysis of the state's evolving energy landscape and outlines strategic pathways to achieve sustainable industrial transformation. It highlights Odisha's significant renewable and pumped storage potential, rapid progress in electric mobility and green hydrogen, and policy alignment through the Industrial Policy Resolution (IPR) 2022 and the Odisha Renewable Energy and Hydrogen Missions.

Odisha's strong foundation for green industrialisation is anchored in its port-based ecosystem at Paradeep, Dhamra and Gopalpur, its substantial renewable energy potential, and progressive incentives for green infrastructure and captive generation. The state's 34 GW of pumped storage potential positions it to lead India's energy storage transformation, enabling 24x7 renewable power and enhancing grid stability. Targeted fiscal and regulatory measures such as electricity duty exemptions, tariff reimbursements, capital subsidies and SGST reimbursements are enabling industries to adopt clean technologies and lower their carbon footprint.

The report also identifies financing innovations that can unlock large-scale investments in clean energy infrastructure. Mechanisms such as blended finance platforms, green bonds and participation in carbon markets can help mobilize private capital and de-risk early-stage projects. Recommendations to establish a State Energy Planning and Transformation Unit, develop PPP templates for energy parks, PSPs and hydrogen hubs, and operationalize a state-level blended climate finance facility provide an actionable roadmap for coordinated and accountable transition planning.

The energy transition effort requires a collaborative framework in which governments, industry and financial institutions work together to translate ambition into measurable outcomes. The findings and recommendations in this report are a step in that direction, offering policy clarity, investment confidence and a vision for inclusive green growth.

As India advances towards its 500 GW non-fossil capacity target, the 2070 net zero vision, and the Viksit Bharat 2047 goal, Odisha's energy transition offers a model for how states can lead from the front integrating growth, green technology and inclusivity into a unified strategy. The state stands poised to become a benchmark for integrated, resilient and equitable clean energy development in the years ahead.

Somesh Kumar

Partner and Leader,
Power & Utilities,
EY India

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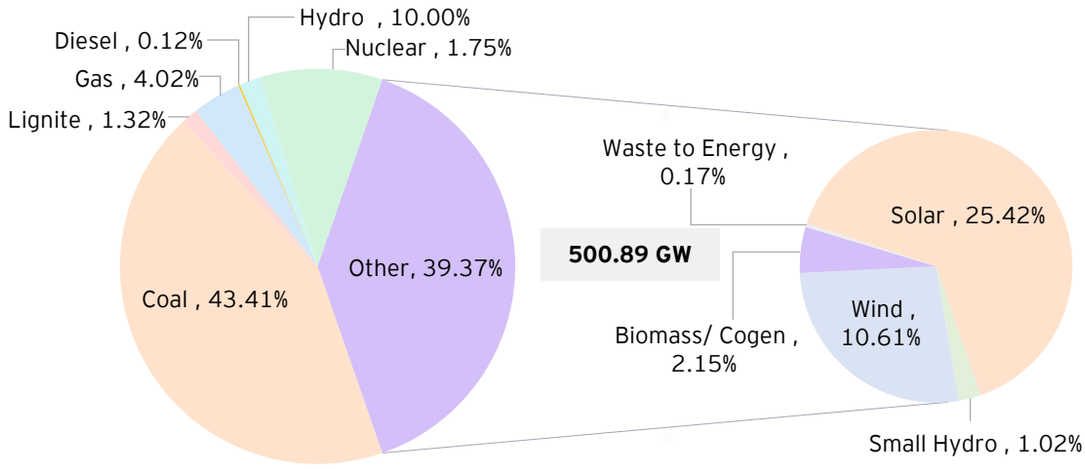
India's energy sector outlook

India's installed capacity and energy mix

India's energy landscape is shaped by its reliance on fossil fuels, which account for nearly 40% of the nation's energy demand[1]. This dependence increases vulnerability to global price fluctuations and geopolitical risks. To strengthen its energy resilience, India is focused on developing a diversified and sustainable energy mix, leveraging abundant domestic low-carbon resources to reduce import reliance and bolster energy independence.

India's energy mix is a cornerstone of its power sector, playing a pivotal role in shaping the country's energy policies and economic growth trajectory. The diverse energy mix encompasses coal, natural gas, renewables, nuclear and hydro. Each source plays a vital role in addressing the country's energy needs, but the sector is also shaped by ongoing efforts to reduce carbon emissions, enhance energy efficiency and integrate renewable energy at scale.

All India installed capacity as on 30.09.2025



Source: CEA Installed Capacity Report

As of 30 September 2025, India's total installed electricity generation capacity stood at 500.89 GW, reflecting the continued expansion and diversification of the national power system. The generation mix shows the transitional pathway balancing conventional thermal generation with an accelerating portfolio of renewable and low-carbon sources.

Thermal power remains the backbone of the national grid, with coal-based plants contributing 217.46 GW, accounting for 43.41% of total capacity. Lignite and gas-based generation add 6.62 GW and 20.13 GW respectively, while diesel-based installations contribute a marginal 0.59 GW. Nuclear energy capacity stands at 8.78 GW, forming 1.75% of the total mix.

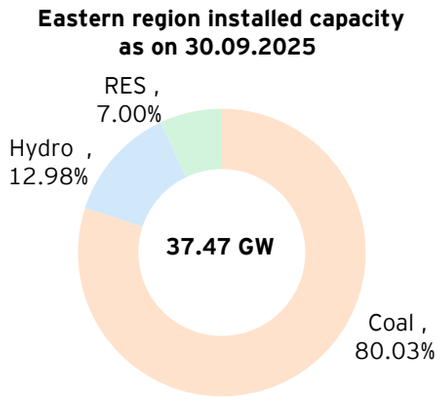
Hydropower continues to play a crucial role in system flexibility and peaking support, with large hydro projects contributing 50.11 GW and small hydro projects adding 5.13 GW, together representing nearly 11% of the national capacity. Among renewable energy technologies, solar power remains the principal growth driver, reaching 127.33 GW or 25.42% of the total capacity. Wind power follows with 53.12 GW, reflecting sustained policy and investment support in high-potential states. Biomass and co-generation projects collectively account for 10.76 GW, while waste-to-energy contributes 0.85 GW.

The overall renewable energy portfolio, including hydro, has reached approximately 199.33 GW, representing nearly 40% of India's installed capacity, which is a clear indication of the country's progress toward achieving its non-fossil capacity targets under the Nationally Determined Contributions (NDCs).

1 *CEA Installed Capacity Report*

Energy mix in the Eastern Regional Grid

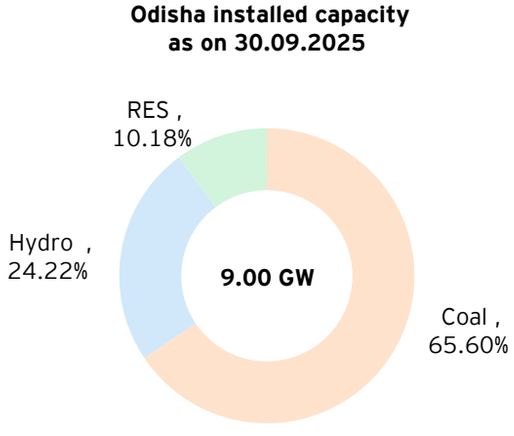
Within the Eastern Region, the total installed capacity stood at 37.47 GW as of September 2025. Coal continues to dominate the regional mix with 29.99 GW, constituting 80.03% of the total. Hydropower contributes 4.86 GW or 12.98%, while renewable energy sources, including solar, wind and biomass account for 2.62 GW, representing 7.00% of the region's capacity. The regional generation profile highlights its continued reliance on coal, although increasing solar and hydro investments signal gradual diversification.



Source: CEA Installed Capacity Report

Energy mix in Odisha

In Odisha, the total installed capacity reached 8.99 GW, with a relatively balanced structure compared to the regional average. Coal-based power contributes 5.90 GW (65.60%), supported by 2.18 GW (24.22%) of hydropower and 0.92 GW (10.18%) from renewable sources. Odisha's hydropower share is notably higher than the Eastern Region's average, reflecting the state's favorable hydro potential and active development of small hydro and pumped storage projects. The growing renewable capacity, driven by solar park developments and industrial decarbonization commitments, indicates the state's strategic shift toward cleaner and more resilient energy infrastructure.



Source: CEA Installed Capacity Report

Overall, the data as of September 2025 captures India's steady progress toward a diversified, low-emission power system. While coal continues to dominate the national and regional electricity supply, the rapid acceleration in solar and wind deployment, coupled with hydro and emerging storage technologies positions India on a credible trajectory toward achieving a sustainable and balanced energy mix by 2030.

India's energy transition and net-zero vision

Under the UN Framework Convention on Climate Change (UNFCCC), countries must develop pathways tailored to their unique circumstances. In line with this, India has charted an energy transition roadmap aligned with its economic priorities, aiming to achieve the vision of 500 GW of renewable energy by 2030[2], amounting to 50% cumulative electric power installed capacity from non-fossil fuel-based energy resources[3] and net-zero emissions by 2070[4] as announced at COP26.

This marks a pivotal turning point in the nation's long-term energy and economic transformation. The transition roadmap emphasizes clean energy expansion, industrial decarbonization and sustainable mobility, while balancing the imperatives of growth, energy access and fiscal prudence. Key 2030 targets under India's Nationally Determined Contributions (NDCs) include:

2 *Press Information Bureau (PIB)*

3 *Ministry of Power*

4 *Press Information Bureau (PIB)*

- **Sustainable living practices:** Promoting a sustainable lifestyle through the 'Lifestyle for Environment' (LiFE) initiative, emphasizing conservation and moderation.
- **Cleaner economic path:** Adopting a climate-friendly development trajectory distinct from the carbon-intensive pathways of other economies at similar stages of growth.
- **Emissions reduction:** Reducing GDP emissions intensity by 45% from 2005 levels.
- **Renewable energy goals:** Achieving 50% of cumulative electric power installed capacity from non-fossil fuel sources, supported by technology transfer and low-cost international finance, including Green Climate Fund (GCF) resources.
- **Carbon sink expansion:** Creating an additional carbon sink of 2.5–3 billion tons of CO2 equivalent through enhanced forest and tree cover.
- **Adaptation investments:** Enhancing resilience in climate-vulnerable sectors, such as agriculture, water resources, coastal areas and disaster management, through targeted investments.
- **Resource mobilization:** Securing domestic and international funding to bridge resource gaps for mitigation and adaptation efforts.
- **Technology and R&D collaboration:** Establishing frameworks for deploying cutting-edge climate technologies and fostering joint international research and development initiatives.

The United Nations Conference on Sustainable Development held in Rio de Janeiro in 2012, initiated the global dialogue on the post-2015 development agenda. Building on this, the 70th Session of the UN General Assembly in September 2015 adopted the landmark resolution "Transforming Our World: The 2030 Agenda for Sustainable Development." The Agenda established 17 Sustainable Development Goals (SDGs) and 169 associated targets, effective from 1 January 2016, to guide global action over a 15-year horizon. SDGs have become de facto global commitments, compelling nations to align domestic priorities with sustainable, inclusive and equitable growth objectives. The "Sustainable Development Goals from the 2030 Agenda for Sustainable Development" of India are as listed[5 6 7].

Goal 1

No Poverty

End poverty in all its forms everywhere

Goal 2

Zero Hunger

End hunger, achieve food security and improved nutrition and promote sustainable agriculture

Goal 3

Good Health and Well-being

Ensure healthy lives and promote well-being for all at all ages

Goal 4

Quality Education

Ensure Inclusive and equitable quality education and promote lifelong learning opportunities for all

Goal 5

Gender Equality

Achieve gender equality and empower all women and girls

Goal 6

Clean Water and Sanitation

Ensure availability and sustainable management of water and sanitation for all

Goal 7

Affordable and Clean Energy

Ensure access to affordable, reliable, sustainable and modern energy for all

Goal 8

Decent Work and Economic Growth

Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

5 *https://www.mospi.gov.in/sustainable-development-goalssdgs*

6 *https://www.sdgindia2030.mospi.gov.in/dashboard/overview*

7 *https://www.niti.gov.in/sites/default/files/2024-07/SDG_India_Index_2023-24.pdf*

Goal 9

Industry, Innovation and Infrastructure

Butid resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

Goal 10

Reduced Inequality

Reduce inequality within and among countries

Goal 11

Sustainable Cities and Communities

Make cities and human settlements inclusive, safe, resilient and sustainable

Goal 12

Responsible Consumption and Production

Ensure sustainable consumption and production patterns

Goal 13

Climate Action

Take urgent action to combat climate change and its impacts

Goal 14

Life Below Water

Conserve and sustainably use the oceans, seas and marine resources for sustainable development

Goal 15

Life on Land

Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Goal 16

Peace, Justice and Strong Institutions

Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and bull effective, accountable and inclusive institutions at all levels

Goal 17

Partnerships for the Goals

Strengthen the means of implementation and revitalize the global partnership for sustainable development

These national commitments are supported by sectoral missions and institutional frameworks developed by the Ministry of Power (MoP), Ministry of New and Renewable Energy (MNRE), NITI Aayog and multilateral partners such as the World Bank, ADB and IFC, who are aligning financial and technical support toward decarbonization of power, industry and transport sectors.

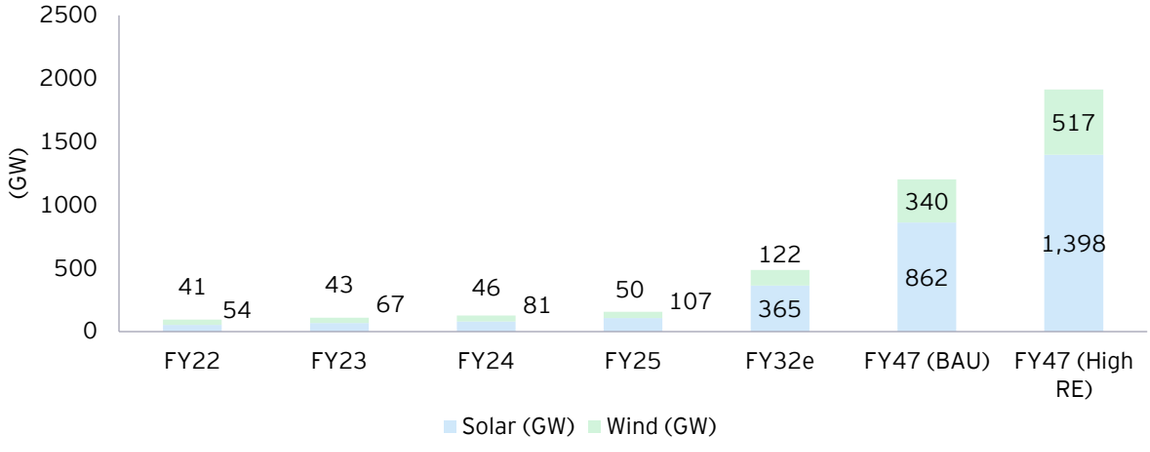
Renewable energy expansion and market transformation

Surpassing Nationally Determined Contribution (NDC) targets

India has surpassed its NDC target under the Paris Agreement by achieving over 50% of installed power generation capacity from non-fossil sources five years ahead of schedule[8]. As of 30 July 2025, India's total installed capacity stood at ~490 GW, of which ~243 GW came from non-fossil sources, including ~188 GW of renewables, ~49.6 GW of large hydro and ~8.8 GW of nuclear power. According to the Central Electricity Authority's Optimal Generation Mix Report (CEA, 2023), India aims to achieve 500 GW of non-fossil-based capacity by 2030, a goal that will require sustained annual capacity additions of approximately 35–40 GW throughout the decade.

While renewables now account for over 40% of total installed capacity, their contribution to actual electricity generation remains below 15%, reflecting intermittency and grid integration challenges. Solar energy continues to dominate with ~120 GW, followed by ~50 GW of wind power. This rapid expansion is attributed to strengthened institutional mechanisms for demand aggregation, competitive bulk procurement, de-risked Power Purchase Agreements (PPAs), and improved payment security frameworks. Streamlined green open-access regulations and transparent market structures have further accelerated private participation.

All India solar and wind power generation capacity (expected) (GW)



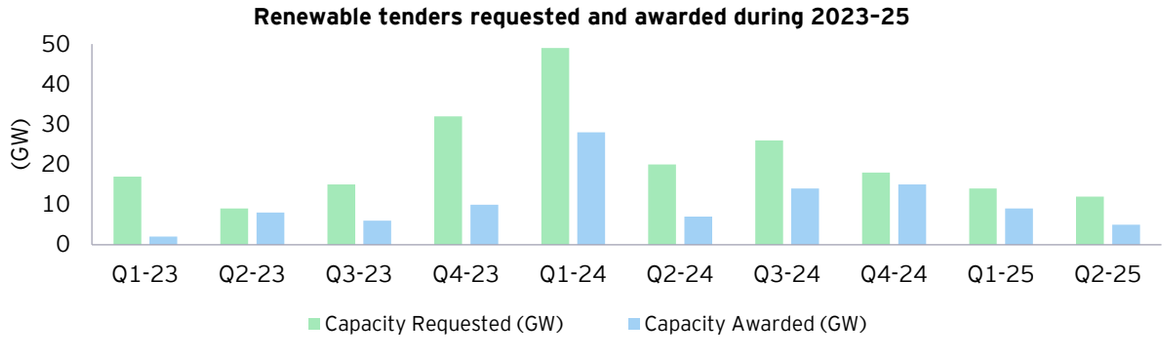
Tariff competitiveness of RE power

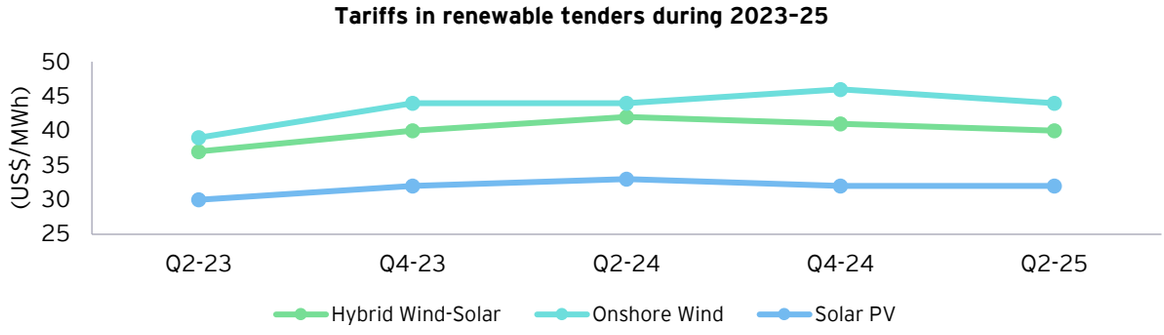
India's renewable power market continues to demonstrate strong tariff competitiveness, supported by large-scale tendering and evolving market structures that increasingly integrate energy storage for dispatchable renewable supply. As of June 2025, India's renewable installed capacity has reached 185 GW, with 22 GW of new additions in the first half of the year—approximately 60% higher year-on-year, driven by developers rushing to avail full inter-state transmission system (ISTS) charge waivers before their expiry[9].

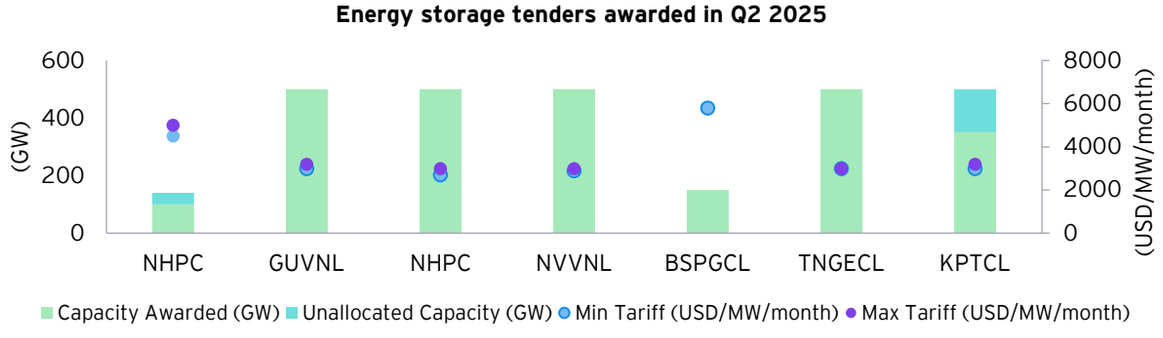
A gradual reintroduction of Inter-state Transmission System (ISTS) charges —beginning with 25% from July 2025 and rising to 100% by June 2028—is expected to influence future tariff dynamics. However, full waivers for projects with co-located storage and pumped hydro remain in force until 2028, providing a strong incentive for hybrid and storage-based renewable projects.

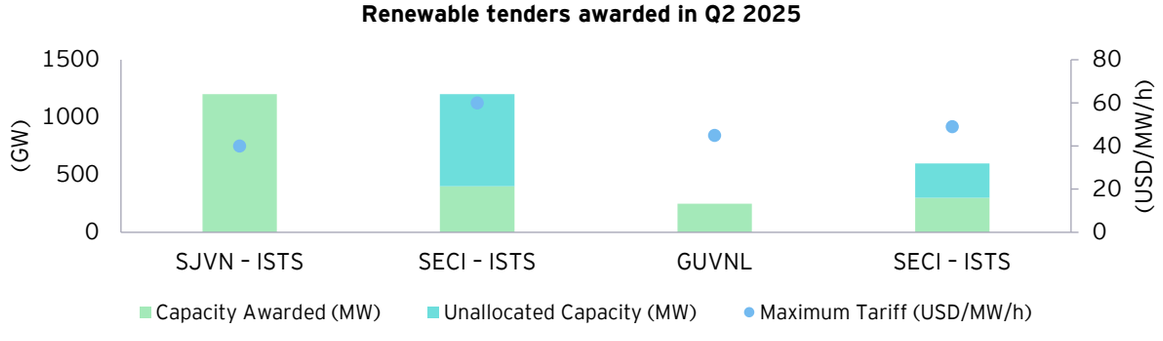
8 *EY Eigenvectors of net-zero energy transition: Pathways to Viksit Bharat 2047*

9 *https://www.spglobal.com/commodity-insights/en/news-research/blog/energy-transition/081125-renewables-tender-in-india-energy-storage-dominates-awarded-capacity*









Source: S&P Global

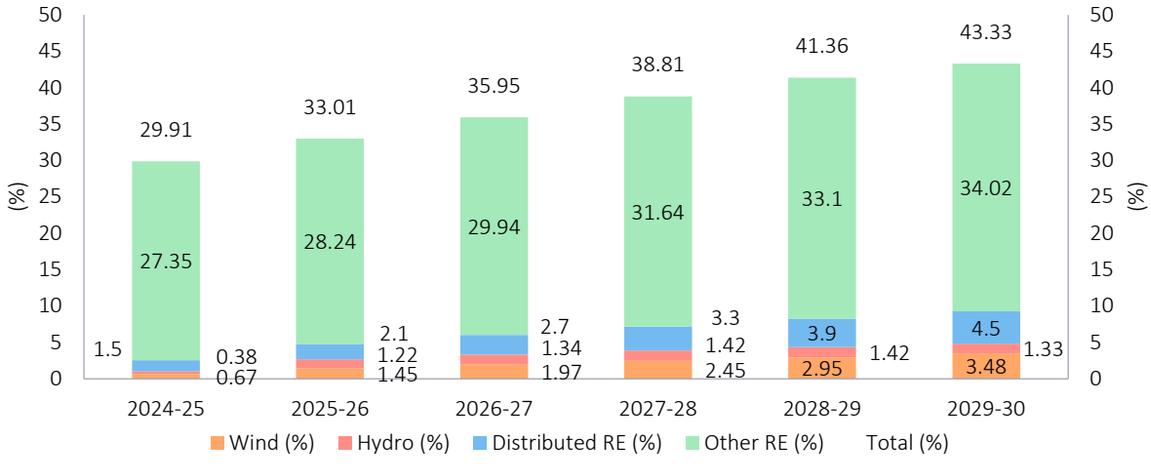
Tariff trends in recent competitive tenders indicate that renewable-plus-storage projects are increasingly cost-competitive, with prices averaging around US$31/MWh, notably lower than standalone wind projects (US$44–47/MWh). Hybrid tenders with storage now account for nearly half of all awarded capacity, reflecting a market shift toward firm and dispatchable renewable energy models.

NHPC	*National Hydroelectric Power Corporation Limited*	NVVN	*NTPC Vidyut Vyapar Nigam Ltd*
GUVNL	*Gujarat Urja Vikas Nigam Limited*	TNGECL	*Tamil Nadu Green Energy Corporation Limited*
BSPGCL	*Bihar State Power Generation Company Ltd.*	KPTCL	*Karnataka Power Transmission Corporation*

Role of RPOs in accelerating energy transition

The Renewable Consumption Obligation (RCO), notified under the Energy Conservation (Amendment) Act, 2022, represents a pivotal regulatory instrument designed to accelerate India's transition towards a low-carbon energy system. The RCO mandates all designated consumers—comprising electricity distribution licensees, open access consumers and captive users—to ensure a minimum percentage of their total electricity consumption is sourced from renewable energy. This policy framework extends the earlier Renewable Purchase Obligation (RPO) mechanism by linking renewable energy consumption directly to energy users, thereby enhancing accountability and compliance under the broader energy conservation framework[10] [11].

Renewable Consumption Obligation (RCO) targets



Source: Ministry of Power

By setting progressively increasing targets—from 29.91% in FY 2024-25 to 43.33% by FY 2029-30—the RCO establishes a predictable and enforceable trajectory for renewable energy integration across sectors. The inclusion of specific sub-targets for wind, hydro and distributed renewables encourages technological diversification and decentralized energy generation. The fungibility of compliance mechanisms, including Renewable Energy Certificates (RECs), Virtual PPAs and buyout options, further enhances flexibility while ensuring market-based compliance.

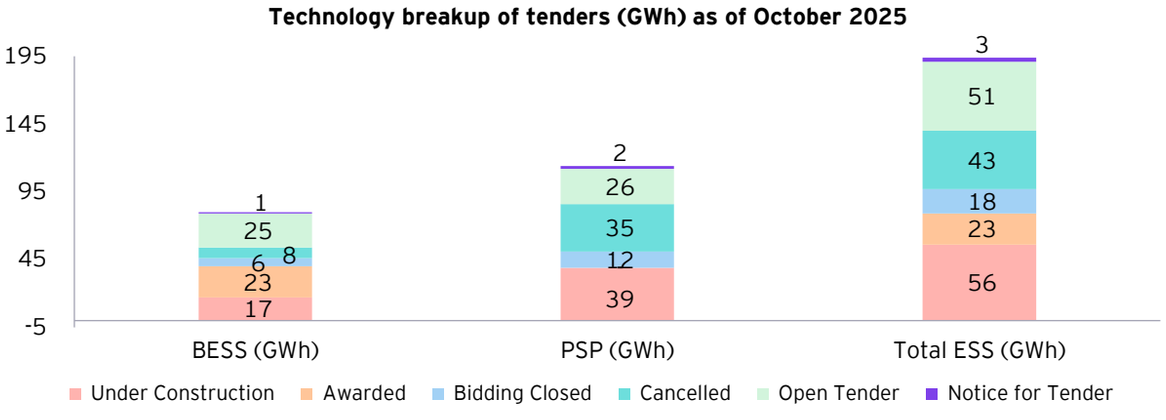
Energy storage and pumped storage development

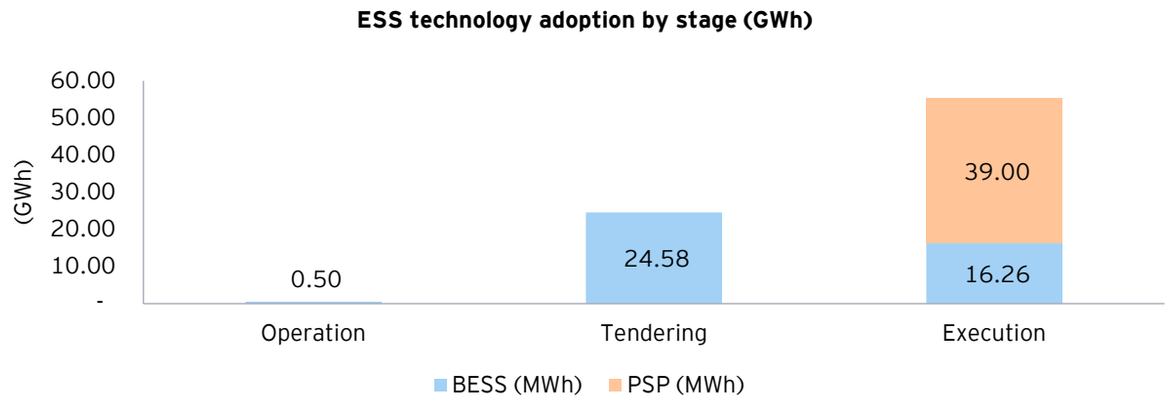
To manage the growing intermittency from variable renewables, India is accelerating deployment of energy storage systems. The India Energy Storage Market Overview (IESA, 2025) reports as of October 2025, 195 GWh of Energy Storage Systems (ESS) capacity tenders has been shared of which 79 GWh is in various stages of execution and 70 GWh is in tendering process with 43 GWh tenders cancelled[12].

10 *https://beeindia.gov.in/renewable-consumption-obligations-rco.php*

11 *https://beeindia.gov.in/sites/default/files/Revised%20draft%20notification%20on%20RCO%20under%20EC%20Act%20(3).pdf*

12 *IESA Market Overview, October 2025 Update*

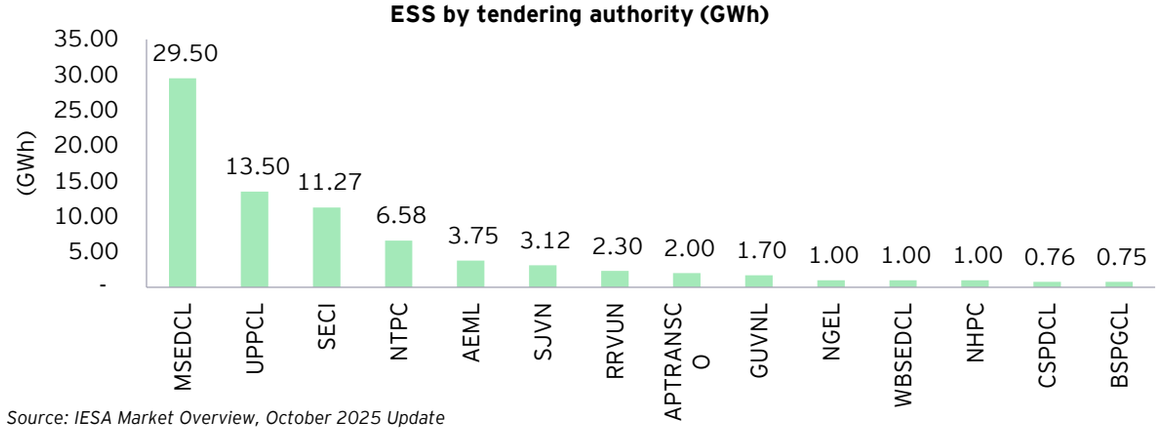




Source: IESA Market Overview, October 2025 Update

India's energy storage sector has entered a phase of accelerated deployment. As of October 2025, operational Energy Storage Systems (ESS exceed 800 MWh, spanning solar-plus-storage, standalone BESS and Round-the-Clock(RTC)/ Firm and Dispatchable Renewable Energy (FDRE) projects. Key operational examples include SECI's 400 MW/100 MWh Karnataka RTC project and TPDDL's 10 MWh pilot in Delhi.

Projects under execution indicate a major scale-up, with over 13 GWh of BESS capacity contracted through SECI, NTPC, NHPC and SJVN-led FDRE and Solar+ESS tenders. Winning tariffs are in the INR3.4–4.7/kWh range, marking a clear trajectory toward cost competitiveness.



Source: IESA Market Overview, October 2025 Update

MSEDCL	*Maharashtra State Electricity Distribution Company Limited*	RRVUN	*Rajasthan Rajya Vidyut Utpadan Nigam*
UPPCL	*Uttar Pradesh Power Company Limited*	APTRANSCO	*Transmission Corporation of Andhra Pradesh Limited*
SECI	*Solar Energy Corporation of India*	GUVNL	*Gujarat Urja Vikas Nigam Ltd.*
NTPC	*National Thermal Power Corporation*	NGEL	*NTPC Green Energy Limited*
AEML	*Adani Electricity Mumbai Limited*	WBSEDCL	*West Bengal State Electricity Distribution Company Limited*
SJVN	*Satluj Jal Vidyut Nigam*	NHPC	*National Hydroelectric Power Corporation Limited*
CSPDCL	*Chhattisgarh State Power Generation Company*	BSPGCL	*Bihar State Power Holding Company Limited*

The tender pipeline remains robust, exceeding 35 GWh across 2025, driven by SECI, NTPC, MSEDCL, APTRANSCO and RRVUNL, with both BOO and EPC models gaining traction. Large pumped storage projects such as NTPC's 3 GWh and MSEDCL's 24 GWh tenders are emerging as strategic complements to BESS for long-duration flexibility.

Energy Storage Systems (ESS) under execution as of October 2025									
Tendering authority	**Location**	**RE (MW)**	**ESS (MWh)**	**Tender scope**	**Category**	**Winners**	**Storage technology**	**Winning bid (INR)**	**Commission approval / PSA signed month**
Standalone PSP									
NTPC	Pan-India	-	3,000	BOO	PSP	Greenko	PSP	27.8 lakh/MW/ year	Sep-24
MSEDCL	Maharashtra	-	24,000	BOO	PSP	NHPC and Torrent	PSP	0.80 - 1.10 crore/MW/ year	Mar-25
UPPCL	Uttar Pradesh	-	12,000	BOO	PSP	JSW &and Adani	PSP	93.9 kW/MW/ year	Nov-24

Source: IESA Market Overview, October 2025 Update

This expanding portfolio demonstrates India's transition from pilot-scale deployments to grid-scale ESS integration, establishing a diversified technology mix and a competitive tariff structure essential for achieving national flexibility and reliability goals.

Highlights of the National Electricity Plan (2023–2032)

The National Electricity Plan (2023–2032) emphasizes on the centrality of energy storage in achieving India's long-term power system flexibility and reliability objectives. The Plan projects a cumulative storage requirement of approximately 74 GW / 411 GWh by FY 2031–32[13] [14]. The key highlights of the plan are provided.

Review of 2017–22 performance and installed capacity overview

- The scheduled conventional capacity addition for 2017–22 was 51,561.15 MW, whereas the achieved addition stood at 30,667.91 MW.
- India's cumulative installed renewable energy capacity, including large hydro, rose from 156,607.9 MW (March 2022) to 167,750.3 MW (December 2022).
- Around 26,421.5 MW of planned capacity (Coal–18,320 MW, Hydro–4,801.5 MW, Nuclear–3,300 MW) was delayed mainly due to COVID-19 disruptions.
- As of 31 March 2022, total installed capacity stood at 398,986.9 MW, including 235,599 MW Thermal, 6,780 MW Nuclear, and 156,607.9 MW Renewables.

13 *https://www.energy-storage.news/india-requires-74gw-411gwh-of-energy-storage-by-2032-according-to-national-electricity-plan/*

14 *https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2023/09/20230901125607134 9.pdf*

Demand and energy requirement projections

- As per the 20th EPS Report, the projected energy requirement is 1,907.8 BU and peak demand 277.2 GW for 2026–27.
- For 2031–32, energy requirement and peak demand are projected at 2,473.7 BU and 366.4 GW, respectively.
- Energy savings projections for 2026–27 are 213 BU (moderate) and 285 BU (ambitious), rising to 304 BU and 404 BU by 2031–32.

Capacity addition and under-construction projects

- Under-construction capacities include 26,900 MW coal, 11,494 MW hydro, 2,780 MW PSP, and 8,700 MW nuclear.
- Solar and wind projects totalling 117,580 MW (Solar–92,580 MW, Wind–25,000 MW) are under implementation for 2022–27.
- Total retirements of 2,121.5 MW are planned during 2022–32, aligned with modernization and environmental compliance needs.

Generation capacity requirement (2022–27)

- The required capacity addition for 2022–27 totals 211,819 MW, including 31,880 MW conventional and 179,939 MW renewable-based capacity.
- The renewable capacity includes Large Hydro–10,462 MW, Solar–131,570 MW, Wind–32,537 MW, and PSP–2,700 MW.
- Battery Energy Storage System (BESS) capacity of 8,680 MW/34,720 MWh is projected for this period.
- Likely installed capacity by 2026–27 will reach 609,591 MW, with 273,038 MW conventional and 336,553 MW renewable-based capacity.

Generation capacity requirement (2027–32)

- For 2027–32, projected capacity addition is 291,802 MW, comprising 32,080 MW conventional and 259,722 MW renewable-based capacity.
- Renewable capacity includes Solar–179,000 MW, Wind–49,000 MW, PSP–19,240 MW, and Large Hydro–9,732 MW.
- BESS requirement increases substantially to 38,564 MW/201,500 MWh by 2031–32.
- Likely installed capacity by 2031–32 will be 900,422 MW, including 304,147 MW conventional and 596,275 MW renewable-based capacity.

Scenario analysis and storage requirements

- Beyond under-construction 26.9 GW Coal, additional coal requirement till 2031–32 ranges between 19.1 GW and 27.1 GW.
- BESS requirement in 2026–27 varies from 2.1 GW/8.4 GWh to 22.8 GW/91.2 GWh across scenarios.
- For 2031–32, BESS requirement is expected between 38.7 GW/193.6 GWh and 67 GW/335.2 GWh.
- Total storage by 2031–32 is projected at 73.93 GW/411.4 GWh, comprising 26.69 GW PSP and 47.24 GW BESS.

Electricity generation and fuel utilization

- Projected generation in 2026–27 is 2,025 BU, including Coal–1,203.4 BU, Hydro–207.7 BU, and Solar PV–339.3 BU.
- Coal Plant Load Factor (PLF) is expected to be 58.4% in 2026–27 and 58.7% in 2031–32.
- Domestic coal demand rises to 866.4 MT (2026–27) and 1,025.8 MT (2031–32), with 28.9 MT imports for specific plants.

Financial requirements and investment outlook

- Total fund requirement for 2022–27 is INR14,54,188 crore, including advance expenditure for 2027–32 projects.
- Fund requirement for 2027–32 is estimated at INR19,06,406 crore, excluding post-2032 projects.
- For 2022–27, developers need INR3,63,547 crore equity and INR10,90,641 crore debt infusion.
- For 2027–32, estimated equity requirement is INR4,76,602 crore and debt requirement INR14,29,805 crore.

Environmental and sustainability performance

- Average CO_2 emission rate from coal stations shows a continuous decline, reflecting efficiency improvements in generation.
- Fly ash utilization achieved 259.86 million tonnes (95.95%) during 2021–22, showcasing environmental compliance efforts.
- Total CO_2 emissions are projected to increase from 1,002 MT (2021–22) to 1,100 MT (2031–32).
- Emission factor is expected to reduce from 0.548 kg CO_2/kWh (2026–27) to 0.430 kg CO_2/kWh (2031–32).
- Share of non-fossil capacity will increase from 40% (2022) to 57.4% (2026–27) and 68.4% (2031–32), signifying strong decarbonization momentum.

Earlier modeling by the CEA had estimated a need for around 28 GW / 108 GWh of storage capacity by 2030 to support India's 500 GW non-fossil generation target, which includes 450 GW of solar and wind capacity. The NEP 2023, however, presents a more dynamic trajectory, reflecting enhanced renewable integration targets, peaking demand growth and the emerging role of storage in frequency regulation and peak-load management. Beginning FY 2026–27, the CEA anticipates a phased scale-up of both battery and pumped hydro storage capacity, as summarized below:

Year	Battery storage output	Battery storage capacity	Pumped hydro output	Pumped hydro capacity	Total output	Total capacity
UoM	(GW)	(GWh)	(GW)	(GWh)	(GW)	(GWh)
2026-2027	8.68	34.72	7.45	47.60	16.13	82.32
2029-2030	41.65	208.25	18.98	128.15	60.63	336.40
2031-2032	47.24	236.22	26.69	175.18	73.93	411.40

Source: IESA Market Overview, October 2025 Update

This implies aggregate investments exceeding INR3 trillion over the period, of which approximately INRI75.2 billion (US$910 million) is expected for pumped hydro projects and INR2,926 billion (US$35.2 billion) for BESS. Looking ahead, the CEA's long-term scenario (Vision 2047) projects a storage requirement of nearly 320 GW / 2,380 GWh, comprising approximately 230 GW / 1,840 GWh of battery systems and 90 GW / 540 GWh of pumped hydro capacity[15].

National Hydrogen Mission and emerging Hydrogen economy

With its renewable energy capacity, decarbonization goals and favorable cost structures, strategic government policies and industry participation aim to establish a self-reliant ecosystem lead the global green hydrogen market by serving both domestic needs and international demand[16] [17].

Decarbonization initiatives

- Replacement of natural gas in industries such as refineries and fertilizers.
- Current hydrogen consumption in India stands at approximately 6 MMTPA.
- By 2030, GH2 consumption is projected to reach 12 MMTPA, with prices to be approx US$2 - 2.5/kg.

Industrial applications

- Adoption in high carbon intensive sectors such as steel, cement, heavy trucking, aviation, and maritime to enable decarbonization.

Energy storage and grid flexibility

- Provides alternative energy storage solution, offering flexibility to grids through physical (compressed gas) or chemical storage (e.g., ammonia).

15 *https://www.energy-storage.news/india-requires-74gw-411gwh-of-energy-storage-by-2032-according-to-national-electricity-plan/*

16 *India's hydrogen demand projected at 12mmtpa by 2030; prices expected at $2-2.5/kg, ET EnergyWorld (indiatimes.com)*

17 *Green hydrogen push: India eyes $7-15 billion import substitution, plans $4-12 billion investment, ET EnergyWorld (indiatimes.com)*

Energy self-reliance

- India aims to reduce fossil fuel dependence through its green hydrogen mission, fostering energy security.

Competitive production costs

- Low-cost RE generation positions India to be a competitive hydrogen producer, with electrolyzer costs expected to decrease due to economies of scale and global policy support.

Export potential

- India, along with countries like Argentina, Australia, and Saudi Arabia, is poised to become a key player in the global green hydrogen and ammonia market.

Green hydrogen policy landscape

The government's policy push, coupled with investments in hydrogen production, can create jobs and foster a new ecosystem for growth. Public sector enterprises, such as Oil India Limited and NTPC, are already pioneering green hydrogen initiatives, further accelerated by supportive government policies[18].

National Green Hydrogen Mission

Budgetary allocation:

- Total outlay of INR19,744 crore until FY 30.

Strategic goals:

- Annual production target of 5 MMT of GH2 by 2030.
- Addition of 125 GW of RE capacity for GH2 production.
- Mobilization of INR8 lakh crore in investments across the hydrogen value chain.

•SIGHT Programme (Strategic Interventions for Green Hydrogen Transition):

- Electrolyzer manufacturing: Allocated INR4,440 crore to support indigenous manufacturing.
- Green hydrogen production: INR13,050 crore for production incentives.
- Green ammonia expansion: Enhanced annual production capacity to 750,000 tons.
- Focused measures to drive cost reductions and boost adoption rates.

18 *Understanding the Green Hydrogen landscape in India: Demand from industries, global collaborations are the key, ET EnergyWorld (indiatimes.com)*

State Policy Initiatives

Adoption across states

- Rajasthan, Uttar Pradesh, Maharashtra, and Andhra Pradesh spearheading green hydrogen policy implementation.
- Provisions for capital subsidies (up to 30%) and financial support for R&D and land acquisition in Odisha.

Tax incentives:

- GST refunds for equipment and operations related to green hydrogen.
- Waivers on electricity duties and cross-subsidy surcharges to lower operational costs.

Policy impact:

- Encouraging investments in state-level green hydrogen hubs.
- Boosting local manufacturing and creating job opportunities.

Other policy measures

Transmission benefits:

- 25-year inter-state transmission charge waiver for renewable projects commissioned before 2030.
- Enhances cost-effectiveness for green hydrogen producers.

•Environmental clearances:

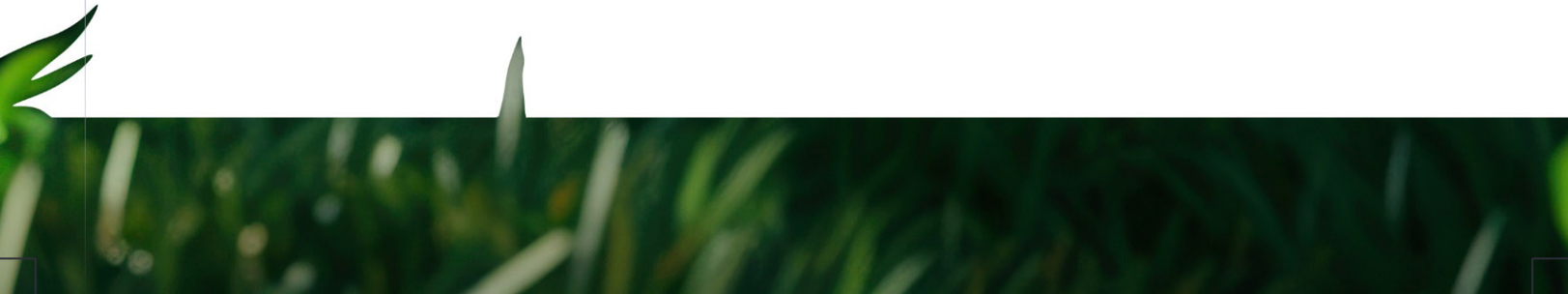
- Exemption for green ammonia plants from prior environmental approvals.
- Reduces bureaucratic hurdles and accelerates project timelines.

Electricity (Promoting Renewable Energy through Green Energy Open Access) Rules, 2022:

- Streamlined open access to renewable energy for green hydrogen production.
- Encourages industrial-scale adoption and integration.

Green hydrogen investments

The sector in India is emerging and its widespread adoption requires significant support from public and private sectors. Scaling up capacity would necessitate substantial investment to develop a robust ecosystem.



Reliance Industries Limited (RIL)

Along with other conglomerates, plans to set up green hydrogen (GH) and green ammonia (GA) units at Deendayal Port Authority (DDA) in Gujarat, with RIL alone committing INR1 lakh crore. (over US$12 billion), one of the largest investments in India's energy infrastructure.

Green Hydrogen Policy Impact

The Kerala government has received investment proposals totaling INR72,760 crore from four major companies seeking subsidies under the green hydrogen policy.

Essar Group

Plans to invest INR30,000 crore (US$3.7 billion) over four years to establish a green hydrogen plant in Jamnagar, Gujarat, with 1 GW electrolyzer capacity and associated green molecule production of 1 MTPA

Hygenco Green Energy

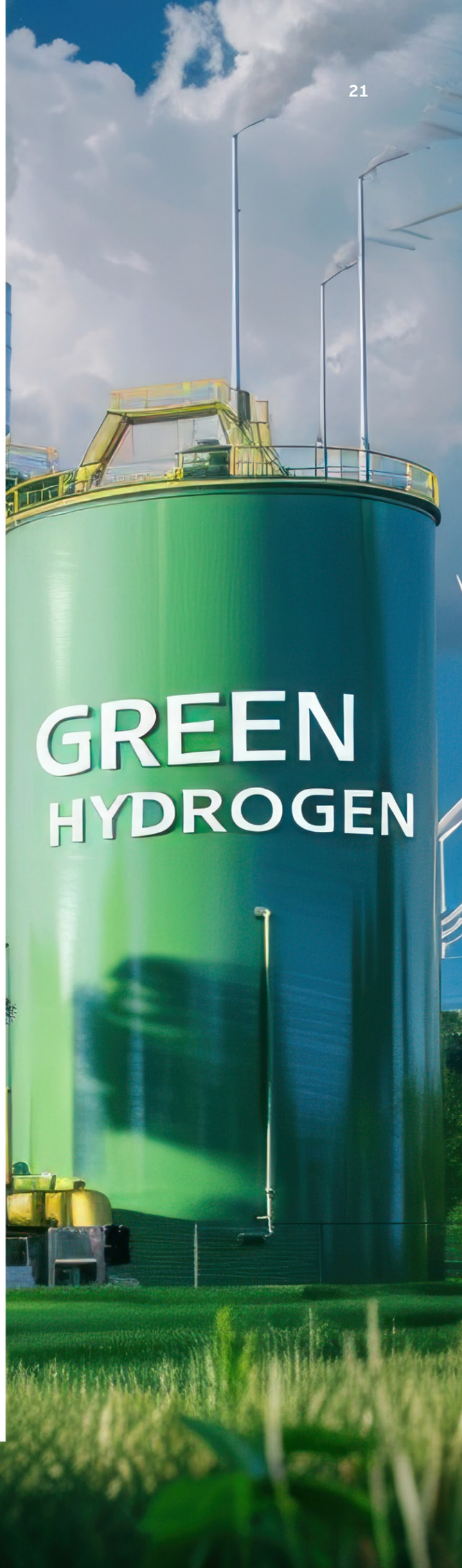
Plans to invest US$2.5 billion over three years to set up green hydrogen projects across various states, currently operating two plants and a 140 KW R&D project in Ujjain and a 3 MW plant in Hisar.

National Thermal Power Corporation (NTPC)

Signed a Land Lease Agreement and, in February 2024, entered into an agreement with AP Industrial Infrastructure Corporation for developing an integrated green hydrogen hub including a facility with production capacity of 1,200 tons per day.

NTPC Green Energy Limited (NGEL)

Signed an MoU with Govt. of Maharashtra for developing green hydrogen, green ammonia, and green methanol up to 1 MTPA as part of Maharashtra's Green Investment Plan, with a potential investment of INR80,000 crore.

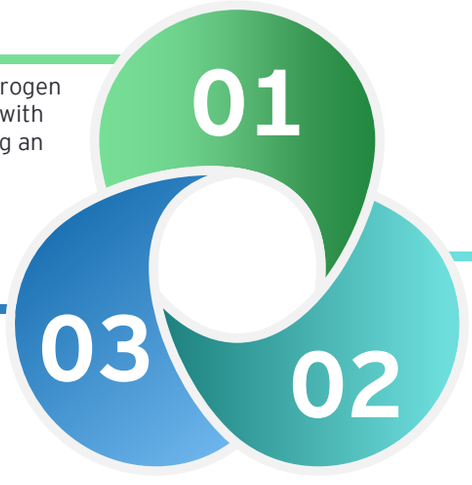


Hydrogen export opportunities: Reversing the energy flow tides

The disparity between the production and consumption could drive the emergence of a tradeable green hydrogen market[19]. While supply-side incentives have effectively kickstarted development, domestic demand will be a key factor in sustaining growth. Currently, 90% of hydrogen in India is used for captive purposes leading to a small market[20]. Until domestic demand is established, exporting could be a vital strategy to achieve economies of scale. The EU, Japan and South Korea are major importers due to their consumption targets, with the EU aiming to consume 20 million tons by 2030[21].

ACME India

Proposes a 1.2 MTPA Green Hydrogen and Ammonia Project in Odisha, with IHI Corporation of Japan securing an offtake agreement.



Sembcorp Industries

Entered into an agreement with Japan's Sojitz Corp and Kyushu Electric Power Co. to export green hydrogen from India to Japan.

YARA Clean Ammonia and Greenko ZeroC

Signed an agreement for the supply of renewable ammonia from a production facility in Kakinada, Andhra Pradesh

India's industrial sectors, steel, ammonia and refining are expected to drive early domestic demand of over 2.5 MMT annually by 2030 (EY, 2024). The export market, particularly toward Japan, Korea and the EU, presents an additional US$20–25 billion opportunity. The eastern coastal corridor, led by Odisha, holds strategic advantage due to port connectivity, industrial clusters and renewable potential for green hydrogen-based exports.

Energy efficiency in Odisha via State Energy Efficiency Action Plan

Odisha's industrial sector is a cornerstone of its economic and energy landscape, contributing significantly to the state's Gross Value Added and accounting for a major share of total electricity consumption. The State Energy Efficiency Action Plan (SEEAP)[22] identifies the industrial sector as a focus area for achieving large-scale energy savings, emission reductions and productivity gains. The plan outlines baseline energy consumption patterns, potential savings under moderate and ambitious scenarios and a framework for implementing energy efficiency measures through national and state-level programs such as Perform, Achieve and Trade (PAT) and the BEE-SME initiative. The section below presents a consolidated summary of industrial energy efficiency under the SEEAP, structured into five key subsections.

Industrial energy profile and baseline assessment

- Odisha's industries account for over 54% of total energy consumption, with large energy-intensive sectors leading demand growth.
- The Iron and Steel sector dominates industrial consumption, representing nearly 60% of total industrial energy use in the state.
- The mining sector, driven by coal and mineral extraction, contributes approximately 15% of industrial energy consumption.
- MSMEs in clusters such as rice mills, refractories, and food processing units collectively account for 8%–10% of total industrial energy use.
- The total electricity consumption in industries reached around 22,000 MU in FY 2022–23, with steady annual growth driven by capacity expansion.

19 *Harnessing_Green_Hydrogen_V21_DIGITAL_29062022.pdf (niti.gov.in)*

20 *The East Asian opportunity: Prioritising Japan and Korea in India's green hydrogen strategy (orfonline.org)*

21 *Green hydrogen push: India eyes $7-15 billion import substitution, plans $4-12 billion investment, ET EnergyWorld (indiatimes.com)*

22 *https://beeindia.gov.in/sites/default/files/SEEAP_Odisha_Final.pdf*

Energy efficiency potential and scenario projections

- The SEEAP estimates moderate energy savings potential of 2,719 ktoe by 2030 under existing policies and ongoing programs.
- An ambitious scenario projects potential savings of 4,133 ktoe, achievable through enhanced adoption of advanced technologies and retrofits.
- The industrial sector's emission reduction potential is estimated at approximately 9 million tonnes of CO_2 equivalent by 2030.
- Total investment potential for industrial energy efficiency measures is projected at around INR25,000 crore, primarily in process optimization and waste heat recovery.
- Energy savings are expected through improved boiler efficiency, waste heat utilization, motor system optimization, and renewable integration in captive power use.

Key energy efficiency programs and implementation mechanisms

- The Perform, Achieve, and Trade (PAT) Scheme covers 33 Designated Consumers (DCs) across major industries including steel, aluminium, and thermal power.
- PAT cycles have resulted in cumulative energy savings exceeding 1 Mtoe, demonstrating measurable efficiency improvements across energy-intensive facilities.
- The BEE-SME Program supports over 100 MSMEs in Odisha through energy audits, technology demonstration, and capacity-building initiatives.
- The plan promotes Energy Management Cells (EMCs) within industries to institutionalize continuous monitoring of efficiency and consumption trends.
- The Odisha State Designated Agency (SDA) coordinates implementation with sectoral associations, DISCOMs, and OREDA for cross-sectoral synergy and data reporting.

Policy and regulatory framework for industrial efficiency

- The SEEAP aligns with the Odisha Industrial Policy Resolution (IPR) 2022, emphasizing sustainable production and resource-efficient operations.
- The Odisha Renewable Energy Policy 2022 complements energy efficiency by encouraging solar-based captive generation for industrial loads.
- Mandatory energy audits and benchmarking protocols are recommended for industries consuming above 1,000 TOE per annum.
- Incentives are proposed for ISO 50001 certification, adoption of energy-efficient motors, and retrofit of inefficient equipment in MSMEs.
- A centralized monitoring framework under the SDA enables data collection, evaluation, and reporting of energy performance indicators annually.

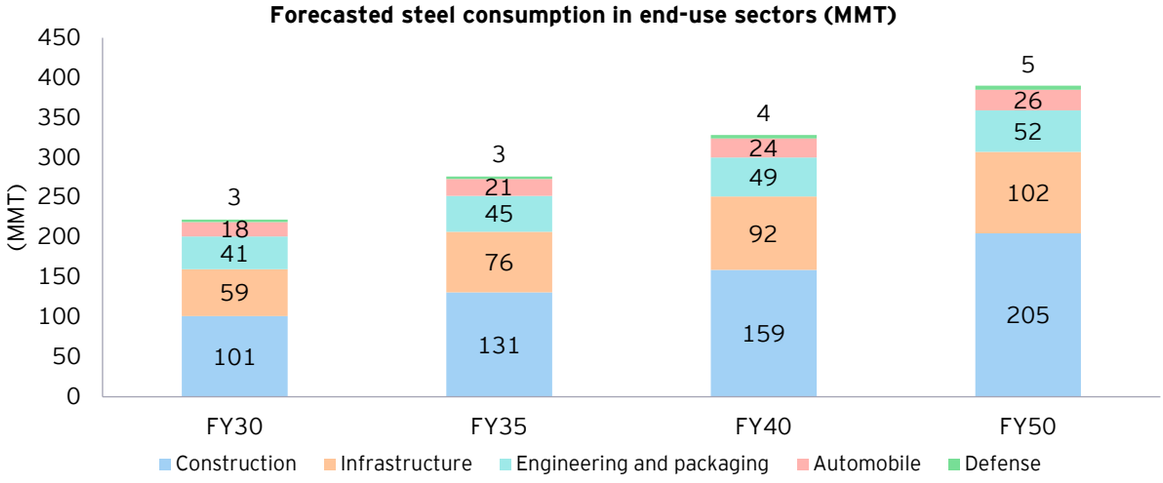
Strategic roadmap and future outlook

- The SEEAP envisions establishing five energy efficiency clusters (including Angul, Jharsuguda, and Rourkela) as industrial EE demonstration zones.
- Capacity-building programs could train over 500 energy managers and auditors to support monitoring and verification at the cluster level.
- A dedicated Industrial EE Financing Facility (IEEFF) is proposed to leverage public and private funding for large-scale retrofits.
- Industries may be encouraged to adopt digital monitoring systems and IoT-enabled energy dashboards for real-time consumption analysis.
- The SEEAP targets achieving annual energy savings of 1.5% in large industries and 2% in MSMEs from 2025 onward.

Energy efficiency in the steel sector

India's steel sector

India's steel sector is positioned as a central pillar in the nation's journey toward a US$30 trillion economy by 2047. As the backbone of industrial growth, infrastructure development and manufacturing, steel plays a pivotal role in realizing the country's long-term vision of self-reliance and sustainable development. Under the National Steel Policy (NSP) 2017, India set an ambitious target of achieving 300 MMT of crude steel capacity by FY 2030–31, with a projected production of 255 MMT and finished steel output of 230 MMT. Building upon this foundation, the country now envisions expanding its installed capacity to 500 MMT by 2047.

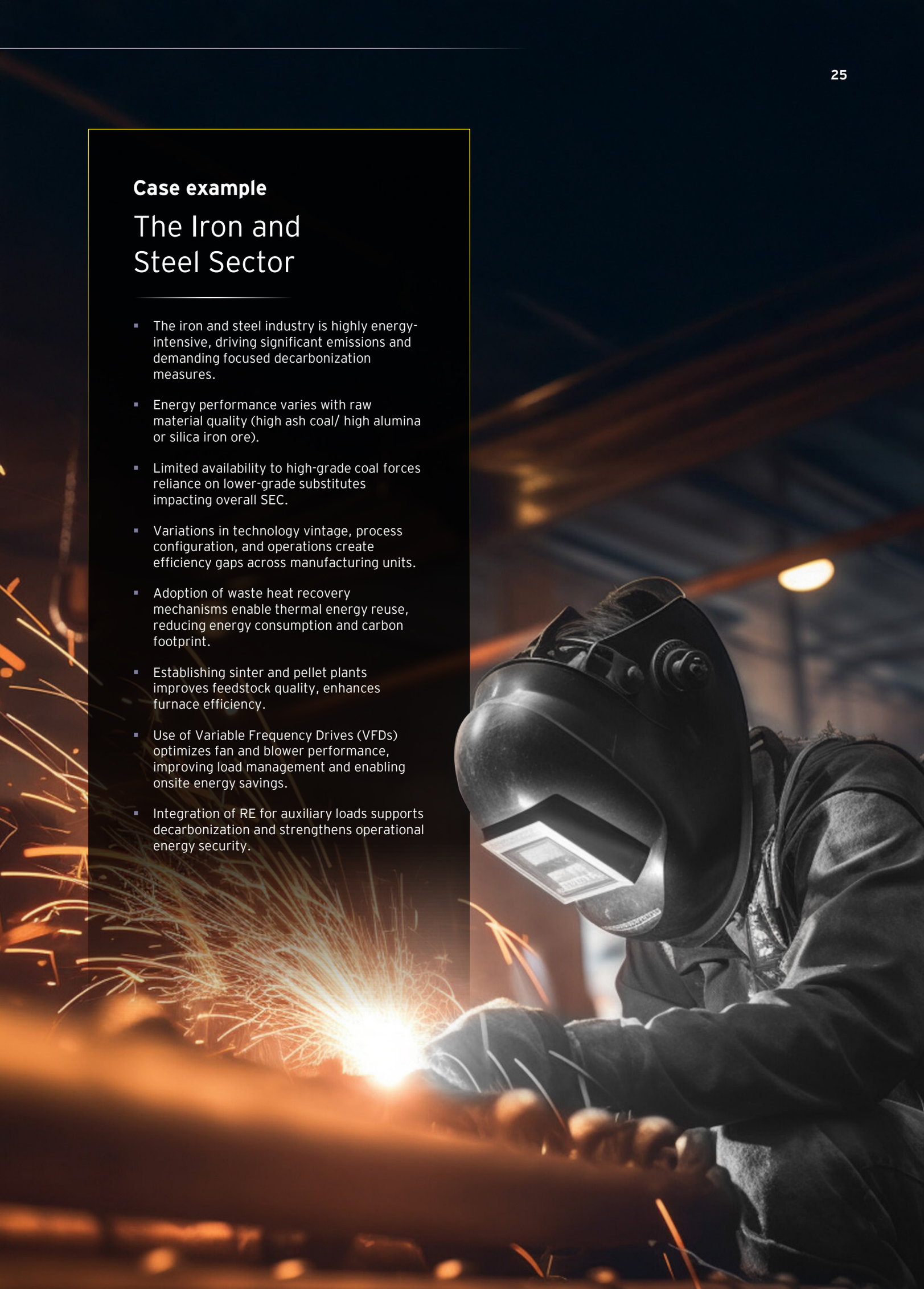


Source: EY Unlocking green steel demand: An assessment of India's automotive, infrastructure and construction sectors

Steel consumption CAGR over the fiscal years across the sectors				
Sector	FY24-FY30	FY30-FY35	FY35-FY40	FY40-FY50
Construction	9.69%	5.34%	3.95%	2.57%
Infrastructure	9.62%	5.19%	3.90%	1.04%
Engineering and packaging	5.34%	1.88%	1.72%	0.60%
Automobile	6.99%	3.13%	2.71%	0.80%
Defence	20.03%	0%	5.92%	2.26%

Source: EY Unlocking green steel demand: An assessment of India's automotive, infrastructure and construction sectors

Current consumption patterns highlight significant potential for growth. In FY 2024, India consumed 136 MMT of steel, with construction and infrastructure sectors jointly accounting for 78% of total demand. However, per capita steel consumption remains at just 97.7 kg one-third of the global average indicating vast untapped potential driven by urbanization, industrialization and government-led capital investments. By FY 2050, total steel demand is projected to reach 390 MMT, led by construction (205 MMT) and infrastructure (102 MMT). To sustain this trajectory, the sector must balance capacity expansion with decarbonization, quality enhancement and supply chain resilience, ensuring that India's steel growth aligns with global sustainability and competitiveness goals.



Case example

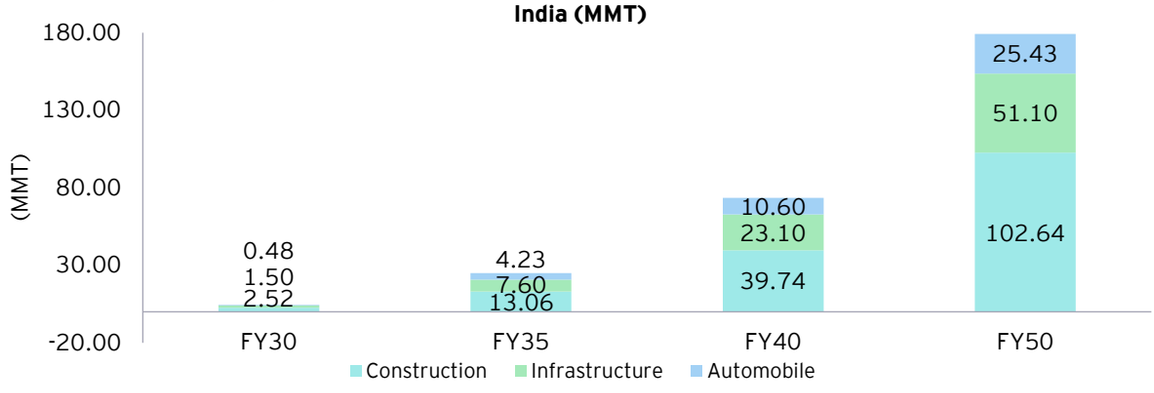
The Iron and Steel Sector

- The iron and steel industry is highly energy-intensive, driving significant emissions and demanding focused decarbonization measures.
- Energy performance varies with raw material quality (high ash coal/ high alumina or silica iron ore).
- Limited availability to high-grade coal forces reliance on lower-grade substitutes impacting overall SEC.
- Variations in technology vintage, process configuration, and operations create efficiency gaps across manufacturing units.
- Adoption of waste heat recovery mechanisms enable thermal energy reuse, reducing energy consumption and carbon footprint.
- Establishing sinter and pellet plants improves feedstock quality, enhances furnace efficiency.
- Use of Variable Frequency Drives (VFDs) optimizes fan and blower performance, improving load management and enabling onsite energy savings.
- Integration of RE for auxiliary loads supports decarbonization and strengthens operational energy security.

Green steel: Decarbonization in the steel sector

India's transition towards green steel is gaining strategic momentum, driven by industrial decarbonization targets, global supply chain pressures and evolving ESG mandates. Green steel produced through green hydrogen-based Direct Reduced Iron (H_2-DRI) or renewable energy-powered Electric Arc Furnaces (EAF) offers a viable pathway to reduce emissions intensity below 0.5 tCO_2 per ton of crude steel. Demand, though negligible today, is projected to rise sharply from 4.49 MMT in FY 2030 to 179 MMT by FY 2050, led primarily by construction (102.6 MMT), infrastructure (51.1 MMT) and automobile (25.4 MMT) sectors.

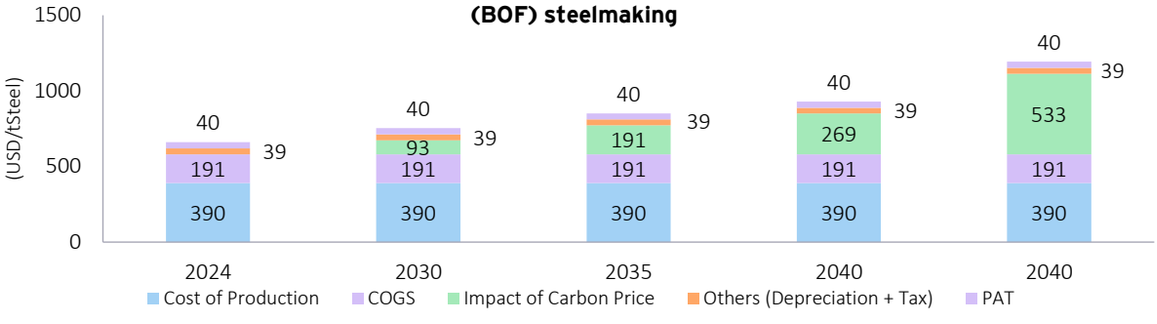
Demand for green steel in construction, infrastructure and automobile sectors in India (MMT)



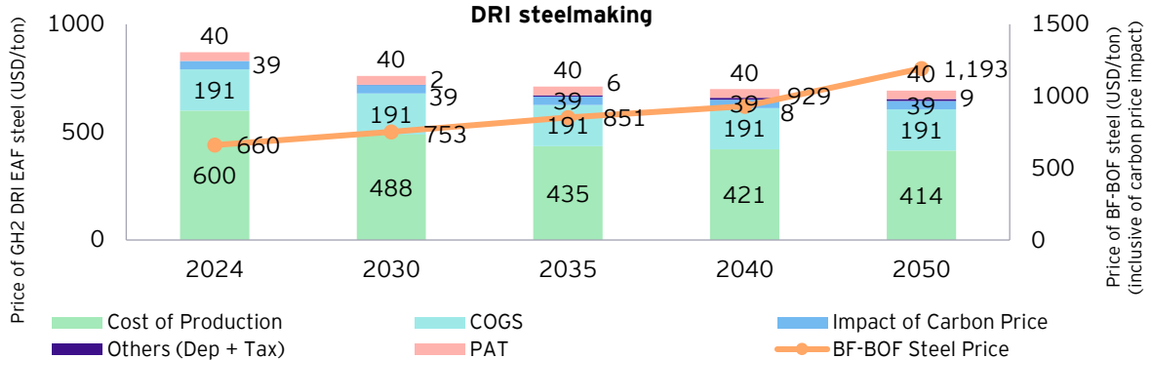
Source: EY Unlocking green steel demand: An assessment of India's automotive, infrastructure and construction sectors

The construction sector is expected to dominate early adoption due to sustainable building requirements, followed by infrastructure projects incorporating green materials in line with public procurement mandates. The automobile industry is expected to accelerate uptake as OEMs target Scope 3 emission reductions. However, supply through H_2-direct reduced iron (DRI) routes may lag, resulting in a projected deficit exceeding 200% under the Net Zero 2070 scenario.

Impact of carbon price on sales price of blast furnace (BF)-basic oxygen furnace (BOF) steelmaking



Green steel premium and impact of carbon price on sales price of H2 DRI steelmaking

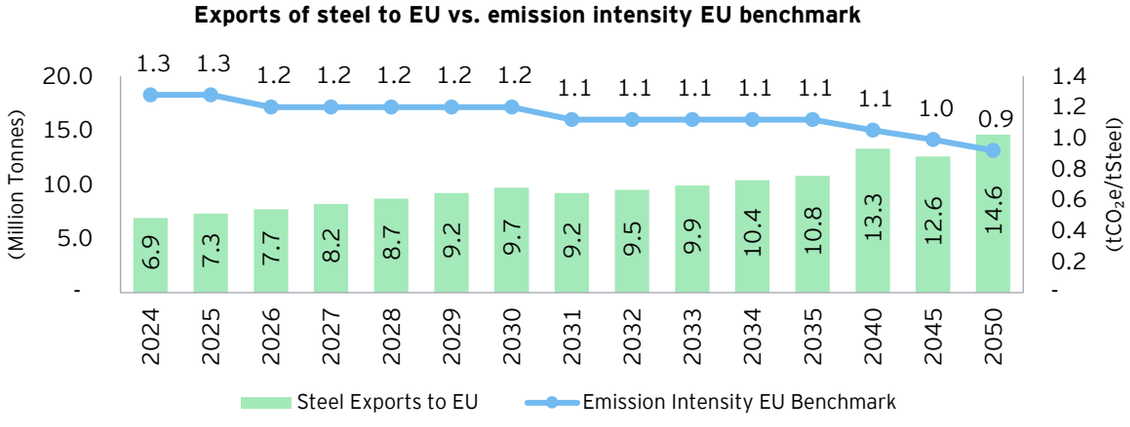


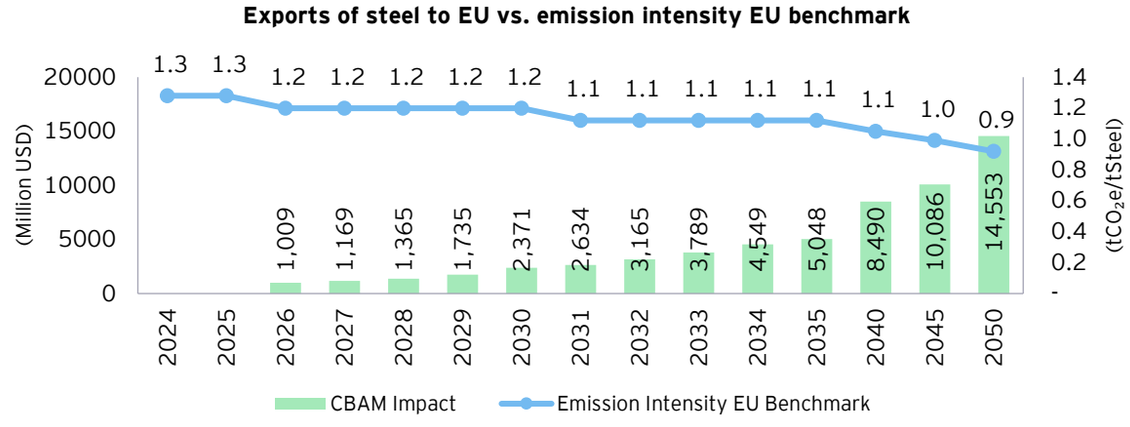
Source: EY Unlocking green steel demand: An assessment of India's automotive, infrastructure and construction sectors

While a green steel premium of ~US$210/ton currently elevates project costs by 3%–5%, declining hydrogen and renewable costs are expected to achieve price parity by 2035–2040. Supported by carbon pricing, policy incentives and technology scale-up, green steel could transition from a niche to a mainstream material anchoring India's journey toward industrial decarbonization and sustainable growth.

Implications of the EU Carbon Border Adjustment Mechanism (CBAM)

The European Union's Carbon Border Adjustment Mechanism (CBAM) introduces a carbon-pricing framework on imports from countries lacking equivalent emissions control measures, covering six key sectors including steel. The measure seeks to prevent "carbon leakage" and align global producers with the EU's decarbonization pathway. For India's steel industry, which currently exports around 7 million metric tons (MMT) to the EU, CBAM poses a significant competitiveness challenge due to its higher average emission intensity of 2.5 tCO2 per ton of steel, compared to the EU benchmark of 1.28 tCO2 per ton[23].





Source: EY Unlocking green steel demand: An assessment of India's automotive, infrastructure and construction sectors

With the EU progressively tightening its emission norms and phasing out free allowances under the Emissions Trading System (ETS), the carbon cost burden for Indian exporters is projected to rise sharply. Carbon prices, currently at approximately US$71 per ton CO_2, are expected to reach US$120–130 by 2030 and as high as US$400–450 by 2050. Consequently, the financial impact on Indian steel exports could escalate from around US$1 billion in 2026 to nearly US$14.5 billion by 2050.

Odisha, being home to some of India's largest steel producers, is strategically positioned to pilot green steel pathways by integrating renewable energy and hydrogen-based reduction models.

23 *EY Unlocking green steel demand: An assessment of India's automotive, infrastructure and construction sectors*

02

Investment dynamics and industrial transition pathways

Eastern regional energy landscape and strategic context

Eastern India, comprising Odisha, West Bengal, Jharkhand and Bihar, occupies a unique position in the national energy geography. Historically known as the country's mining and heavy industrial heartland, the region's energy system has been shaped by an abundance of coal, bauxite, iron ore and hydro resources, along with a robust base of power-intensive industries such as steel, aluminum, cement and fertilizers. As India accelerates toward its net-zero 2070 and 500 GW renewable capacity by 2030 targets[24], this region faces a dual challenge, decarbonizing a high-emission industrial base while leveraging its rich natural and port infrastructure to anchor new clean-energy value chains.

Eastern India holds a significant yet underutilized RE potential that can play a pivotal role in advancing India's clean energy transition. According to MNRE Renewable Energy Statistics 2023-24[25], the five eastern states collectively possess an estimated renewable energy potential exceeding 99 GW, comprising 66.36 GW of solar, 17.45 GW of wind, 11.81 GW of hydro (both large and small) and 3.16 GW of biomass and cogeneration resources. Odisha alone accounts for nearly 42% of the total potential (~41.3 GW), followed by Jharkhand (~18.9 GW) and Bihar (~17.2 GW).

Estimated RE potential in Eastern India (MW)[26]

State	Wind	Small Hydro	Biomass	Bagasse Cogeneration	Solar	Large Hydro
Odisha	12,129.00	286.22	298.72	-	25,780.00	2,824.50
West Bengal	1,281.00	392.06	1,741.74	-	6,260.00	809.20
Jharkhand	16.00	227.96	146.31	-	18,180.00	300.00
Bihar	4,023.00	526.98	964.37	346.60	11,200.00	130.10
Sikkim	-	266.64	4.73	-	4,940.00	6,051.00
Total	17,449.00	1,699.86	3,155.87	346.60	66,360.00	10,114.80

RE installed capacity in Eastern India (MW)

State	Wind	Small Hydro	Biomass	Bagasse Cogeneration	Solar	Large Hydro
Odisha	-	115.63	8.82	50.40	495.63	2,154.55
West Bengal	-	98.50	48.36	300.00	194.07	1,341.20
Jharkhand	-	4.05	19.10	-	162.40	210.00
Bihar	-	70.70	27.72	112.50	239.23	-
Sikkim	-	55.11	-	-	7.04	2,282.00
Total	-	343.99	104.00	462.90	1,098.37	5,987.75

24 *EY Energy Transition: India's Journey to Net Zero (2024)*

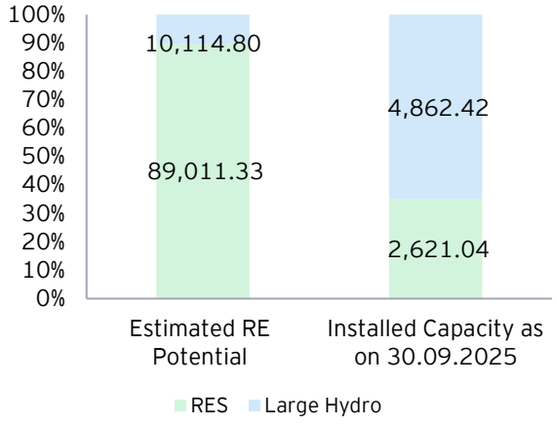
25 *https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2024/10/20241029512325464.pdf*

26 *https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2024/10/20241029512325464.pdf*

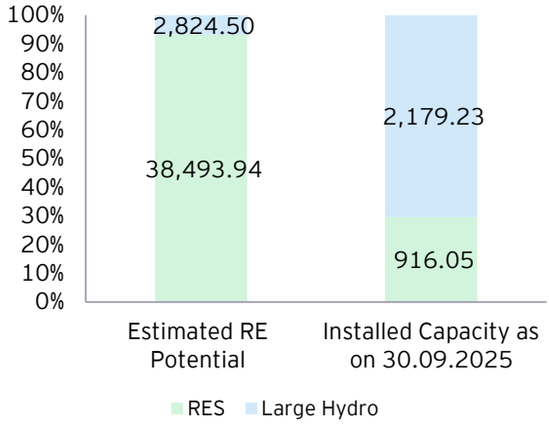
However, the actual deployment remains disproportionately low, with the region's aggregate installed RE capacity at only ~8.0 GW, representing just over 8% of its total potential. Among the states, Odisha leads with ~2.8 GW of installed capacity, followed by Sikkim (~2.3 GW) and West Bengal (~2.0 GW). While large hydro exhibits relatively high utilization levels (59% region-wide), solar, wind and biomass remain underexploited, with potential utilization rates of 1.66%, 0% and 3.3%, respectively.

Odisha, with a total RE potential of 41.3 GW, stands out as a critical growth hub for India's low-carbon transition. The state's resource endowment includes 25.78 GW of solar, 12.13 GW of wind, 2.82 GW of large hydro and 0.58 GW from small hydro and biomass sources. Despite this strong potential, the state's installed renewable capacity is only about 2.8 GW, translating to an overall utilization level of 6.8%. Performance varies across technologies, large hydro exhibits a high utilization rate of 76%, reflecting long-standing investments, while solar (1.9%) and biomass (2.9%) remain underutilized. The absence of operational wind capacity despite over 12 GW of potential requires accelerated project development, land allocation and grid readiness measures.

Eastern India estimated RE potential vs. installed capacity as on 30.09.2025



Odisha's estimated RE potential vs. installed capacity as on 30.09.2025



Source: MNRE Renewable Energy Statistics 2023-24

Highlights of CEA's Resource Adequacy Plan for Odisha

The Resource Adequacy Plan for Odisha, prepared by the Central Electricity Authority under the Ministry of Power, outlines a comprehensive roadmap to enable reliable and least-cost power supply for the state till FY 2033–34. The study integrates demand projections, renewable purchase obligations (RPO), generation capacity expansion and reliability analysis using stochastic modeling techniques. The objective is to maintain a secure, sustainable and resilient power system aligned with national decarbonization and net-zero goals.

Demand growth and power scenario

- Odisha's electricity demand is projected to grow at a CAGR of 3.92% in energy and 4.3%–5.7% in peak load till FY 2033–34.
- Peak demand is expected to rise from 6,635 MW (2023–24) to 10,564 MW (2033–34), with total energy requirement reaching 64,027 MU.
- The state currently has 8,150 MW of contracted capacity, of which 47% is non-fossil-based (hydro, wind, solar, biomass).
- Demand peaks during August–September and remains low from October to March, exhibiting high seasonality.
- Peak loads are generally recorded during night hours, necessitating flexible resources like battery storage, PSPs, and market purchases.

RPO compliance and capacity addition

- The RPO targets increase from 29.9% in 2024–25 to 49.5% in 2033–34, incorporating fungibility between RE sources.
- Cumulative renewable energy requirement is projected to rise to 31,693 MU by 2033–34.
- Total renewable capacity addition required during FY 2024–34 is estimated at 9,231 MW, comprising hydro, wind, solar, and distributed RE.
- The study highlights that distributed renewable energy (DRE) plays a crucial role in meeting flexibility and RPO compliance.
- Odisha's RE expansion strategy balances large-scale solar and wind deployment with decentralized and hydro-based resources.

Results and capacity mix projections

- Odisha still faces an unserved energy of approximately 5,600 MU (8.7%) by 2033–34, mainly during April–September.
- By FY 2033–34, Odisha's total contracted capacity is projected to reach 26,237 MW, distributed as follows:
  - 6,225 MW Coal
  - 3,567 MW Hydro
  - 2,376 MW Wind
  - 7,455 MW Solar
  - 1,420 MW PSP
  - 3,393 MW Distributed RE
  - 1,800 MW Market Procurement (STOA)
- This capacity mix enables compliance with RPO, enhances system reliability, and supports energy transition objectives.

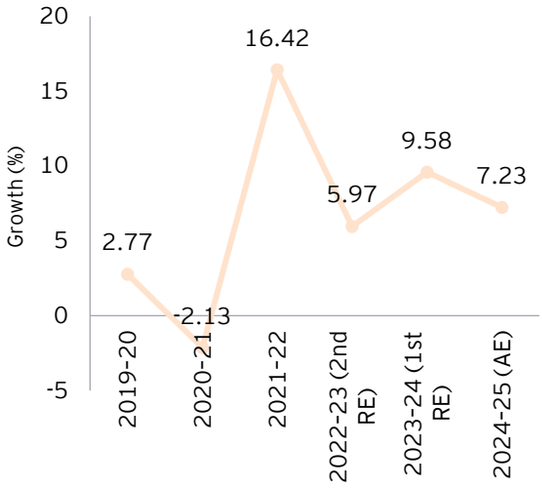
Odisha's strategic positioning in India's energy transition

Odisha has emerged as one of India's most strategically positioned states in the national energy transition, combining a robust industrial base with an abundant natural resource endowment and coastal infrastructure of global significance. The state contributes a substantial share to India's steel, aluminum and thermal power capacity, forming the backbone of the country's heavy industrial ecosystem.

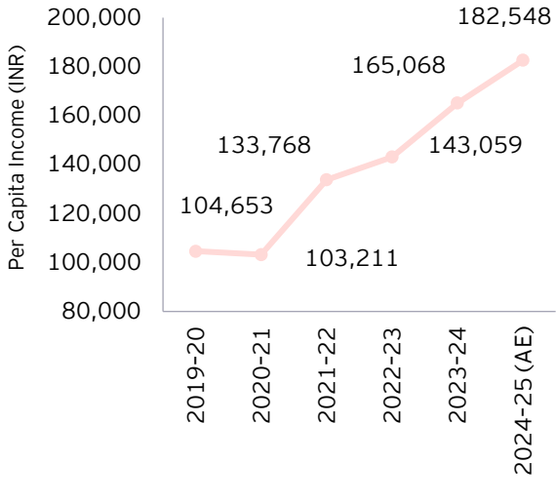
During FY 2024–25, Odisha recorded an economic growth rate of 7.23%, reflecting strong industrial momentum and recovery across key sectors. The per capita income stood at INR1,82,548, demonstration steady improvements in living standards. The sectoral composition of Gross State Value Added (GSVA) at current prices indicates a highly industrialized economy, with industry contributing 43.95%, followed by services at 37.11% and agriculture at 18.94%. Gross State Domestic Product (GSDP) reached approximately INR9.49 lakh crore, positioning Odisha among the leading state economies in eastern India[27].

27 *https://des.odisha.gov.in/en/odisha-glance?dashboardId=3396799d-da4e-4d63-9c32-f3c3d2c9461&dashboardName=GSDP%20of%20Odisha*

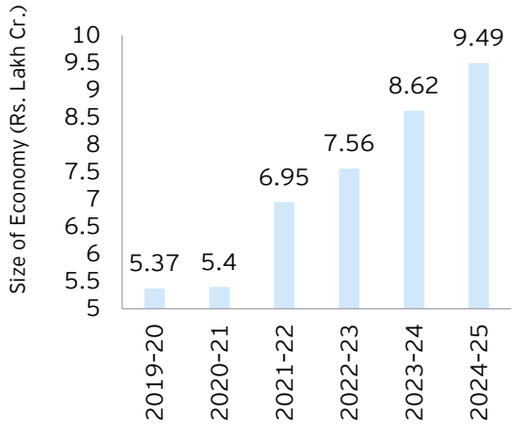
Odisha's economic growth (%)



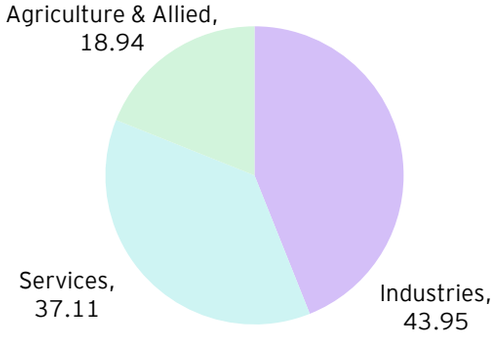
Odisha's per capita income (INR)



Odisha's size of economy (INR lakh crore) (GSDP at current price)



Sectoral composition of GSVA (%) at current prices (2024-25)



Source: Directorate of Economics and Statistics (DE&S), Odisha

Industrial and services sector growth in Odisha

Odisha has emerged as a rapidly transforming economy, shown by strong industrial expansion, robust services sector development and progressive policy frameworks. The state's focus on mineral-based industries, manufacturing competitiveness, MSME growth and strategic infrastructure investment has positioned it among India's high-performing regional economies. Complementing this, Odisha's service sector driven by IT, tourism, logistics and financial services has demonstrated steady diversification, supported by institutional reforms, digitalization and human capital investments. The following sections summarize the state's industrial and services sector growth trajectory, policy mechanisms and institutional ecosystem[28].

28 *https://www.ibef.org/download/1750930837_Odisha-April-2025.pdf*

Industrial sector performance and composition

- Odisha's industrial base is anchored in mineral and metal industries, contributing 41.9% of India's total mineral production (by value) in FY 2022–23.
- The state recorded mineral production revenues of US$4.56 billion in FY2022–23, reflecting significant growth in resource-based industrial activity.
- Large-scale industries in steel, aluminium, cement, and power continue to attract significant private and public investment.

MSME expansion and entrepreneurship development

- Odisha ranks among India's top 10 states with the highest number of registered MSME enterprises, demonstrating strong grassroots industrialization.
- The state's MSME ecosystem supports employment-intensive sectors such as food processing, handicrafts, textiles, and engineering goods.
- Through Agricultural Promotion and Investment Corporation of Odisha (APICOL), the state promotes agro-processing industries, having financed 145 commercial agro-enterprises with combined investment exceeding US$2.4 million.
- The district, state and high-level clearance authorities oversee projects below and above defined investment thresholds (US$10.9–219.4 million and beyond).

Services sector evolution and economic diversification

- Tourism and cultural services remain a priority under the Odisha Tourism Policy 2016, promoting sustainable tourism and heritage conservation.
- Financial and administrative services have been strengthened through e-Governance, transparency initiatives, and digitized government service delivery.
- Education and healthcare services have received substantial public expenditure: 7.6% on health and 7.1% on rural development in FY 2023–24, exceeding national averages.
- Odisha's growing hospitality, logistics, and port services sectors are catalyzed by major maritime initiatives such as the Maritime India Summit 2021 commitments.
- The state's PPP framework and infrastructure development strategy have enabled private participation in roads, ports, and industrial parks.

Investment facilitation

- Odisha's FDI inflows totaled INR1,476 crore (US$172.79 million) between October 2019 and December 2024, reflecting consistent investor confidence.
- The state's cost of doing business remains competitive, with industrial land priced between US$2 and US$15 per sq. meter.
- Odisha maintains a robust infrastructure base, including 5,897 km of national highways and 44 operational PPP projects across sectors.

The government has articulated this long-term vision through a suite of progressive policy frameworks, including the Odisha Renewable Energy Policy (2022)[29], Pumped Storage Policy (2025)[30], Industrial Policy Resolution (IPR 2022)[31] and the State Energy Efficiency Action Plan (2025)[32]. Collectively, these instruments aim to position Odisha as a preferred green investment destination and a net exporter of clean energy, aligning state-level priorities with India's broader decarbonization and industrial.

Renewable energy potential and policy landscape

Odisha possesses significant renewable energy potential across solar, wind, hydro, biomass and emerging green hydrogen segments. Recognizing the strategic importance of sustainable energy transition, the Government of Odisha notified the Odisha Renewable Energy Policy, 2022[33] to create an enabling ecosystem for investment, innovation and grid integration. The policy emphasizes a diversified renewable portfolio, anchored on competitive bidding frameworks, streamlined clearances, fiscal incentives and alignment with national targets such as 500 GW of non-fossil capacity by 2030. It provides a structured pathway for developing solar, wind, hydro, biomass, waste-to-energy and green hydrogen projects, supported by institutional mechanisms, banking provisions and R&D initiatives.

Solar Energy Development Framework

- Odisha targets large-scale development of land-based, rooftop, and floating solar projects to harness its estimated 25 GW solar potential.
- Solar projects are to be developed through competitive bidding on BOO basis, enabling transparent tariff discovery and bankable contracts.
- The policy provides for solar park development by public or private entities, supported by land facilitation and evacuation infrastructure.
- Distributed and rooftop solar systems are promoted across government buildings, industries, and commercial complexes with net metering provisions.
- Canal-top and floating solar projects are encouraged on irrigation and reservoir assets to minimize land use conflicts.
- Exemption from electricity duty, cross-subsidy surcharge, and wheeling charges is available for captive and third-party solar use.

Wind energy and hybrid integration

- Wind projects are developed under BOO mode, with 25-year concession periods and open access to state or interstate buyers.
- The policy encourages wind-solar hybrid configurations and Round-the-Clock (RTC) supply models for firm renewable power delivery.
- Banking of surplus wind energy is permitted in line with OERC's notified framework, with defined banking charges and annual settlement.
- Hybrid and co-located projects are eligible for infrastructure development support and renewable purchase obligation (RPO) compliance benefits.

29 *https://energy.odisha.gov.in/sites/default/files/2022-12/3354-Energy%20dept._1.pdf*

30 *https://investodisha.gov.in/odisha-psp-policy-2025/*

31 *https://investodisha.gov.in/industrial-policy-resolution-2022/*

32 *https://beeindia.gov.in/sites/default/files/Odisha_Whitepaper.pdf*

33 *https://energy.odisha.gov.in/sites/default/files/2022-12/3354-Energy%20dept._1.pdf*

Hydro and Pumped Storage development

- Small Hydro Projects (SHPs) are allotted through transparent bidding, with 30-year concession periods extendable by mutual agreement.
- For dam-toe and canal-based SHPs, priority is accorded to the state's irrigation departments for project identification and integration.
- Large hydro and pumped storage projects (PSPs) are encouraged under BOO/BOOT formats to support renewable grid balancing and energy storage.
- The policy incentivizes reservoir-based and off-river pumped storage with streamlined clearances and revenue-sharing frameworks.
- PSPs are considered strategic assets for Renewable Energy–Round-the-Clock (RE–RTC) systems, supporting flexibility and reliability of the grid.

Biomass, Waste-to-Energy and emerging technologies

- Biomass projects are awarded via competitive bidding under BOO mode, with a 25-year concession period and defined tariff structure.
- Municipal Waste-to-Energy (WtE) projects are promoted in partnership with urban local bodies (ULBs), with GRIDCO designated as the off-taker for power purchase.
- The policy targets complete urban solid waste utilization through bio-methanation, RDF combustion, and hybrid processing technologies.
- Green Hydrogen and Green Ammonia initiatives are prioritized for industrial decarbonization, export opportunities, and value-chain localization.
- Dedicated green corridors and port infrastructure are envisaged to support hydrogen clusters.

Power system infrastructure strengthening

Renewable energy and transmission integration

India's renewable energy expansion has significantly outpaced the growth of its transmission infrastructure, resulting in rising curtailment risks even for technically and financially robust projects. This challenge is particularly pronounced for solar, wind, hybrid and storage-integrated projects under Round-the-Clock (RTC) and Firm and Dispatchable Renewable Energy (FDRE) tenders, which rely on uncongested transmission corridors during peak hours to deliver flexibility and reliability[34]. Unless addressed through targeted transmission augmentation and coordinated planning at the state level, these inadequacies could hinder RE integration trajectory, risking underutilization of clean energy assets and stalling progress toward decarbonization goals.

The ongoing Green Energy Corridor-II and the Eastern Region Strengthening Scheme-XXI (ERSS-XXI) being implemented by POWERGRID in coordination with state utilities are central to this effort. These projects aim to strengthen 400 kV and 765 kV transmission corridors connecting key generation nodes in Jharkhand and Odisha to the National Grid, thereby enhancing the region's evacuation capability and enabling efficient power transfer from renewable generation clusters to demand centers across India.

34 *EY Eigenvectors of net-zero energy transition: Pathways to Viksit Bharat 2047*

ERSS-XXI Project Rationale	01 The Eastern Region's growing industrial and renewable capacity in Odisha, Jharkhand, and Bihar necessitated higher transmission reliability and connectivity.	02 ERSS-XVIII was approved to establish a 765 kV high-capacity East–West transmission corridor ensuring power transfer to major load centers.	03 ERES-XXXIV was planned to support Paradeep's emerging industrial and green hydrogen clusters through integrated ISTS-level connectivity.
System configuration	01 ERES-XXXIV covers a new 765/400/220 kV Paradeep substation and Angul–Paradeep 765 kV D/c line in Phase I.	02 Future phases include Angul–Paradeep 2nd D/c and Paradeep–Medinipur 765 kV D/c lines to form a 765 kV ER ring.	
Implementation framework and cost structure	01 ERSS-XVIII executed under Tariff-Based Competitive Bidding (TBCB) through Powergrid Medinipur–Jeerat Transmission Ltd. (SPV of POWERGRID).	02 Bid process by PFC; estimated cost INR3,994 crore; levelized tariff INR498.65 crore with phased commissioning (2021–2022).	03 ERES-XXXIV approved under ISTS framework with a 24-month implementation schedule; replaces intra-state Paradeep substation by OPTCL.
Commissioning progress and operational status	01 ERSS-XVIII components progressively commissioned between February 2021 and August 2022, including Ranchi–Jeerat 765 kV lines and major substations.	02 Paradeep (ERES-XXXIV) project is under advanced planning, with construction to begin after allocation to ISTS developer.	
Strategic and economic impact	01 Establishes a resilient East–West 765 kV backbone, supporting regional load centers and inter-state renewable integration.	02 Enables industrial load growth in Paradeep, catering to emerging hydrogen, ammonia, and steel industries under India's Green Hydrogen Mission.	03 Enhances renewable balancing capability, strengthens grid security, and supports India's transition toward a net-zero power system.

Within this broader context, the strengthening of Eastern India's transmission backbone holds the key to unlocking regional balancing between high renewable generation zones in the western and southern regions and industrial demand hubs in the east. When complemented by long-duration energy storage systems, this integrated network can provide flexibility, grid stability and round-the-clock clean power.

Infrastructure and grid modernization

A modern, resilient and digitally enabled grid is central to sustaining industrial electrification and renewable energy integration in Eastern India. Despite a strong generation base, the region continues to experience transmission congestion and reliability constraints, particularly along the Odisha–Chhattisgarh–Bihar interface, where multiple high-load corridors converge.

Ongoing programs such as the National Smart Grid Mission (NSGM) and the Revamped Distribution Sector Scheme (RDSS) are progressively addressing these challenges through the deployment of Advanced Metering Infrastructure (AMI), digital substations, GIS-based asset mapping and outage management systems[35]. These interventions are expected to enhance network visibility, reliability and operational efficiency across both transmission and distribution levels.

In parallel, major infrastructure programs such as the Biju Economic Corridor and the Eastern Dedicated Freight Corridor are expected to strengthen multi-modal logistics and industrial connectivity. These corridors would be instrumental in supporting the transport and export of green hydrogen, green ammonia and renewable-energy equipment, thereby positioning Eastern India as a strategic manufacturing and export gateway in India's clean-energy transition.

35 *National Smart Grid Mission Progress Report (2023)*

Smart Grids, digital infrastructure and energy efficiency

The National Smart Grid Mission (NSGM) Implementation Framework establishes the structural, financial, operational and monitoring mechanisms necessary to modernize India's power distribution sector. It defines institutional roles, investor participation models, performance monitoring processes and technological evolution pathways for Smart Grid and Advanced Metering Infrastructure (AMI) projects[36].

Strategic context and evolution of Smart Grid implementation

- NSGM aims to transform India's power distribution through intelligent, consumer-focused, technology-driven solutions.
- Smart Grid enhances reliability, efficiency, transparency, and supports demand management and renewable integration.
- Technological interventions span generation, transmission, distribution, and consumption with scalable implementation.
- Utilities define project boundaries and adopt models aligned with operational and financial capacity.
- NSGM acts as a catalyst through partnerships, MoUs, workshops, and structured knowledge sharing.

Business models and investor participation mechanisms

- Capex model: Utilities invest with government support and gain through performance-based maintenance contracts.
- Lease rental model: Suppliers fund infrastructure; utilities pay performance-linked rentals over the contract term.
- Savings-linked model: Suppliers are paid from operational savings achieved through efficiency improvements.
- Franchise model: Private operators manage assets under defined performance norms ensuring efficiency and revenue.
- JV model: Utilities and partners co-invest, aligning interests and enabling large-scale project financing.

Measurement, reporting and verification (MRV) framework

- MRV systematically assesses Smart Grid performance against defined operational and strategic targets.
- It brings in transparency in progress tracking, technology adoption, and outcome realization.
- Supports evaluation, benchmarking, and identifying areas for R&D or policy refinement.
- Defines measurable indicators for rollout goals, capacity-building, and financial monitoring.
- Guides decision-making to align project results with national Smart Grid objectives.

Smart Grid rollout goals and outcome indicators

- Goals include consultations held, roadmaps prepared, and regulatory notifications issued.
- Progress indicators cover PMU setup, monitoring frameworks, and capacity-building programs.
- Utility readiness is tracked through maturity ratings and incentive-based performance schemes.
- Implementation metrics include AT&C loss reduction, RE integration, AMI rollout, and feeder automation.

Evolution of smart metering and energy storage technologies

- Smart meters evolved to enable real-time analytics and remote operations.
- Energy storage maturity varies across electrochemical, mechanical, and thermal technologies.
- Convergence of metering and storage boosts flexibility, empowerment, and grid resilience.
- Technology maturity shapes business models, financing, and infrastructure planning under NSGM.

Detailed MRV for Advanced Metering Infrastructure (AMI) projects

- AMI MRV tracks operational, financial, and consumer improvements in metering and service delivery.
- Metrics quantify savings from reduced reading costs and improved collection efficiency.
- Indicators measure outage reduction, theft prevention, and consumer satisfaction.
- Provides formulas for estimating savings, recovery, and efficiency gains.
- Assesses peak load management through demand response, pricing, and load shifting.

36 *https://www.nsgm.gov.in/sites/default/files/NSGM-Framework-Final.pdf*

Green mobility in Odisha

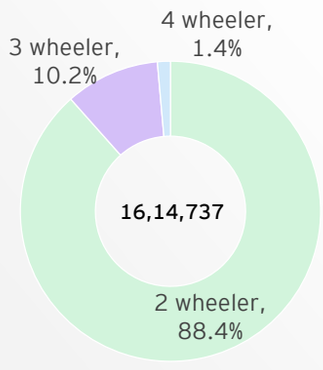
EV penetration in Odisha

India's transition towards electric mobility has gained substantial momentum under national flagship initiatives such as the FAME India Scheme and the PM e-DRIVE Program, both aimed at accelerating EV adoption across segments and geographies. As of December 2024, approximately 1.61 million EVs have been supported under FAME II, of which 88.4% are two-wheelers, 10.2% are three-wheelers and 1.4% are four-wheelers[37].

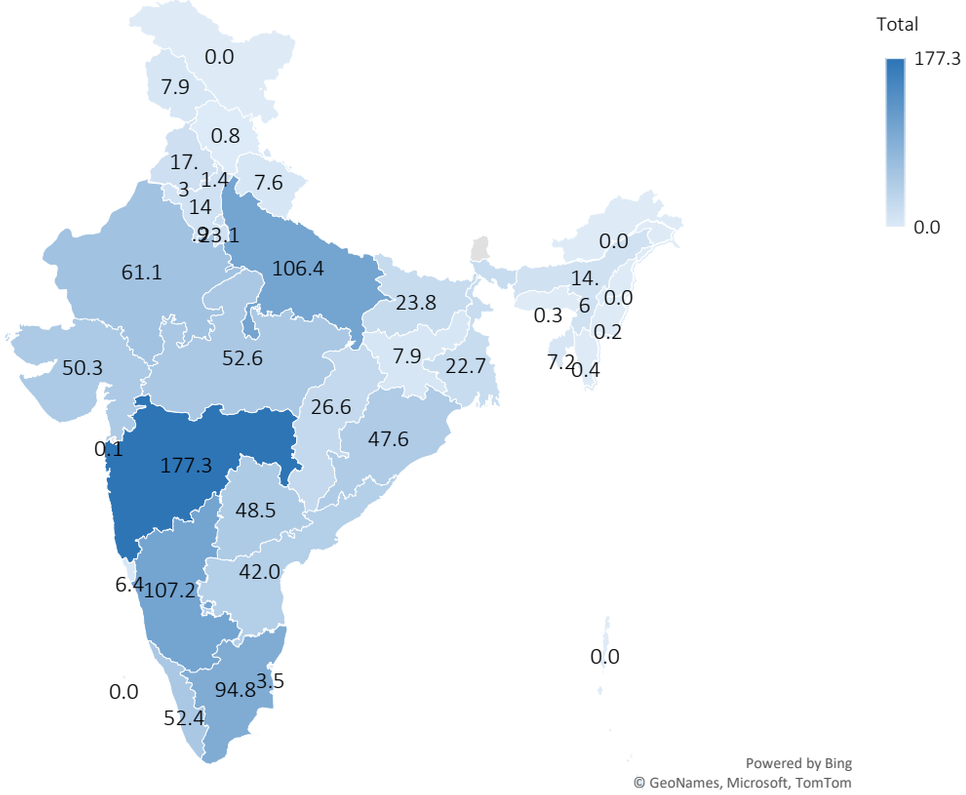
Under the PM e-DRIVE Scheme, cumulative EV sales across India reached significant scale by March 2025, with Uttar Pradesh (1.06 lakh), Maharashtra (1.77 lakh), Karnataka (1.07 lakh) and Tamil Nadu (0.95 lakh) emerging as leading states in EV adoption. These states have benefited from strong industrial ecosystems, fiscal incentives and supportive infrastructure policies[38].

Odisha recorded a total of 47,604 EVs under the scheme, including 45,926 electric two-wheelers and 1,678 electric three-wheelers, reflecting the growing consumer acceptance and policy traction since the implementation of the Odisha Electric Vehicle Policy, 2021. However, the state still lags behind the national frontrunners due to infrastructural constraints and lower availability of fast-charging networks.

Segment-wise number of EVs under FAME Scheme as on 31 December 2024



State-wise cumulative EVs sold ('000) under PM E-DRIVE Scheme as on 31 March 2025



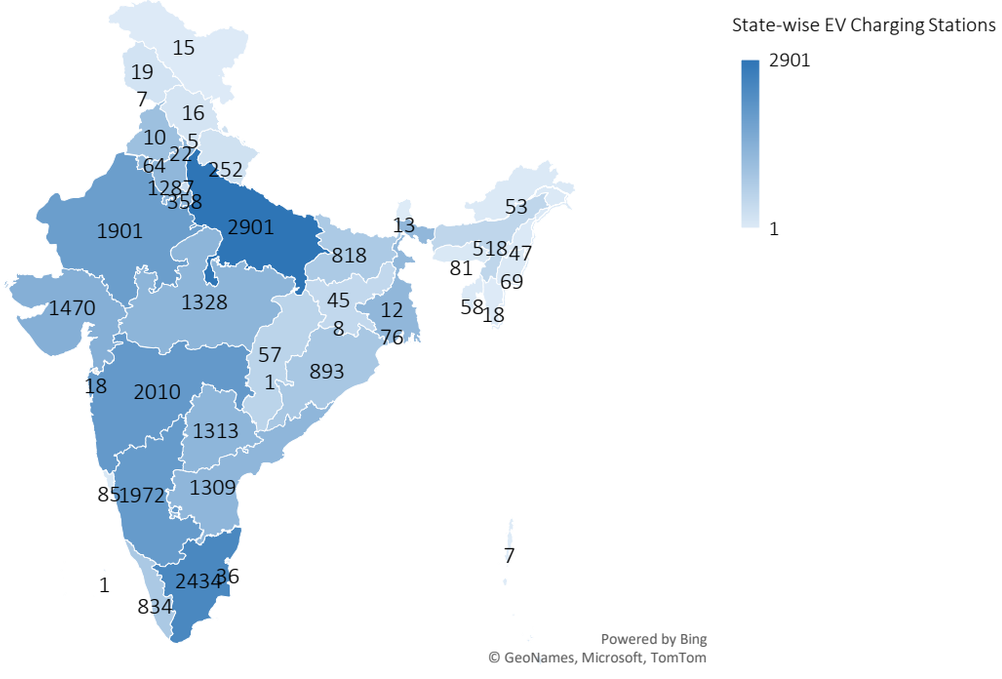
37 *https://odisha.data.gov.in/resource/ev-segment-wise-number-electric-vehicles-ev-under-faster-adoption-and-manufacturing-hybrid*

38 *https://odisha.data.gov.in/resource/stateut-wise-number-electric-vehicle-ev-sold-under-pm-e-drive-scheme-31-03-2025*

EV charging infrastructure development

The pace of EV adoption in Odisha has been significantly influenced by the state's charging infrastructure readiness. Despite registering 1.61 lakh EVs over the last four years, including 24,000 pure EVs and 850 strong hybrids, growth momentum has slowed markedly—from an exponential 405% rise in 2022 to 48% in 2023—largely due to inadequate public charging availability[39].

State-wise cumulative EV charging stations as on 01 March 2025



As of early 2025, Odisha hosts 893 public charging stations[40], which is notably lower compared to peer states such as Tamil Nadu (2,434), Maharashtra (2,010) and Karnataka (1,972). The Bureau of Energy Efficiency (BEE) estimates the state requires 47,381 public chargers by 2030 to meet projected demand, driven by 80% penetration of electric two- and three-wheelers and 50% four-wheelers under national targets.

EV policy landscape

The Government of Odisha has introduced the Odisha Electric Vehicle Policy, 2025[41], aimed at positioning the state as a leader in sustainable mobility and aligning with India's broader decarbonization and net zero commitments. The policy builds upon the earlier 2021 framework and incorporates strategic interventions to accelerate EV adoption, expand charging infrastructure, promote local manufacturing and enhance research, innovation and employment generation.

Target segments and adoption goals

01

Accelerates EV adoption across public, commercial, and private transport through fiscal and non-fiscal incentives.

02

Sets adoption targets for 2W, 3W, 4W, buses, and goods carriers by FY 2030.

03

Prioritizes fleet electrification of government and public transport vehicles.

39 *https://www.newindianexpress.com/states/odisha/2025/Mar/24/lack-of-charging-stations-dampen-ev-sales-in-odisha*

40 *https://odisha.data.gov.in/resource/stateut-wise-number-electric-vehicle-ev-charging-stations-installed-01-03-2025*

41 *https://www.kalingatv.com/wp-content/uploads/2025/09/Click-here-to-read-Odisha-Electric-Vehicle-Policy-2025-in-detail.pdf*

Manufacturing and industrial promotion

01
Encourages EV and battery manufacturing investments through dedicated parks and ready infra.

02
Offers fiscal incentives like capital subsidies, SGST reimbursement, and stamp duty exemptions.

03
Provides non-fiscal support via streamlined clearances and single-window facilitation for EV industries.

Charging and battery infrastructure development

01
Promotes extensive EV charging networks across cities and highways through PPP models.

02
Coordinates with DISCOMs and municipalities for standardization and tariff rationalization.

03
Supports battery swapping and renewable-integrated charging to enhance operational sustainability.

Fiscal incentives, financing, and green mobility ecosystem

01
Offers purchase incentives, tax exemptions, and fee waivers to lower EV ownership costs.

02
Provides interest subvention and credit support to improve financing access for small operators.

03
Promotes fleet aggregation, shared mobility, and EV retrofitment for cleaner transport transition.

Hydropower and Pumped Storage potential

The hydrological endowment of Eastern India represents one of the region's most powerful natural assets for enabling clean-energy balancing and grid flexibility. Odisha, in particular, is uniquely positioned to capitalize on this advantage, given its extensive network of legacy multipurpose dams and favorable topography conducive to pumped storage development. Several existing reservoirs are technically suitable for conversion or augmentation into pumped-storage configurations, offering cost and environmental efficiencies compared to greenfield developments.

Odisha has undertaken a comprehensive assessment of pumped storage potential, identifying 45 prospective sites with an aggregate capacity exceeding 34 GW[42], based on reconnaissance studies by GRIDCO and OHPC. These include a mix of off-stream open-loop and off-stream closed-loop projects distributed across multiple districts.

42 *https://greenenergyinvest.odisha.gov.in/pumped-storage-projects/*

Odisha potential PSP sites			
Sl No.	Name	District	Capacity in MW (assumption)
Identified by GRIDCO (off stream open loop PSP sites)			
1	Dandadhar	Keonjhar	900
2	Deo Dam	Mayurbhanj	150
3	Telengiri	Koraput	650
4	RET Dam	Kalahandil	450
5	Brahmani river stream	Sundargarh	450
6	Salandi reservoir	Keonjhar	300
7	Ghodahada	Ganjam	250
8	Patora Dam	Nuapada	350
9	Harbhangi	Gajapati	300
10	Badanalla stream	Rayagada	600
Sub-total			4,400
Identified by OHPC (off-stream closed loop PSP sites)			
1	Koldihi	Deoghar	640
2	Khunta	Mayurbhanj	1,000
3	Madhapur	Baudha	1,000
4	Tumudibandh	Kandhamal	3,000
5	Ambapani	Kalahandi	1,000
6	Kamalakheta	Gajapati	800
7	Lakaisuni	Gajapati	920
8	Prahadipanga	Kandhamal	2,300
9	Panabari	Nayagarh	720
Sub-total			11,380
Identified by GRIDCO-(off stream closed loop PSP sites)			
1	Kumulsingi	Gajapati	750
2	PSP_2	Malkangiri	3,179
3	PSP_3	Gajapati	2,380
4	Makod Ghat	Sundergarh	300
5	PSP_5	Gajapati	1,158
6	PSP_6	Kehdujhar	1,117
7	Barhagarh	Ganjam	1,000
8	Sikabadi	Gajapati	600
9	Dhayagurha	Koraput	750
10	PSP_10	Kalahandi	583
11	PSP_11	Ganjam	507
12	PSP_12	Nayagarh	484
13	Dudhapalli	Malkangiri	600

Odisha potential PSP sites			
Sl No.	Name	District	Capacity in MW (assumption)
Identified by GRIDCO-(off stream closed loop PSP sites)			
14	PSP_14	Koraput	465
15	Mahughar	Gajapati	720
16	PSP_16	Kehdujhar	367
17	PSP_17	Malkangiri	349
18	PSP_18	Kandhamal	343
19	PSP_19	Kandhamal	299
20	PSP_20	Sundergarh	270
21	Jharigumma	Kalahandi/Nabarangpur	500
22	Bhataguda	Malkangiri	720
23	PSP_23	Nayagarh	228
24	PSP_24	Malkangiri	210
25	Balinala	Ganjam	750
26	PSP_26	Malkangiri	201
Sub-total			18,830
Grand Total			34,610

To facilitate the systematic development of this potential, the Operational Guidelines to the PSP Policy (2025) emphasizes public–private partnership models, fast-tracked land and water approvals and concessional water-use charges to attract private investment[43]. The policy seeks to align project implementation with national renewable integration targets and to provide regulatory certainty for investors.

From a system-planning perspective, the deployment of PSPs in Odisha and neighboring states can play a critical role in firming intermittent renewable generation anticipated to expand significantly by 2030. These projects could provide frequency control, ramping capability and seasonal energy shifting, which are essential prerequisites for deep renewable integration and system reliability within the Eastern Regional Grid.

When co-optimized with upcoming solar and wind projects, Odisha's pumped storage capacity can serve as the anchor for a flexible, low-carbon power system, enabling the state to evolve from a resource-based energy producer into a strategic balancing hub for India's renewable energy transition.

Strategic positioning of PSPs

The development of large-scale storage capacity is essential for time-shifting excess generation to periods of peak demand, ensuring optimal utilization of renewable resources and minimizing curtailment losses[44,45]. Curtailment occurs when the grid cannot absorb all the generated 'must-run' renewable energy, or there is insufficient demand for the generation, or transmission congestion and network constraints prevent the export of excess power, leading to financial losses for Independent Power Producers (IPPs) and discoms[46]. PSPs can mitigate curtailment by storing surplus energy and dispatching it when the grid can accommodate it, thus enhancing the overall efficiency and profitability of renewable energy projects. Additionally, using a PSP as a peaking resource, which can typically generate approximately 4 to 5 peak hours of supply, avoids the needs for new generation capacity to meet peak demand and improves the economics for solar PV that is not available to meet electricity demand in the evenings.

43 *https://investodisha.gov.in/download/odisha-psp-policy-2025.pdf*

44 *IRADe Report on Role of Pumped Hydro Energy Storage in India's Renewable Transition*

45 *IRADe Report on Role of Pumped Hydro Energy Storage in India's Renewable Transition*

46 *CSTEP Report on Pricing Mechanism of Pumped-Hydro Storage in India*

Enhancing grid stability

PSPs represents a crucial development in India's power sector, particularly in the context of RE integration and grid balancing. This project is pivotal for several reasons, including addressing the intermittency of renewable energy sources, enhancing grid stability and contributing to India's ambitious renewable energy targets.

Regulation 30(1) of the CERC (Indian Electricity Grid Code) Regulations, 2023 (IEGC 2023) mandates a National Reference Frequency of 50.00 Hz and an allowable frequency band of 49.90-50.05 Hz. High intermittent renewable energy penetration, along with factors such as demand variations, can lead to frequency fluctuations and voltage instability. PSPs can provide essential Ancillary grid services such as frequency regulation, voltage support and load balancing by rapidly adjusting its output[47] which are vital for maintaining grid stability and reliability and which would improve the quality of power supply. By participating in the ancillary service markets, the PSP can generate revenue while contributing to grid stability. The key services are depicted in the graphic.

30. Frequency control and reserves

01 The National Reference Frequency shall be 50.000 Hz and the allowable band of frequency shall be 49.900-50.050 Hz. The frequency shall be measured with a resolution of +/- 0.001 Hz by NLDC, RLDCs and SLDC and such frequency data measured every second shall be archived by RLDCs.

02 The NLDC, RLDC and SLDC shall endeavor that the grid frequency remains close to 50.000 Hz and in case frequency goes outside the allowable band, ensure that the frequency is restored within the allowable band of 49.900-50.050 Hz at the earliest.

03 All users shall adhere to their schedule of injection or drawl, as the case may be, and take such action as required under these regulations and as directed by NLDC or respective RLDCs or respective SLDCs so that the grid frequency is maintained and remains within the allowable band.

CERC (Indian Electricity Grid Code) Regulations, 2023

01

Peak shaving

- A PSP can swiftly meet peak demands with high ramp rates of up to 200 MW/Min, which shall be validated with the technical consultants.

02

Load balancing

- It can store excess power during off-peak periods and releases it during high-demand times, leveling out load fluctuations

03

Frequency regulation

- The PSP can help maintain grid frequency within specified limits by adjusting active power. It operates in pumping mode to absorb excess frequency and generation mode to supply deficit frequency

04

Frequency regulation

- With its rapid ramping capabilities, the PSP can serve as backup or spinning reserve, supporting grid stability during sudden generator outages or load failures

05

Quick-start capability

- The PSP can start generating power within minutes, significantly faster than gas turbines or steam-based generation method

06

Black-start capability

- When conditions permit, the PSP can energize the grid independently after a total blackout, starting from a full upper reservoir

07

Voltage control

- The PSP can regulate voltage by managing reactive power (VARs) through its excitation system. It can operate in various modes (lead, lag, synchronous condenser) to stabilize voltage and improve system power factor as needed

47 *A. Sant & N. Thakre: Enabling Fast Response Ancillary Services Using Pumped Storage Hydro Power Projects*

Grid mechanism for PSP

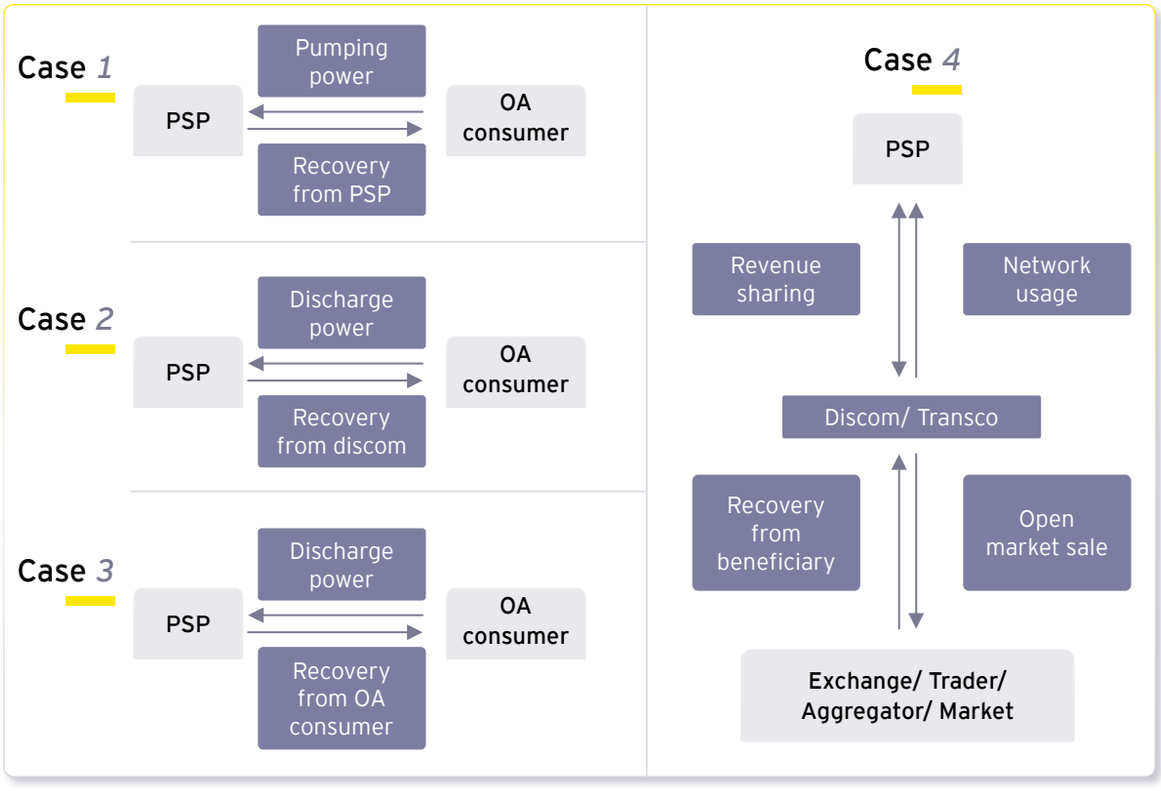
The grid integration and power evacuation framework for PSPs may follow multiple operational and commercial configurations, depending on the offtake structure and market participation mechanisms. The potential cases include:

Case 1	Case 2	Case 3	Case 4	Case 5
100% sale of within the state, through long-term PPAs with state distribution utilities	100% sale to external markets, though open access, or power exchanges or energy traders, or any other mechanism	Part sale within the state, and balance sale to external markets	Dedicate use for ancillary services	Use for ancillary services in combination with any of the above cases

The pumping power requirement for charging PSP reservoirs may be met either from the grid or through dedicated RE sources under Green Energy Open Access provisions, enabling the delivery of Round-the-Clock (RTC) green power.

For transmission system cost recovery, several mechanisms may be adopted:

- Recovery from the distribution utility during power supply;
- Application of transmission charges to the PSP entity during pumping operations;
- Recovery from open access consumers utilizing PSP power;
- Revenue-sharing mechanisms between the PSP developer and the transmission licensee for market-based sales through exchanges or traders; or
- Any suitable combination of the above approaches, ensuring equitable cost allocation and efficient grid utilization.



RE integration and grid flexibility

By 2030, India's electricity system is projected to be significantly dominated by variable renewable energy sources such as wind and solar. This shift would require enhanced grid flexibility mechanisms to enable real-time balancing of supply and demand. Pumped hydro storage will play a critical role in providing intraday balancing, frequency stabilization and reserve capacity.

PSPs facilitate energy shifting by storing surplus solar generation during daytime hours and releasing it during evening or peak demand periods when renewable output declines. They also enable thermal plant optimization by absorbing excess generation during low-demand periods, reducing forced shutdowns and minimizing operational cycling losses. Thus, PSPs enhance both the reliability and economic efficiency of the grid while enabling higher penetration of renewable energy sources.

PPP business models evaluation

To attract private sector investment and allow for efficient risk allocation, multiple Public–Private Partnership (PPP) structures may be considered for PSP development which include BOT, BOOT, BOO, BLT, DBFO, DBOT, DCMF, etc. A comparative assessment of these PPP structures and market configurations would help determine the most suitable development pathway, ensuring financial sustainability and optimal value addition to the state and national power sectors.

01 100% Discom

- Value-add for private sector: Minimal or no direct involvement in project execution and operation. Potential contracts for construction and maintenance work.
- Value-add for Discom: Full project and operations control. Retains all profits. Full financing, risks, and management responsibility.
- Value-add for overall sector: Ensured alignment with state energy policies and objectives. Potentially less efficient due to lack of private sector innovation and efficiency incentives.

02 26% Discom 74% Private

- Value-add for private sector: Shared investment and risk, leading to moderated financial exposure. Opportunity to gain returns on investment and operational involvement. Potential for leveraging private sector efficiency and innovation.
- Value-add for Discom: Shared financial burden and risks with the private sector. Ability to leverage private sector expertise and efficiency. Still retains significant control and a substantial share of profits.
- Value-add for overall sector: Balanced risk distribution can lead to optimal project performance. Combination of public sector control with private sector efficiencies.

03 26% Discom 74% Private

- Value-add for private sector: Majority control, leading to higher returns on investment. Greater influence on operational decisions and project direction. Higher risk exposure but potential for higher rewards.
- Value-add for Discom: Lower financial burden and risk. Retains a significant minority stake, ensuring some level of control and input. Gains access to private sector capital and expertise.
- Value-add for overall sector: Higher efficiency and innovation due to private sector dominance. Potential risks if private sector priorities misalign with public policy goals.

04 100% Private

- Value-add for private sector: Full control over the project, maximizing potential returns. Complete operational and financial risk. Freedom to implement innovative solutions and technologies.
- Value-add for Discom: No financial burden or risk. Potential to purchase power under long-term agreements without owning the infrastructure.
- Value-add for overall sector: Potential for high efficiency and innovation. Risks related to ensuring alignment with public energy policy and long-term state goals.

Hydrogen and Ammonia export corridors

Eastern India's coastal belt from Dhamra to Haldia is rapidly emerging as a strategic hub within the National Green Hydrogen Mission (MNRE, 2021). The corridor uniquely integrates deep-water ports, heavy industrial clusters and established export infrastructure with abundant inland renewable energy resources, creating a strong foundation for the development of green hydrogen and green ammonia value chains.

In Odisha, the Paradip Port complex is being positioned as a key export terminal for green hydrogen and ammonia, supported by coordinated initiatives from port authorities, industrial enterprises and private developers. Its proximity to renewable generation potential zones in Angul, Jharsuguda and Kalahandi and to major industrial consumers, provides both logistical efficiency and scalability[49].

Context and strategic relevance

- The Green Hydrogen Mission, launched by India in 2022, targets annual production of 5 MMTPA by 2030, positioning India among 30+ global leaders.
- Odisha is identified as a priority green hydrogen cluster with Bhubaneswar designated for a Green Hydrogen Valley project, supported by central government funding.
- Green hydrogen serves as a critical enabler for decarbonisation across Odisha's high-emission sectors, including steel, fertilisers, refineries, and heavy transport.
- Transitioning to a green hydrogen economy can enable Odisha to reduce fossil fuel dependence, enhance industrial competitiveness, and attract green investments.

Economic and industrial opportunities

- Deployment of 1 MMTPA of green hydrogen by 2030 can generate approximately 65,000 full-time equivalent (FTE) jobs across the value chain.
- The market potential is estimated at US$5 billion, including hydrogen production revenues and electrolyser manufacturing opportunities.
- Cumulative capital investments of US$6.9 billion are projected in deployment, manufacturing, and associated renewable energy infrastructure.
- Odisha's port-based industrial ecosystem at Paradip and Gopalpur provides a strong foundation for export-oriented hydrogen and ammonia production.
- Adoption of green hydrogen in steel, fertiliser, and refinery sectors would safeguard Odisha's export competitiveness under emerging global carbon border regulations.

Challenges and mitigation pathways

- High hydrogen production costs (US$4–7/kg) remain a barrier, requiring cost reductions through scale, hybrid RE systems, and concessional finance.
- Land acquisition complexities for RE and hydrogen clusters necessitate government-facilitated land pooling and transparent lease frameworks.
- Gaps in safety and quality standards across hydrogen storage, transport, and dispensing require urgent harmonisation with international norms.
- The absence of long-term offtake contracts limits bankability; the state may consider offtaker guarantees and green hydrogen use mandates.
- Water-intensive electrolysis processes must be strategically located in non-water-stressed districts to minimise environmental and social risks.

48 *https://www.pib.gov.in/PressReleasePage.aspx?PRID=2177591*

Strategic outlook for Odisha

- With proactive policy support, Odisha can emerge as India's green hydrogen and electrolyser manufacturing hub, leveraging industrial strength and port access.
- Strategic investments in R&D, renewable energy integration, and hydrogen export readiness can position Odisha as a global leader in the green economy transition.
- Developing an integrated green hydrogen ecosystem can enable economic diversification, employment generation, and long-term sustainability for the state's industrial future.

Financing and investment facilitation

The Odisha Industrial Policy Resolution (IPR) 2022 provides a comprehensive framework to promote sustainable industrial growth, investment facilitation and employment generation across the state. It identifies Priority and Thrust Sectors to attract high-value industries, incentivize renewable energy adoption and encourage innovation-driven manufacturing. The policy integrates fiscal, infrastructural and environmental incentives covering power tariff reimbursements, capital investment subsidies, SGST reimbursements and employment-linked benefits to enhance competitiveness and industrial resilience[49]. By aligning with the state's green transition agenda, IPR 2022 positions Odisha as an attractive destination for responsible and future-ready industrial development.

01

Power incentives for priority, thrust, and Green Hydrogen sectors

- The IPR 2022 introduces targeted power incentives to promote industrial competitiveness and clean energy adoption across sectors.
- Priority sector units are eligible for 100% electricity duty exemption and INR2.00/unit tariff reimbursement for seven years.
- Thrust sector units receive similar benefits for 10 years, incentivising high-value manufacturing and technology-driven industrial projects.
- Green Hydrogen and Green Ammonia units are granted 100% electricity duty exemption for 20 years from commercial production.
- These units also receive INR3.00/unit reimbursement on power procured from local Discoms or GRIDCO for 20 years.
- Full exemption of cross-subsidy surcharges, additional surcharges, and state transmission charges applies for renewable energy procurement.
- The framework enables cost-competitiveness of green industries, fostering large-scale decarbonisation and renewable energy integration within the state.

49 *https://www.pib.gov.in/PressReleasePage.aspx?PRID=2177591*

02

Incentives for captive renewable energy and green Infrastructure

- Industries adopting captive renewable generation (solar, wind, hydro, hybrid, PSP, BESS) are eligible for substantial fiscal and regulatory incentives.
- A 30% capital investment subsidy is provided for plant, machinery, and transmission infrastructure related to renewable power generation.
- 100% exemption of electricity duty and state transmission charges applies for 20 years from renewable energy consumption.
- Renewable project developers are eligible for priority land allocation and long-term leases for floating solar installations on reservoirs.
- Power banking within the state is permitted monthly, subject to OERC regulation, enabling improved renewable energy utilization.
- The incentives promote energy self-sufficiency, reduce industrial energy costs, and align with Odisha's green growth strategy.

03

Capital, employment and environmental incentives

- Priority sector units receive a 20% capital investment subsidy, while thrust sector units are eligible for 30%, disbursed over five years.
- Industrial units may also claim 100% reimbursement of SGST on net state tax paid, capped at 200%–300% of plant cost.
- Employers in priority and thrust sectors are reimbursed for ESI and EPF contributions for five to seven years, promoting local employment.
- A 25% subsidy on green infrastructure such as green buildings, wastewater treatment, and Zero Liquid Discharge (ZLD) systems is available up to INR10 crore.
- Industrial parks developed by the private sector receive capital grants up to 50% of infrastructure cost, capped at INR25 crore per park.
- R&D and innovation investments in thrust and priority sectors are supported through 50% financial assistance, up to INR10 crore per institution.
- Collectively, these provisions strengthen Odisha's industrial sustainability framework, incentivising green growth, innovation, and employment generation.

At the national level, India's Sovereign Green Bond Framework (2023)[50] has expanded access to climate-aligned capital across sectors such as renewable energy, clean transport and green buildings. Odisha can leverage this framework by developing project-specific Special Purpose Vehicles (SPVs) in areas such as renewable energy, pumped storage and green hydrogen, enabling direct participation in sovereign and sub-sovereign green bond issuances. Development Finance Institutions (DFIs) and Multilateral Development Banks (MDBs) are concurrently deploying Energy Transition Mechanisms (ETMs)[51] and Just Transition Funds[52] to facilitate early retirement of coal assets and promote inclusive reindustrialization through green infrastructure investments.

The emergence of carbon markets presents an additional and complementary revenue opportunity. The Carbon Credit Trading Scheme (2023), introduced by BEE, operationalizes both compliance and voluntary trading mechanisms for emission reductions[53]. For Odisha's energy-intensive industries, this enables monetization of certified emission reductions derived from renewable energy integration, process optimization, energy efficiency upgrades and CCUS projects, while simultaneously improving Environmental, Social and Governance (ESG) performance.

50 *https://dea.gov.in/files/policy_and_guidelines_document/FrameworkSovereignGreenBonds.pdf*

51 *https://www.adb.org/what-we-do/energy-transition-mechanism-etm*

52 *https://ec.europa.eu/regional_policy/funding/just-transition-fund_en*

53 *https://beeindia.gov.in/sites/default/files/Draft_Compliance_Procedure_October_2023.pdf*

Financing the green transition across Eastern India and particularly in Odisha, would demand innovative and blended financial architectures capable of derisking early-stage projects and crowding in private capital. Key enabling mechanisms include:

Blended finance platforms

- MDBs such as ADB, KfW, and the World Bank are expanding Green Infrastructure Financing Facilities (GIFFs) that combine concessional loans, guarantees, and private equity participation. Odisha's pumped storage and green hydrogen projects are well positioned to leverage these blended structures under ETM-linked frameworks.

Green bonds and ESG funds

- Following India's inaugural Sovereign Green Bond issuance (2023), state-linked SPVs and creditworthy infrastructure entities such as GRIDCO and IDCO could issue sub-sovereign green bonds dedicated to renewable energy, PSP, and industrial decarbonization projects.

Carbon market integration

- Through participation in the BEE Carbon Credit Trading Scheme (2023) and voluntary standards such as Verra and the Gold Standard, Odisha's industrial clusters can generate and trade high-value carbon credits, enhancing project bankability and ESG ratings.

Just Transition Funds

- Targeted financial support from national Just Transition mechanisms can enable coal-bearing districts such as Jharsuguda, Angul, and Sundargarh to diversify into renewable manufacturing, battery assembly, and green-hydrogen services, ensuring a socially equitable and regionally balanced energy transition.

Public–private partnership (PPP) models

- Odisha's well-established PPP framework, proven in industrial infrastructure, logistics, and energy distribution, can be strategically extended to energy storage systems, renewable energy parks, and hydrogen hubs. This would facilitate risk-sharing, transparent project structuring, and accelerated implementation, essential for scaling clean-energy infrastructure.

03 Recommendations

01 Strategic State Energy Planning & Transformation Unit

Government of Odisha (Industries Department, Energy Department), may constitute a strategic State Energy Planning & Transformation Unit. The unit's mandate must include integrated planning for RE, PSP, hydrogen, ports, transmission, land-pooling and finance mobilization; coordination of various utility and renewable agency plans and a monthly monitoring dashboard shared with development partners. This body would eliminate sectoral silos, accelerate approvals and provide a single accountability forum for the state's transition pipeline. It may be preferable to institutionalize a public Project Investment Tracker that reports project stage, approvals, land status, financing status and expected commissioning date. Mandate periodic third-party verification of claimed project milestones. Transparent tracking increases investor confidence and enables early corrective action

02 PPP templates for energy parks, PSPs and Hydrogen Hubs including targeted incentives

IPICOL and the Finance Department may issue standardized PPP procurement templates, for design-build-finance-operate (DBFO) PSPs, energy parks and hydrogen hubs, that include risk allocation tables, revenue stacking frameworks (capacity payments, ancillary services, merchant sales) and dispute resolution mechanisms. These templates can accelerate competitive bidding and create predictable risk-return profiles.

The Industries Department, OREDA and OERC may jointly review and issue a targeted incentive addendum for green hydrogen, green ammonia and PSP projects, covering concessional land rates in port corridors, time-bound SGST/EPF/ESI refunds and transmission charge reimbursement for first movers.

03 Port-Hydrogen Export Corridor Scheme with pilot project roll-outs

IPICOL, IDCOL, Paradeep, Dhamra and Gopalpur port authorities and the Industries Department may prepare an Investible Port-Hydrogen Export Corridor Master Plan. The plan must map land parcels for hydrogen parks, identify berth and storage upgrades and specify common utilities (water desalination, port cryogenic storage, ammonia handling). The scheme can preferably roll out a PPP model with suitably structured VGF schemes to enable private port operators to invest with predictable returns.

IPICOL, IDCO and the Energy Department may prioritize a tranche of 3-5 pilot projects (e.g., a PSP + hybrid park, a port-linked hydrogen facility and a green-steel/green-aluminum offtake cluster) with clear procurement and blended finance structures. Pair each pilot with an anchor buyer commitment (state utility, large industrial buyer, or export contract). Successful pilots could create replicable playbooks for scale.

04 Dedicated blended climate finance facility and green bond issuance

Government of Odisha (Finance Department), IPICOL and GRIDCO may create a state-level blended climate finance vehicle, combining concessional donor/ MDB capital with private co-investment, to underwrite first-loss for PSP, large-scale PSP + RE hybrid and hydrogen anchor projects. In parallel, establish a Green Bond issuance program through a suitable SPV to attract institutional investors for state-sponsored infrastructure assets. These instruments can compress perceived risk and mobilize long-tenor capital.

05 Industrial offtake and Green PPA Facilitation Cell

OREDA may establish a Green PPA Facilitation Cell to facilitate long-term offtake agreements between state industrial clusters (steel, aluminum, fertilizers) and renewable + storage suppliers. The Cell could provide standardized PPA templates, offtake credit enhancement instruments and matchmaking to secure anchor demand for 24x7 green power. This will materially reduce merchant risk for developers.

06 Skill development and Just Transition program

The Energy Department, OSDA and the Industries Department may co-design modular curricula for RE O&M, PSP operation, electrolysis plant operation, hydrogen safety and battery assembly. Implement a Just Transition Fund to finance reskilling of coal-sector workers and create apprenticeship pipelines linked to IPICOL's industrial parks. This would enable workforce absorption and social legitimacy. It will also be equally important to develop the local workforce by institutionalizing the energy transition aspects into the curriculum of skill development organizations suitably.

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ASSOCHAM

ASSOCHAM initiated its endeavor of value creation for Indian industry in 1920. It brings in actionable insights to strengthen the Indian ecosystem, leveraging its network of more than 4,50,000 members, of which MSMEs represent a large segment. With a strong presence in states, and key cities globally, ASSOCHAM also has more than 400 associations, federations and regional chambers in its fold.

Aligned with the vision of creating a New India, ASSOCHAM works as a conduit between the industry and the Government. The Chamber is an agile and forward-looking institution, leading various initiatives to enhance the global competitiveness of the Indian industry, while strengthening the domestic ecosystem. With more than 100 national and regional sector councils, ASSOCHAM is an impactful representative of the Indian industry. These Councils are led by well-known industry leaders, academicians, economists and independent professionals. The Chamber focuses on aligning critical needs and interests of the industry with the growth aspirations of the nation.

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Vision

Be the knowledge architect for the Indian economy, with a focus on strengthening India's domestic ecosystem and enhancing global competitiveness.

Mission

Its mission is to impact the policy and legislative environment so as to foster balanced economic, industrial and social development.

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