Confederation of Indian Industry

Charting Pathway for Energy Transition

Overview:

The World Meteorological Organization (WMO) estimates that extreme weather events have resulted in over two million deaths and a loss of nearly $4.3 trillion in economic losses over the last fifty years. The onus of addressing climate change through energy transition is, therefore, important. However, the onus of addressing climate change and adopting energy transition practices is disproportionately distributed among the developed and the developing nations. As is the access to funds for climate action. Consequently, the urgency of adapting energy transition measures needs to come with energy equity since only such an approach will ensure energy access for all and prevent any job displacement.

Climate Policy Initiative's Landscape of Green Finance says that India will require at least INR 162.5 trillion (USD 2.5 trillion) by 2030 to meet its Nationally Determined Contributions[1]. Although there has been a gradual increase in tracked green finance, India has a significant funding gap of USD $10 trillion to achieve its net-zero target by 2070. In a 2021 report published by the World Economic Forum, it was estimated that around 50 million jobs can be created with a projected contribution of $15 trillion through India's transition to a net zero economy.[2] Energy transition in India will, therefore, have a multiplier effect that would add value to economy, society and help achieve net-zero targets.

The trend towards greater share of RE in overall installed capacity has seen an upswing globally. Worldwide, an impressive installation of 473.17 GW has been done under RE sector during the year 2023-24, which is significantly higher than the installation of 98.83 GW added in the non-RE sector during the same period. Thus, out of the total installed capacity addition during last five years, around 80% of yearly addition has been from the renewable energy sector.[3] 46 per cent

As on 31st December 2024, the installed renewable energy capacity internationally was over 4448 GW, which is 46 per cent of the total installed generation capacity in the world.[4] In terms of year-on-year global capacity addition, renewable energy sector has demonstrated remarkable expansion, compared to the non-RE sector.

---

[1] Landscape of Green Finance in India 2022 - CPI

[2] WEF_Mission_2070_A_Green_New_Deal_for_a_Net_Zero_India_2021.pdf

[3] **https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2024/10/20241029512325464.pdf**)

[4] https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2025/Mar/IRENA_DAT_RE_Capacity_Statistics_2025.pdf

As per data from Renewable Energy Statistics 2023-24, during the period 2015- 2023 the Asian region led with the largest expansion of 1325.94 GW in installed capacity under renewable energy sources. Asia enhanced its installed capacity in RE from 633.14 GW in 2014 to 1,959.08 GW by 2023 followed by Europe, which recorded an expansion of 345.87 GW during the period registering a growth of 78.62%. During the same period, North America also raised its installed capacity from 287.52 GW in 2014 to 526.97 GW in 2024.

The report states that by 2023, in terms of percentage increase in the installed capacity under renewable energy sources Asia's share of RE increased to 50.69%, while Europe, North America, South America, and other regions of the world accounted for 20.33%, 13.64%, 7.50%, and 7.84%, respectively. This increase in RE in installed capacity has been continuing with a simultaneous decline in capacity installation under the non-RE sector in Europe and North America.

According to data released by IRENA, India ranks 5th globally in overall renewable energy installed capacity with 175.93 GW capacity. More specifically, India holds 4th position in both wind power and bio power installations, and 5th position in both solar power and hydropower installations. India also ranks 5th globally in overall renewable energy generation. China, USA, Brazil, India and Germany have been ranked as the top five countries in total renewable energy installed capacity as of December 2023. China leads globally in installed RE capacity with 1453.70 GW, Brazil and USA have 194.09 GW and 385.21 GW, respectively.

Indian Landscape:

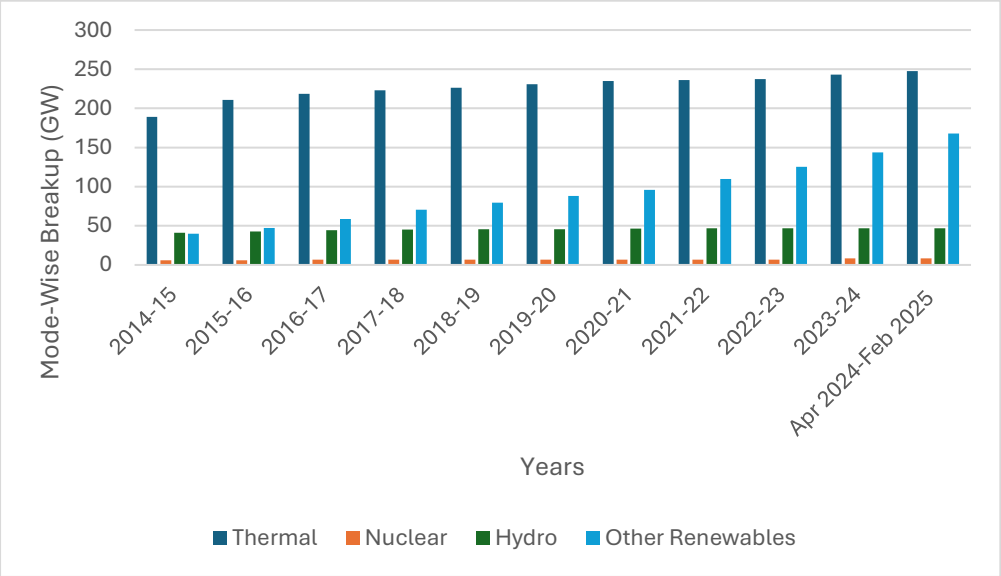
India' s performance has been quite impressive with the country managing to achieve two of its NDC targets, namely reduction of emissions intensity of its GDP to 35 per cent by 2030 and creating 40 per cent cumulative electric power installed capacity from non-fossil-based energy resources by 2030, way ahead of time. By the end of December 2024, renewable energy accounted for 38.3 per cent of its total installed power generation capacity. This is over 15 percentage points higher than what it was in December 2015 when it stood at 22.7 per cent.[5]

India has also set itself an ambitious goal of reaching non-fossil capacity of 500 GW by 2030. To reach this important milestone, India will need to install 50-60 GW every year from now till 2030, an ambitious road for its journey to net-zero by 2070.

According to Renewable Energy Statistics 2023-24, during the last decade, the contribution of renewable energy sector in the total installed capacity has risen significantly, from 29.44% in 2014-15 to 43.12% in 2023-24. The share of nuclear energy in installed capacity has also risen from 5.78 GW in 2014-2015 to 8.18 GW in

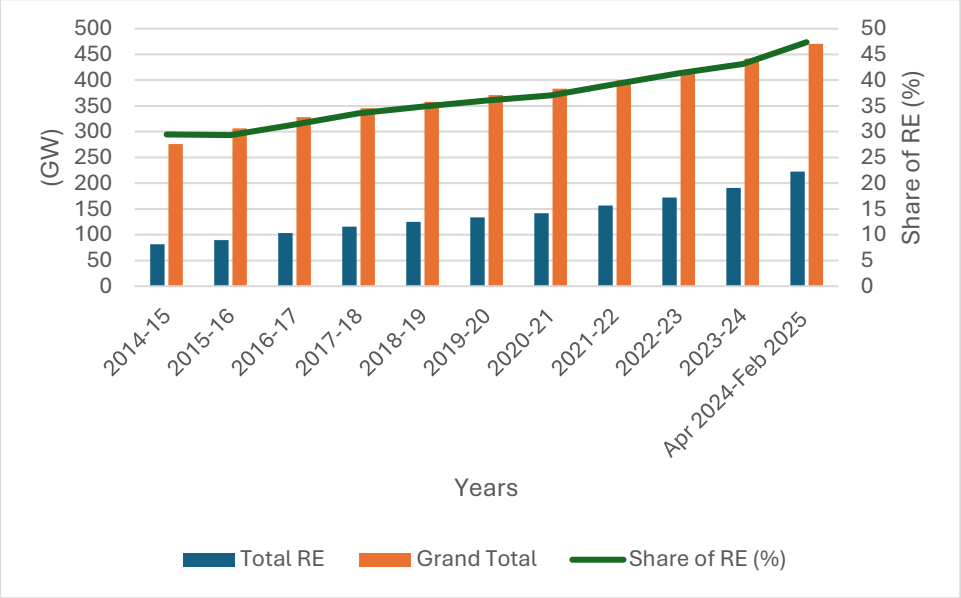
[5] Ibid

2023-2024, indicating a policy shift towards using this source as not only a clean alternative to coal but also as a balancing source of power.



Mode-Wise Breakup (GW) Non-RE and RE in Installed Capacity
Source:https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2024/10/20241029512325464.pdf **)**

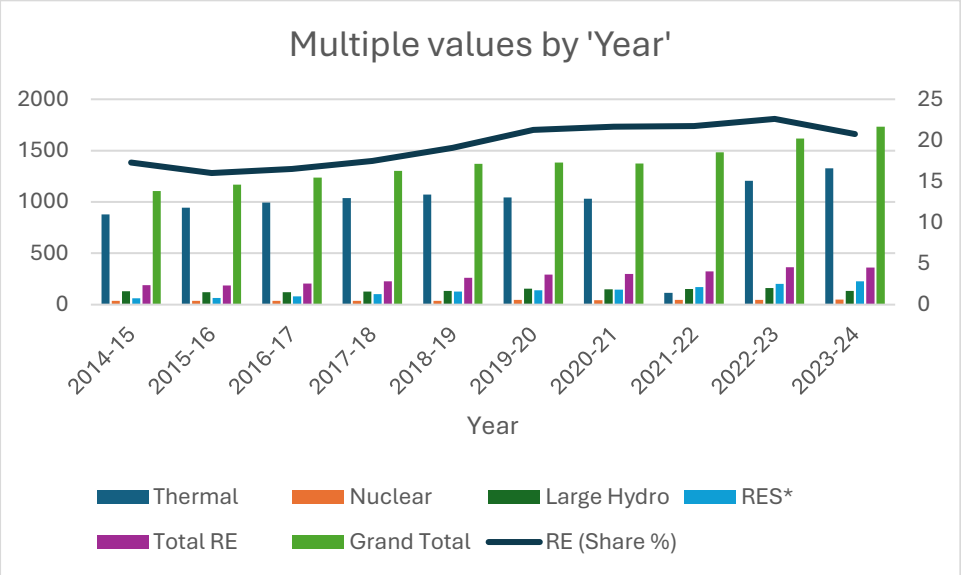
** As on 28.02.2025



Share of RE (%) in Installed Capacity
(Source:https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2024/10/20241029512325464.pdf **)** ** As on 28.02.2025

The Renewable Energy Statistics 2023-24 report also states that as on March 31, 2024, Gujarat, Rajasthan, Tamil Nadu, Karnataka and Maharashtra were the top five states in total renewable energy installed capacity. These top five states contributed

significantly to the renewable energy sector, representing around 61% of total installed capacity of the country. The share of renewable energy in India's overall generation has also gone up significantly.



Year-wise All India Energy Generation, Non-RE & RE in Billion Units and RE (Share %)

(source:https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2024/10/20241029512325464.pdf **)**

India's total electricity generation stood at approximately 1,734.12 billion units (BU), during the year 2023-24, which marks a significant increase from 1,105.38 BU in the year 2014-2015.

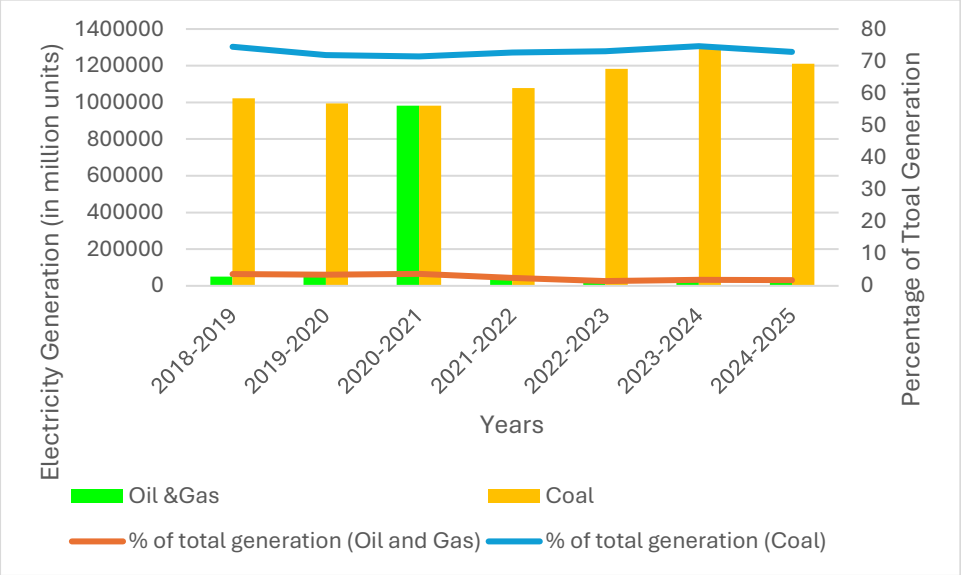
Energy generation from renewable energy sources have contributed 359.89 BU, which accounted for 20.75% of the total generation, registering a growth of 88.46% from that of 2014-15.

Generation from solar power, wind power, bio-power and small hydro power have shown an impressive growth of 265.89%, underscoring substantial advancements in India's renewable energy sector, states the Renewable Energy Statistics 2023-24. The report states that around 73% of the total energy generation in the country through the sources of solar, wind, bio power and small hydro power were concentrated in the states of Rajasthan, Gujarat, Karnataka, Tamil Nadu, and Maharashtra.

The Coal & Gas Play

Despite the rise in share of renewable energy in installed capacity and power generation in India, coal continues to play an important role in the power sector. Natural gas has also shown an increased share in power generation in India. Data available on India Climate and Energy dashboard says nearly 72.93% of power generation was from coal and 1.81% from oil and gas in 2024-2025.

According to media reports, India had to double up production from its gas-fired power stations to generate 8.9 billion kilowatt-hours (kWh) during in April and May 2024 as compared to the same period last year. More than 75% of India's power generation was from coal in 2023, while gas-fired plants accounted for only about 1.81% in recent years, largely because of the high cost of gas in comparison to coal. In the month of May 2024, coal's share dipped to 74%, compared with 75.2% during the same month last year, while gas's share nearly doubled to 3.1% from 1.6%. India's gas-fired power output is expected to grow by 10.5% in the fiscal year ending in March 2025, following 35% growth the previous year.[6]



Oil, Gas & Coal in electricity generation in India (in Million Units)

Source: https://iced.niti.gov.in/energy/electricity/generation/power-generation

Source-wise electricity generation trend for oil and gas and coal since 2018 are a strong indicator that power generation from RE has a long way to go before it can address peaking requirements. It is also important to note here that, according to a 2015 working paper by IRENA, *"From baseload to Peak"*, the critique of renewables in power generation as being unsuitable for baseload supply is misleading. This, the paper argues, is because baseload is a demand characteristic and not a supply technology characteristic. It means that nuclear or coal power plants are operated in

6 https://ddnews.gov.in/en/scorching-heat-drives-indias-gas-fired-power-use-to-multi-year-highs-in-may/

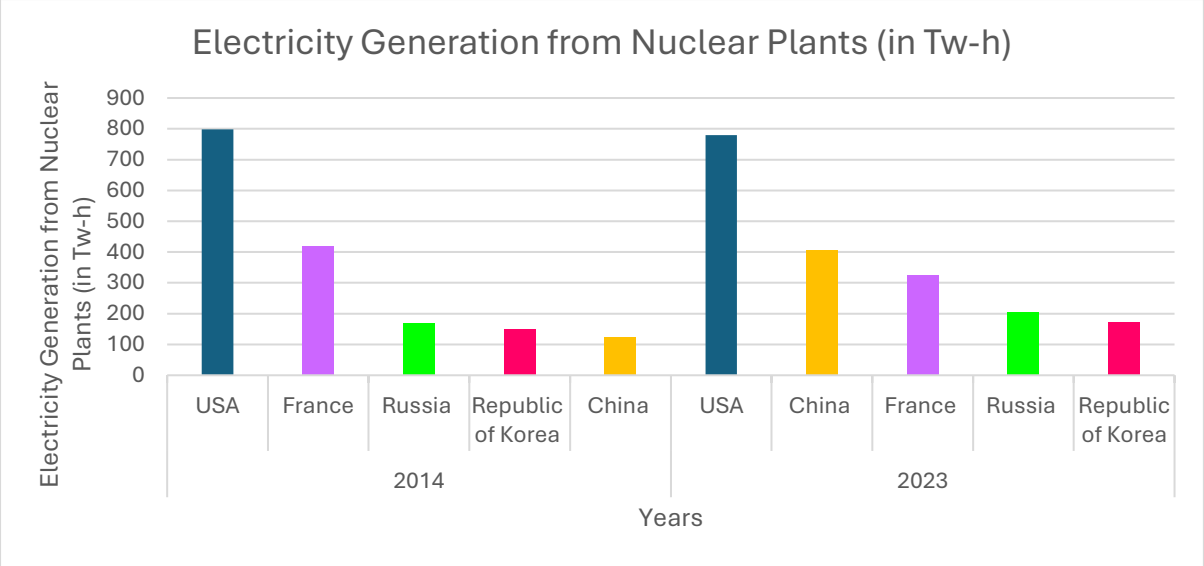
the baseload mode only because they are not technically capable of operating in a more variable mode. The paper also makes a case for renewable energy sources as reliable sources for power generation on the premise that in the future power system, the value of baseload will decrease, and variable renewable power generation would be ideal as there is an ease of combining it with smart-grid technologies, demand response, energy storage and more flexible generation technologies, including gas power plants and dispatchable renewable power supply options. The future of power systems is, therefore, a shift to flexible renewables as they are not only reliable but also economically efficient, it says[7].

Renewed Focus on Nuclear

India has announced its ambition to generate 100 GW of nuclear energy by 2047 as part of energy transition. In both her budgets for FY2025 and FY2026, Union finance minister Nirmala Sitharaman spoke about increased government focus on nuclear power generation. Nuclear Energy Mission for Viksit Bharat was announced- "Development of at least 100 GW of nuclear energy by 2047 is essential for our energy transition efforts. For an active partnership with the private sector towards this goal, amendments to the Atomic Energy Act and the Civil Liability for Nuclear Damage Act will be taken up. 62. A Nuclear Energy Mission for research & development of Small Modular Reactors (SMR) with an outlay of Rs 20,000 crore will be set up," she mentioned in her speech on 1 February 2025.[8] At least, five indigenously developed SMRs will be operationalized by 2033. India ranked 10th globally with 44.65 Tw-h nuclear based power generation in 2023. This number was 33.2Tw-h in 2014.

[7] https://www.irena.org//media/Files/IRENA/Agency/Publication/2015/IRENABaseload_to_Peak_2015.pdf

[8] https://www.indiabudget.gov.in/doc/budget_speech.pdf



Top 5 Countries in Nuclear Power Generation

Source: IAEA[9]

The current Indian government emphasis is to shift captive power generation to nuclear based, in line with India's journey to energy transition. This will strengthen efforts towards reducing carbon emissions and meeting future energy demands through non-fossil fuel sources. For increased public private partnership, in this segment, it will be important to amend the Atomic Energy Act, 1962 and the Civil Liability for Nuclear Damage Act, 2010.

Connectivity through pipelines and transmission lines

India is aiming to increase its power transmission capacity to 650,000 circuit km by FY32, focusing on integrating renewable energy and securing 24x7 power supply. The country plans phased additions, targeting 114,000 circuit km by FY27 and 76,787 circuit km between FY27 and FY32. The country's current transmission capacity is about 480,000 circuit km of transmission lines, as in October 2024.

LPG pipeline networks have been expanding to provide gases to remote areas. As of September 2023, the total length of major LPG pipelines was over 5 000 km, according to PPAC. World's longest LPG pipeline is being built between Kandla and Gorakhpur. Once completed, it is expected to provide LPG to 22 bottling plants in Gujarat, Madhya

[9] https://www.iaea.org//sites/default/files/publications/reports/2014/gc59-7_en.pdf

https://pris.iaea.org//PRIS/WorldStatistics/NuclearShareofElectricityGeneration.aspx

Pradesh and Uttar Pradesh. The maximum capacity is 8.25 mtpa, or 260 kb/d, which is about 30% of the country's current demand.

Inefficiencies in energy infrastructure crop up due land acquisition, right of way (RoW) issues and approval delays. The standard bidding documents also do not adequately address compensation uncertainties and contractual risk mitigation. Delay in clearances, lack of uniformity and high right of use charges pose a challenge.

There are also regulatory bottlenecks and associated costs, cybersecurity risks, financial constraints, and lack of standardization in the power transmission sector that need to be addressed for a vibrant flow of energy flow.

Petroleum Consumption and Mobility Trends

India's consumption of petroleum products and natural gas, including LNG imports, have shown an increase over the last decade. For instance, petrol (motor spirit) has shown a growth of about 18% in consumption despite the advent of electric vehicles. In the case of ATF (jet fuel), the increase is phenomenal at 43%. The rise in consumption of petroleum product is driven by economic growth, increased industrial activity, urbanization, the growing transport sector, freight and aviation sectors and changes in energy consumption patterns.

An International Energy Agency report notes that without increased uptake in electric vehicles, and an increased role of biofuels, India's transport sector will face the challenge of decarbonisation. It is estimated combined new electric vehicles (EVs) and energy efficiency improvements will help avoid nearly 480 kb/d of extra oil demand in the 2023-2030 period. However, if this is not achieved, India's oil demand would reach a much higher 1.68 mb/d by 2030 compared with the current forecast.[10]

Energy as a Growth Driver in Manufacturing

Within the energy sector, it will be important to encourage manufacturing of solar modules, solar glass, wind gear, battery, High Voltage Direct Current components and products, electrolyzers, and balance of plant equipment, including those for nuclear power plants.

*****

[10] https://www.iea.org/ /reports/india-oil-market-report

Confederation of Indian Industry

About the Report

The report takes stock of the current trends in energy sector, the change in energy mix, along with changes in the mobility sector. It takes an overview from the macro, trade, and employment angles. The report also makes specific and pointed suggestions for power, renewable energy, nuclear energy, hydrocarbons, bioenergy, green hydrogen and electric mobility sectors. One prerequisite for setting up manufacturing units, establishing power generation projects and creating energy infrastructure is availability of land and right of way. For this, the overall suggestion across the sectors is that dedicated government portal of Project Land Banks (RE) should be operationalised along with specialized wing to facilitate and assist developers in land acquisition.

Various suggestions have been drawn from CII members who deliberated on sectoral issues during meeting of various committees. These suggestions are from the perspective of new reform measures that are required to bring in efficiencies and increase competitiveness of the Indian industry.

Table of Contents:

Serial No.	Topic	Page Number
1.	Power Sector: Integrating Renewable Energy & Promoting Competition	
2.	Transitioning to Green Hydrogen	
3.	Ramping up Nuclear Capacity for Clean Power	
4.	Oil & Gas Sector: Enhancing Supply for Vibrant Economy	
5.	Manufacturing for Enhancing Energy Supply Chains	

Confederation of Indian Industry

Power Sector: Integrating Renewable Energy & Promoting Competition

The Indian Constitution places power sector, which includes renewable energy, in the Concurrent List. Though the policy framework in the sector is governed by the Electricity Act 2003 administered by the Union Power Ministry, State Governments drive the sector, especially in terms of access and quality of power. The Act places the sector under the regulatory oversight of independent statutory regulators; the regulations are set by the Central Electricity Regulatory Commission when it is for more than one state and by the state electricity regulatory commissions when within the state. The technical parameters are laid out by the Central Electricity Authority.

Since the enactment of Electricity Act 2003, the power sector has witnessed significant developments, which includes changes within the sector itself; like induction of renewable energy, power trading, and then external changes, like concern on climate change, growing consumption, and increased use of electric vehicles. In terms of business, there has been a shift from public sector dominance to greater private sector participation begetting competition, especially in power generation.

Further, the induction of renewable energy into the system has thrown up in some pockets the challenge of transmission connectivity to link up generation projects. This is especially challenging in the state of Rajasthan, which has the best solar radiation in the country with the maximum solar radiation intensity of about 6-7kWh/ Sq.m/day and more than 325 sunny days in a year.[11]

Transmission systems also need to integrate green energy, adopt energy storage, and address issues relating to insufficient AI/ML utilization. There are price fluctuations affecting financial planning and requiring introduction of price variation clauses in contracts.

Besides, intermittent nature of renewable energy requires investment in storage technologies and in power sources that can balance the grid. The balancing power could be generated from natural gas, hydropower sources or from green hydrogen-based storage system.

To build consensus on land related reforms and help the power sector by providing ease of doing business, an institutional platform could be created to bring together various state governments and concerned Union ministries. Some of the important areas, where consensus needs to be built include land acquisition policies, standardisation of processes related to land use conversion and registration, complete digitisation of land records, etc.

[11] Sunshine Availability & Solar Radiation in Rajasthan - RajRAS | RAS Exam Preparation

Following key measures could bring in efficiencies that are important for creating access to quality power for people and goods at affordable rates:

(i) Strengthen collaboration between Centre and States on Ease of Doing Business especially in land related issues

Though the Union Ministry of Power regularly holds review meeting with states, an institutional body, on the lines of /GST like Council, for the power sector could be formed to build consensus on broad reforms in the sector, amongst States and Centre. Such a council could also ensure uniformity in policies and exchange of information on best practices.

The Landscape for Power Sector Council could include measures for ease of doing business and can broadly be structured around the following:

Uniformity of Charges and Adopting Best Practices

Uniformity in open access charges, tariff slabs, oversight of consumer related issues which could include assurance of quality power and redressal of maintenance related challenges. It is especially important to have a central and state government oversight on implementation of Electricity (Rights of Consumers) Rules, 2020.

Tariff rationalisation

Phasing out of cross subsidisation of power by industrial consumers to other segments of power consumers will help lower the cost of production for manufacturing and services sectors. State regulators are empowered to set tariffs under Section 86(1)(a) of the Electricity Act 2003. However, SERCs do not allow tariff hikes, leading to accumulation of Regulatory Assets.[12] Power tariff should recover supply costs and reduce cross subsidies. For this, it is necessary to have transparent and independent determination of power tariffs, without distortions like Regulatory Asset.

For consumers, who need to be supported with subsidised power, a direct benefit transfer mechanism could be followed. However, direct benefit transfer of subsidy should ensure that money is disbursed from state government budgets, directly, and not by the power distribution companies. This is because any pay-out by power distribution companies, even if on reimbursement basis from the state government, runs the risk of payment backlog showing on discom balance sheets.

Annual tariff petitions filed with the state regulators could have subsidy transparently defined, in line with the direct benefit transfer by the state governments, bringing in greater clarity on power charges of commercial and industrial consumers.

[12] Regulatory assets in the power sector include previously-incurred losses that are in the nature of deferred expenditure and can be recovered from consumers in future, if allowed by regulatory authorities.

Bringing efficiency in the working of distribution companies

According to the latest report of Power Finance Corporation, state-owned power distribution companies across the country made financial losses amounting to Rs 68,832 crore in 2022-23. This is four times higher than the losses witnessed in 2021-22. It is, therefore, important to improve the health of discoms by alleviating their liquidity position in a sustainable manner. Besides, leakages that add to the AT&C losses[13] need to be prevented through use of smart metering, and other digital and internet of things (IOT) technologies.

Removing restrictions on inter-state sale of power

Some States put restriction on inter-state sale of power. This is despite the circular of Ministry of Power dated 25 October 2023, on imposition of charges by various State Government on various forms of generation of electricity - from Hydropower/Renewables/thermal, etc. This circular clarifies that such supplementary charges including any form of taxation or duty imposed on electricity generation, covering all types of generation such as thermal, hydro, wind solar and nuclear are illegal and violation of the Constitution. Inter-state sale of power should be encouraged to optimize the benefits of One Nation One Grid.

To build consensus on land related reforms and help the power sector by providing ease of doing business, an institutional platform could be created to bring together various state governments and concerned Union ministries. Some of the important areas, where consensus needs to be built include land acquisition policies, standardisation of processes related to land use conversion and registration, complete digitisation of land records, etc.

(ii) Fostering Competition and Consumer Choice through Amendment of Electricity Act

The Electricity (Amendment) Bill, 2022 was introduced in the Lok Sabha in August 2022. It was referred to the Standing Committee on Energy for detailed examination. However, the Bill has now lapsed and would require to be introduced in Parliament. Though the Bill met with political opposition, industry sees the need to bring in amendments to promote competition, efficiency, and induction of renewable energy in the following areas.

Sharing of distribution network

Open access to the distribution network, which is essential to promote competition and group captive generation, is weighed down by charges levied by state owned utilities that do not want to promote competition. Sharing distribution systems will promote consumer choice with competition.

[13] Aggregate Technical & Commercial (AT&C) loss is an actual measure of performance of a power distribution system as it includes both technical losses and commercial losses. it shows the gap of input energy into the system and the units for which the payment is collected.

Allowing multiple discom in one region

Section 5 of the Electricity Amendment Bill allowed more than one distribution licensee (or discom) in one region to distribute power to consumers. Although the provision of allowing more than one discom in one area was also mentioned in the 2003 Act, as per the old law the new discom had to have its own wire and distribution infrastructure. The new Bill, however, allowed the new entrant to use the distribution infrastructure of the existing discom by paying some charges like wheeling charge and others. The Bill should be adopted expeditiously so that new entities can enter the distribution business and greater competition leads to efficiency.

The new Bill had a section 60A (2) whereby if there are multiple discoms in the same area, the State Government could set up a cross subsidy balancing fund (managed by a government company or entity designated by the State Government) as per SERC regulations. Establishing such a fund is an innovative mechanism to address the deficits in cross-subsidy in the area of supply of discoms. Such a fund along with multiple distribution companies in an area could bring in transparency. Therefore, this provision of the Bill should be implemented

(iii) Promotion of captive generation through renewable energy

Section 86(e) of Electricity Act 2003 specifies that one of the functions of state commission is to promote cogeneration and generation of electricity from renewable sources of energy. The Ministry of Power has notified Renewable Generation Obligation for all the thermal plants being operationalized on or after 01.04.2023. MOP vide notification dated 20.10.2023 has directed BEE to maintain data related to compliance of renewable energy utilization by large consumers (includes commercial and industrial consumers) and submit report to the Central Government. It has also been notified that any shortfall in specified renewable energy consumption targets shall be treated as non-compliance and penalty shall be imposed.

While the Electricity Rules, 2005 have been amended in 2024 to rationalise open access charges and now allow large consumers (open access consumers) to buy electricity from the cheapest sources across India, not just from their local Distribution Licensee, some States levy high charge on large consumers to buy electricity from other sources. This also discourages captive renewable energy generation.

CERC could be asked to monitor open access charges at State level so that they are eliminated in four years in true spirit of competitiveness in the electricity sector. Violation by any distribution company could be penalized by reduction in borrowing from the Centre under a pre-determined formula. This mechanism could be like the mechanism which is existent for payment by state-owned utilities. In case of private distribution companies, the penalty could be in the form of a levy by the regulator.

(iv) Strengthening interstate and intra-state transmission networks

To improve reliability of grid infrastructure for transmission and for expansion of grid infrastructure, it is important to develop and deploy high-quality transmission equipment, standardisation of specifications for power transformers and policies around securing integrity of the power grid when equipment for the transmission sector is supplied from border sharing nations.

This will also help in improving the geographical spread of renewable energy across states and increase each state's power import capability to at least 50-60% of peak demand.

State government procurement processes should align with the Central Electricity Authority's standardised specifications to streamline manufacturing, enhance competition, and ensure uniform grid standards across the country. There must be standardisation at the lower voltage levels (220KV and 132 KV) in intrastate projects which causes inefficiencies and additional burdens on OEMs. It would, therefore, be helpful to have CEA specifications in these instances. This will help uphold the "One Nation, One Grid" principle and facilitate scalability for manufacturers and remove limitations on buyer choices.

Integration of renewable energy in transmission requires addressing challenges and strategies for green energy integration into the grid, while balancing the load. Battery Energy Storage Systems (BESS) to ensure uninterrupted power supply, especially as grids prepared to accommodate more green energy, is required. Advanced automation solutions could also be implemented to optimize load balancing when integrating renewable energy sources into the grid.

Automation must be included in turnkey projects to ensure that automation packages are an integral part of turnkey projects rather than being bid separately. This will help avoid integration challenges and execution delays. Bidding for automation packages are currently done separately rather than being a part of turnkey projects, causing integration issues, quality inconsistencies, and execution delays.

Integrating smart technologies, digital monitoring, and automation solutions could enhance grid efficiency, reliability, and operational performance. Automation needs to be integrated into the projects as going forward automation will help optimize grid efficiency.

The lack of AI and machine learning in new and old transmission/distribution lines results in suboptimal capacity utilization, pilferages, and ineffective energy flow mapping. It would be helpful to implement AI/ML in transmission systems. Incorporation of AI and machine learning for all new transmission/distribution lines and retrofitting old lines to optimize capacity utilization and energy flow mapping must be mandated.

Clarity in Sections 68 and 164 of the Electricity Act is required for removing duplicative approval processes and regulatory uncertainty for transmission licensees and generating companies. The confusion over when Section 68 approval is needed, alongside authorization requirement under Section 164, that enforces provisions of the Telegraph Act, creates hurdles. This uncertainty leads to project delays, increased costs, and inefficiencies in execution. It would be helpful to clearly define the interplay between Section 68 and Section 164 to eliminate redundant approvals and streamline the clearance process. By establishing clear guidelines on which approval is required under different circumstances, project developers can avoid unnecessary delays and ensure smoother regulatory compliance.

The government should identify and appoint a dedicated agency to conduct the reconductoring study and oversee its execution. The Central Electricity Authority (CEA) has not yet provided a framework for reconductoring. There is an absence of a long-term (5–10 year) planning approach from a manufacturer's perspective. CEA should provide regulatory framework and mandate a study on reconductoring to provide necessary guidelines, introduce clear policies and standards for insulated cross arms and other key components.

Addressing issues in the transmission sector broadly require streamlining certification processes and approvals, standardized procurement specifications and compensation mechanisms, stronger contractual safeguards in Transmission Service Agreements (TSAs), extending test validity periods, enforcing security regulations, adopting surety bid bonds, and promoting localization through structured policies. These measures will enhance project efficiency, reduce delays, improve financial predictability, and strengthen transmission infrastructure development. Grid efficiency through modernization of transmission infrastructure will also improve energy reliability, and add to the overall industry competitiveness, by reducing costs.

Confederation of Indian Industry

Transitioning to Green Hydrogen

To achieve clean energy transition and become net zero by 2070, it is essential to reduce carbon emissions in hard to abate sectors like steel, cement, transport, etc. Green hydrogen and ammonia have huge potential to replace carbon fuels, however, in absence of appropriate mandates by Government of India, the demand for green hydrogen and ammonia is not created yet.

Following key measures could be adopted in immediate term for bringing visibility and ease of financing in the green hydrogen and derivative sector:

(i) Phased mandates for use of green hydrogen

The Government could notify phased mandates for green hydrogen and its derivatives in phases starting with 10 per cent in the first year to 25 per cent in couple of years on the lines of Renewable Purchase Obligations. It will promote and create domestic demand in the country.

(ii) Infrastructure status

Recognising production of green hydrogen and its derivatives, and its supporting distribution and storage ecosystem as infrastructure will help this sunrise industry in getting high upfront capital investment. To bring more projects into the pipeline, significant project preparation funding will be needed. Currently the green hydrogen/green ammonia projects are not covered in infrastructure lending, the same should be covered in infrastructure lending, so that mainstream financial institutions can appraise these projects and provide the required funding. This will also be in line with National Green Hydrogen Mission and help make India an export hub for Green Hydrogen/green ammonia.

(iii) Special SEZ status for green hydrogen production for export purpose

Wind farms to be considered as contiguous land suppling captive power for production of green hydrogen and derivatives. Currently, the regulations under SEZ (Special Economic Zone) do not consider wind farms as contiguous land since wind turbines are spread out over large areas, unlike solar farms or other infrastructure. This distinction prevents wind projects supporting green hydrogen production from availing SEZ benefits. Projects, where the offtaker holds at least a 26% equity stake and consumes more than 51% of the generated power, should be eligible for SEZ benefits. Also, projects, where the offtaker has a power purchase agreement (PPA) covering 100% of the wind project's capacity, could also be granted similar incentives.

Ramping up Nuclear Capacity for Clean Power

An important pathway towards being a net zero economy by 2070 is induction of non-fossil fuel-based power generation. For having a diversified energy basket, it is important to mainstream adoption of nuclear power generation.

A ranking of 31 countries in terms of their share of nuclear energy in total electricity generation places France at the highest at 65%. According to International Atomic Energy Agency's (IAEA) 2023 ranking, India was just four notches above the lowest at the 28th position with a percentage share of 3% of nuclear energy in its total electricity generation.[14] The country's nuclear capacity is 8180 MW as of January 30, 2025. An IEA's analysis and forecast for 2027 says nuclear power generation will record a significant rise in 2025 driven by a recovery in output in France and Japan and new reactors beginning their operation in China, India and Korea, among other countries.

According to the department of atomic energy, 8700 MW of nuclear power capacity is under construction while 7000 MW capacity addition has been accorded in principle approval. The Central Electricity Authority in its optimal generation capacity mix for 2029-2030 sees 8700 MW under construction nuclear capacity going on stream by 2029-30.[15]

The Union government has allocated Rs 20,000 crore for Nuclear Energy Mission for Viksit Bharat, with the aim to develop at least five indigenously designed and operational small modular reactors by 2033.

Bharat Small Reactors (BSRs) are also being developed under the government supervision. BSRs are 220 MW Pressurized Heavy Water Reactors (PHWRs) which are being upgraded to reduce land requirements, making them suitable for deployment near industry such as steel, aluminium, and metals, serving as captive power plants to aid in decarbonization efforts. For this, partnerships with the private sector is being explored.

The plan involves private entities providing land, cooling water, and capital for financing, while Nuclear Power Corporation of India Limited (NPCIL) handling design, quality assurance, and operation and maintenance.

[14] https://pris.iaea.org//PRIS/WorldStatistics/NuclearShareofElectricityGeneration.aspx

[15] https://cea.nic.in/wp-content/uploads/irp/2023/05/Optimal_mix_report__2029_30_Version_2.0__For_Uploading.pdf

Following key measures could help in scaling up nuclear power ecosystem in the country:

(i) Research & Development of indigenous small modular reactor technologies

Small modular reactors could be used as low carbon alternatives for baseload coal power generation. This could especially be designed to cater to the requirements of industrial consumers who require captive power.

(ii) Fuel availability and security

Increasing nuclear power installed capacity beyond 30 GW will be a challenge since about 18,000 tonne of mined uranium will be required. This requirement is one third of the current global uranium production. Therefore, it is important to reprocess spent fuel and look at alternative technologies like those based on thorium which is available in India.

The country could also look at making investment in uranium reserves overseas like in Australia. This buying of uranium assets abroad could be like buying oil equity and strategic reserves outside India.

(iii) Amendment to the Atomic Energy Act

The Atomic Energy Act, 1962 empowers the Central Government to produce, develop, use and dispose of atomic energy either by itself or through any authority or corporation established by it or by a Government company and carry out research in any matters connected therewith. Only two public sector undertakings (PSUs), Nuclear Power Corporation of India Limited (NPCIL) and Bhartiya Nabhikiya Vidyut Nigam Limited (BHAVINI), which are under the administrative control of Department of Atomic Energy, are currently operating nuclear power plants in the country. In order to enable formation of joint venture companies by NPCIL with other PSUs for civil nuclear power projects and to meet the additional funding requirements for augmenting the nuclear power generation capacity in India, clause (bb) of sub-section (1) of section 2 of the Act was amended in 2015 to include a company in which not less than fifty-one per cent of the paid-up share capital is held by the Union Government.

An amendment in section 14 of the Act was also made to enable the Central Government to issue licence to such joint venture companies to set up nuclear power plants, take measures for their safe operation and to ensure disposal of nuclear material. It further provides for cancellation of licence in case the licensee ceases to be a Government company.

In line with this amendment, the Union Government in September 2024 approved formation of Anushakti Vidhyut Nigam Ltd. (ASHVINI), a joint venture of Nuclear Power Corporation of India Limited (NPCIL 51%) and NTPC Ltd (49%) to build, own & operate nuclear power plants in India. Additionally, the government also approved transfer of Mahi Banswara Rajasthan Atomic Power Project (MBRAPP) 4x700 MWe based on indigenous PHWR technology, from NPCIL to the JV Company ASHVINI.

Further amendment to the Atomic Energy Act could be done to allow formation of joint ventures between PSUs and private sector companies. These could initially be with majority PSU ownership but depending on the growth and risk appetite of the sector as it evolves, increased equity participation of private companies could also be allowed.

Atomic Energy Regulatory Board (AERB) should also be empowered and given autonomy so that there is transparency of operations. This could help in attracting private investment to this high-risk industry.

(iv) Reform in Civil Liability for Nuclear Damage Act

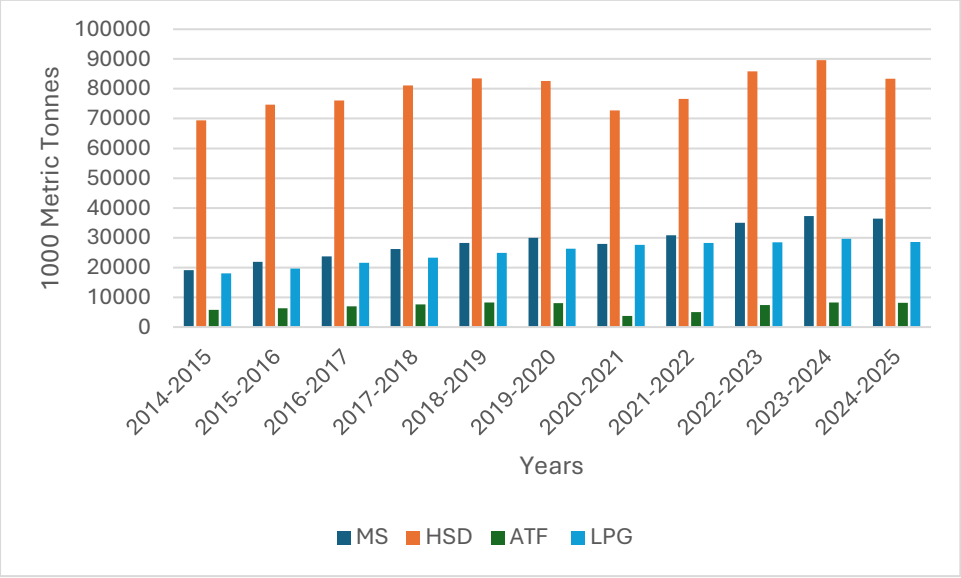
Section 17(b) of the Civil Liability for Nuclear Damage Act provides a right of recourse to the operator when "the nuclear incident has resulted as a consequence of an act of supplier or his employee, which includes supply of equipment or material with patent or latent defects or sub-standard services". This provision comes in the way of private companies supplying equipment for nuclear power plants.

Amendment to the Civil Liability for Nuclear Damage Act (CLNDA) should be done to align it with international Convention for Supplementary Compensation for Nuclear Damage (CSC), which primarily holds operators liable. The strict liability clauses in the CLNDA**, 2010**, place a high degree of responsibility on suppliers for nuclear accidents.

With 3.4 per cent increase in oil demand, India saw the largest single demand growth in 2024, while demand in Southeast Asia (+2.6%) also rose significantly. According to International Energy Agency, India's dynamic economy "has underpinned the advances of recent years, with urbanisation and rising car ownership lifting oil demand 11.6 per cent higher in 2024 than 2019".[16]

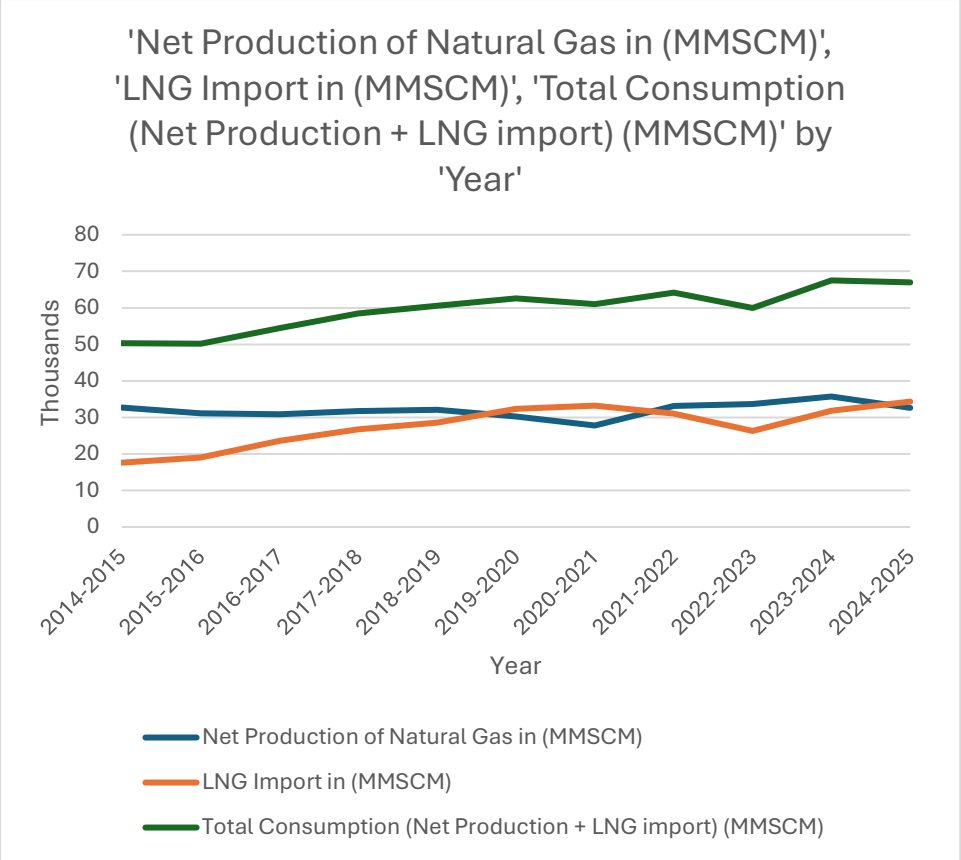
India is also actively promoting biofuels and energy efficiency measures to reduce domestic oil use and import for achieving energy security. For instance, the country has advanced by five years its deadline for doubling nationwide ethanol blending in gasoline to 20% by fourth quarter of 2026. This vision is supported by the country's abundant feedstocks, political support and policy.

India's consumption of petroleum products and natural gas, including LNG imports, has shown a steady increase from 2014-2024. The rise in consumption of petroleum product is driven by economic growth, increased industrial activity, urbanization, the growing transport sector, freight and aviation sectors and changes in energy consumption patterns.



Domestic Consumption of Petroleum Product in India (April to March)

[16] https://iea.blob.core.windows.net/assets/5b169aa1-bc88-4c96-b828-aaa50406ba80/GlobalEnergyReview2025.pdf



Source: PPAC, Ministry of Petroleum and Natural Gas, Govt. of India

Despite India's growing interest in renewable energy, the increase in demand for oil and gas suggests that fossil fuels are still a significant part of the energy mix. An IEA report titled, India Oil Market Report: Outlook to 2030, says India's ambition for industrial expansion will account for almost half of the rise in the nation's demand and more than one-sixth of total global oil demand growth through to 2030.[17]

The Indian government's emphasis on clean cooking programme has led to LPG imports surging nearly three-fold in the past decade and further initiatives will see demand growth continue through 2030, notes the IEA report. As of 1 January 2024, LPG has reached a total 320 million households with 100 million PMUY connections.

The IEA report states that without increased uptake in electric vehicles, and an increased role of biofuels, India's transport sector will face the challenge of decarbonisation. As per estimates, combined, new EVs and energy efficiency improvements will help avoid nearly 480 kb/d of extra oil demand in the 2023-2030

[17] https://www.iea.org/ /reports/india-oil-market-report

period, failing which, India's oil demand would reach a much higher 1.68 mb/d by 2030 compared with the current forecast.

(i) Taxation Reforms in Petroleum Sector

Petrol, diesel, aviation turbine fuel (ATF), crude oil, and natural gas are currently outside the purview of good and service tax (GST). Seven years after the GST was rolled out across the country in July 2017 legacy taxes such as VAT, central sales tax, and central excise duty continue to be applicable on these five products, leading to a cascading effect on their prices. Besides, alternative fuels such as coal, fuel oil, naphtha, and LPG are included under GST at 18% or 5%, allowing them to claim input tax credits, while the exclusion of petroleum products and natural gas from GST deprives them of this benefit. Most manufactured end products fall under GST, whereas petroleum products (motor spirit, high-speed diesel) and natural gas do not. This results in higher costs for end consumers compared to alternative fuels like coal, furnace oil, and light diesel oil (LDO), which are covered under the GST regime.

Bringing petroleum products and natural gas under a uniform taxation system will enhance efficiency in the natural gas and crude oil refining industries and enable more transactions and discourage tax arbitrage across states. A phased approach could be adopted, beginning with bringing natural gas into GST fold.

Natural gas volumes across states are significantly lower compared to petrol and diesel, making the potential revenue loss manageable. The impact is expected to exceed INR 10,000 crore in states, like Gujarat, Assam, and Uttar Pradesh, while for other states, it varies between INR 500-1,000 crore. In nearly half the states, VAT collections from natural gas are negligible or below INR 200 crore.

To mitigate potential revenue losses for central and state governments, a compensation cess mechanism—similar to that for tobacco or automobiles—could be implemented. If required, states could be compensated for five years for any revenue loss. Increased economic activity following the inclusion of gas in GST will further offset revenue losses for state exchequers.

Including natural gas in GST will incentivize gas resource development, attract substantial investment over the next 3-5 years, and increase domestic production by 40-50%, reducing the import bill and benefiting the government through royalties and profit petroleum. Additional investments in pipeline infrastructure and city gas distribution (CGD) networks will support the government's vision for a gas-based economy.

Possible Tax Rates for Natural Gas under GST

Competing and more polluting fuels are taxed at 18%, while LPG is taxed at 5%. Since power companies primarily burn coal, taxed at 5%, the tax rate for natural gas supplied to power companies should not exceed 5%. Supply to fertilizer companies should be taxed at 5%, aligning with the tax rate on urea, which would help reduce government subsidies (allocated at INR 1,954 billion in 2023-24). With these rates, inflation risks

would be mitigated. Anti-profiteering provisions under GST would ensure that tax benefits are passed on to consumers.

A GST rate of 12% for natural gas is recommended, with a concessional 5% rate for the fertilizer and power sectors.

Simplifying the Compliance Structure for the Petroleum Sector

The petroleum sector currently faces a complex compliance structure, involving multiple taxes such as Excise, VAT, CST, and GST, leading to administrative challenges and increased compliance costs. A simplified tax structure, bringing petroleum products under GST, would eliminate the need for multiple tax filings, reducing compliance burdens and fostering ease of doing business. This would also enhance the sector's attractiveness to investors, promoting further development and innovation. Implement a simplified and unified tax regime for petroleum products under GST, reducing compliance costs and fostering investment in the sector.

(ii) A Model City Gas Distribution Policy for Streamlining Clearances for Faster Project Implementation

Laying of pipelines and setting up of retail outlets face several issues that hamper ease of doing business. Delay in various clearances at the state and local levels create challenges. For instance, a city gas distribution (CGD) entity currently coordinates with several agencies (approximately 10-15) to obtain permissions for land and digging leading to delays at various stages and affecting the overall progress.

Some states levy restoration charges if state or city government-owned entities do restoration themselves. Such restoration charges are as high as Rs 2,300 a metre for MDPE (Medium Density Polyethylene) laying activities. Restoration charges for 1 LMC (considering 10 metre of MDPE laying), however, cost around Rs 23,000. Considering that CGD entities are collecting only Rs 5,000 as a deposit for one LMC connection, the restoration charges are more than the actual cost of the LMC connection.

A uniform framework explicitly standardising processes, setting ceiling rates for ROU/ROW charges and timelines to release permissions from municipal council/ nagar parishad/ gram panchayat, PESO, etc., could be put in place. Deemed permission be granted in case the application is not rejected in 07 days (in line with the broadband fibre laying policy of DoT). This will help states to support the Centre through an enabling policy framework.

A single authority at the state level for CGD networks should be created or designated for raising issues/ grievances relating to permissions/clearances. A nodal office for CGD could be the primary point of contact for all CGD-related matters within the state and coordinate with relevant departments, agencies, and stakeholders to facilitate the implementation of CGD projects. Besides, a single application permission to lay steel pipeline/MDPE could be sought in a time-bound manner.

(iii) Marketing & Pricing Freedom for Natural Gas & Rationalisation of Pipeline Tariffs

A balanced risk-reward framework is essential to attract investments and enhance domestic gas production. Provide complete marketing freedom to gas producers.

Ceiling prices imposed under the March 2016 policy disturbs market dynamics. When market prices exceed the ceiling, producers realize only the capped price, while in a downturn, they bear the full downside risk. The Kirit Parikh Committee (2022) recommended discontinuing price ceilings from January 1, 2026.

Adopt pricing freedom to support investments, enhance production, and reduce import dependence. Global examples indicate that pricing freedom boosts investor confidence and strengthens the investment case.

Extending the uniform tariff (UFT) mechanism to all pipelines will ensure maximum pipeline utilization across the network. The current uniform tariff (UFT) does not cover all pipeline networks, limiting the efficient flow of gas across regions. Cross-subsidization in pipeline tariffs currently hinders competition and natural gas penetration.

(iv) Transparency and competition in gas market

Digitalisation initiatives for better data sharing, especially for pipeline booking, will help in bringing transparency among stakeholders.

Implementation of Petroleum and Natural Gas Regulatory Board (Affiliate Code of Conduct for Entities Engaged in Marketing of Natural Gas and Laying, Building, Operating, or Expanding Natural Gas Pipeline) Regulations, 2008, in letter and spirit, could help bring more transparency in marketing and gas transmission work of companies.[18] Regulation (4) defining the Scope of Affiliate Code of Conduct lays down the objective of this code as:

(a) Protection of the interests of the consumers and other entities against the actions of an entity while dealing with its affiliate as also when the entity on its own is engaged in both the activities of transportation and marketing of natural gas;

(b) Prevention of cross-subsidization of the costs between the regulated activity and any other non-regulated activity including the activity of marketing of natural gas either by the entity on its own or through its affiliate which adversely affects or has the potential of adversely affecting fair trade and competition between the entities;

---

18 https://www.pngrb.gov.in/OurRegulation/PNGRB%20Regulations/B.%20Natural%20Gas%20Pipeline/B.2.%20NGPL%20Affiliate%20Code%20Regulations/NGPL%20Affiliate%20Code-%20Post%20Amendment-19.02.2014.pdf

(c) that there is no preferential access allowed by the entity to itself or it its affiliate for the regulated activity; and (d) development of a fair and competitive natural gas market.

These objectives when implemented could help in creating a fair and competitive natural gas market in the country.

(v) Policy Framework for Common Offshore Infrastructure Development:

Many oil and gas discoveries are sub-economical on a standalone basis but can be monetized through joint development and shared infrastructure. Global examples, such as The Eastern Trough Area Project (ETAP) in the North Sea and the Na Kika project in the Gulf of Mexico, demonstrate how shared infrastructure can fast-track project development, enhance domestic production, and reduce import dependence. The Oilfields (Regulation and Development) Amendment Bill, 2024, takes a positive step by enabling infrastructure sharing.

A comprehensive policy framework to support the development and sharing of common infrastructure for monetizing sub-economic discoveries could be evolved in consultation with stakeholders. This will help in optimisation of existing investment in infrastructure.

Confederation of Indian Industry

Manufacturing for Enhancing Energy Supply Chains

The energy sector will play an important role in meeting the country's ambition to be a $30-35 trillion economy by 2047 from the current $3.7 trillion economy.[i] While the target is that 50 per cent of the country's energy requirement is met from green sources by 2030, it is important to build manufacturing capabilities to meet the domestic requirement and be a sourcing destination for other countries. This could supply chain, create employment and enhance India's participation in global value chain.

An important aspect of developing the energy manufacturing segment, that is catering to the demand for environmentally sustainable processes, is the need to diversify the value chain. This can only happen if expert knowledge and best practices are exchanged among countries and with emerging economies. For instance, majority of the global solar PV manufacturing capabilities as well as raw material processing is concentrated in select geographies. Besides, there is also a requirement for diversifying polysilicon and ingot/wafter manufacturing that feed into the solar PV supply chain. The current monopolistic nature of the market creates challenges in supply chain and price uncertainty.

Energy security mitigation will require assessment of demand and required investments both for green transition and for meeting new demand. Besides, decentralised solutions are increasingly being looked at for enhancing energy access.

Emerging markets and developing economies could have cost effective module assembly/manufacturing capacities based on latest technology. This can only happen if expert knowledge is exchanged among countries specifically emerging economies that offer low-cost production facilities. There is also a need to adopt global regulatory frameworks and standards and replicate best practices.

(i) Solar Module Manufacturing:

Within renewable energy manufacturing, India's solar module manufacturing capacity is expected to exceed 100 GW by 2026, indicating need for significant vertical integration efforts into solar cells, wafers, and polysilicon. It is estimated that Solar PV manufacturing projects in India will see approximately $15.5 billion in investments. However, China's low-cost manufacturing capabilities, aided by economies of scale and advanced infrastructure, result in a pricing advantage that India manufacturers find difficult to match. High capital expenditure poses challenges, particularly for new entrants in the upstream market of solar wafer.

India must focus on vertical integration of the solar manufacturing supply chain covering polysilicon, wafers, cells, and modules to reduce reliance on imports and become globally competitive. This will involve large-scale investments in infrastructure, technology, and R&D.

Establishing 50:50 joint ventures to pool resources, de-risk large-scale projects, and share operational expertise. Public Sector Undertakings (PSUs) with their financial strength and long-term investment capability, can collaborate with private sector players to scale these technologies.

Allocate larger Production Linked Incentive (PLI) amount to enable deployment of larger polysilicon manufacturing capacity in India to feed into to the demand of domestic solar module manufacturers. This is required since India does not have any significant reserves of silicon or a well-developed supply chain for polysilicon production. As a result, India is heavily reliant on imports of polysilicon to meet about 80% of its total demand. It is, therefore, important that polysilicon capacities are deployed in India to cater to the domestic demand for ingot/wafer capacities which were awarded under PLI 1 and 2 and will be in production in the coming two to three years.

Removal of anti-dumping duty levied on solar glass to be used in manufacturing of solar module: Anti-dumping duty has been recently imposed on the import of glass from China and Vietnam. This ADD has been imposed based on reference rate i.e. rate of import has been fixed by the Government and difference between this reference rate and landed cost up to the port in India will be considered as anti-dumping duty. This is a non-creditable duty i.e. it will become the part of cost and will increase the cost of module ranging from 10%-12% which is very huge. Apart from the cost, module manufacturing in India is sitting at a target of 61 GW. However, available capacity of the glass is only 10-12 GW. So, it will be very difficult to achieve the target of solar module manufacturing based on the procurement of glass from Indian entity. Another flip side of this levy is that it comes with increase in price by the foreign seller. The Indian importer pays the price as per reference price which increases the foreign currency outgo.

(ii) Encouraging Manufacturing of Wind Energy Components:

China’s economies of scale allow it to produce wind components 15-20% cheaper than India. China leads in advanced turbine technology, particularly in offshore wind, while India lags in large-scale offshore deployments. Vietnam has improved its wind energy infrastructure and is aggressively attracting global supply chains, threatening India’s export market share. While India has improved policy incentives, challenges in land acquisition, grid integration, and long approval processes slow down project execution compared to Vietnam and China.

India's wind energy sector is expected to grow significantly, with a target of 140 GW of installed capacity by 2030, up from the current 45 GW. The sector is projected to attract over $15 billion in investments by 2030, driven by favorable policies and increasing corporate demand for green power.

India has emerged as a key exporter of wind turbine components, particularly blades, towers, and gearboxes, with major export destinations including the U.S., Europe, and Latin America.

Boosting domestic production capabilities through technology collaborations and incentives for component makers could greatly enhance export competitiveness and reduce production costs via economies of scale, tax benefits, and better port infrastructure for global shipments.
Faster Policy Implementation: Addressing regulatory hurdles and providing long-term policy clarity to attract global wind energy investors.
Offshore Wind Acceleration: Developing a clear roadmap for offshore wind projects to compete with China's dominance in deep-sea wind energy.
India has the potential to be a global wind energy hub, but to stay competitive, it must close the cost gap with China and strengthen its export strategy.

(iii) Battery Energy Storage Systems

India's battery storage market is projected to grow at a CAGR of 25%, reaching USD 15 billion by 2030, driven by EV demand, renewable energy integration, and grid storage. The Rs 18,000+ crore Production-Linked Incentive (PLI) for Advanced Chemistry Cells (ACC) aims to create a 50 GWh battery manufacturing capacity. However, there is heavy raw material dependency with India importing 100% of its lithium and China controlling 70% of the global lithium refining market. In fact, China's battery production capacity exceeds 1,200 GWh, while India aims for only 50 GWh by 2030.

While India does not produce enough raw material for battery manufacturing and continues to depend on imports for critical minerals, the nation can still be competitive in battery manufacturing by strengthening the supply chain.

Encouraging setting up mineral refining & processing units with policy incentives could attract global players.

India needs to focus on localizing raw material processing, incentivizing large-scale manufacturing, securing global partnerships for lithium supply, and accelerating battery R&D & recycling initiatives to compete effectively in the global battery market.

(iv) Building Capabilities in Solar Glass

India's solar glass market is projected to grow at a CAGR of 15%, driven by the rising demand for solar modules and production linked incentives for manufacturing of high efficiency solar modules. India currently produces around 25 GW worth of solar glass annually, with expansions planned to reach 50 GW by 2026. Simultaneously, Indian solar glass exports have seen a 30% rise in 2023, primarily supplying markets in Europe, the Middle East, and Southeast Asia. However, China dominates with over 90% of the global solar glass production, offering low-cost, high-volume manufacturing compared to India's limited scale and higher costs.

India imports key raw materials (like silica sand and specialized coatings), whereas China and Vietnam have well-developed local supply chains. Chinese firms have advanced ultra-thin solar glass technology (2.0 mm and below), making their products more efficient and cost-competitive.

India must scale up production, invest in R&D for advanced glass technology, reduce raw material import dependency, and strengthen trade policies to enhance competitiveness in the global solar supply chain.

(v) High Voltage Direct Current (HVDC) & Key Products

The HVDC market in India is expected to grow at a CAGR of 12-15% over the next five years, driven by rising investments in grid modernization, inter-regional transmission networks, and renewable energy integration. India has committed over ₹1.2 lakh crore (~$14 billion) for HVDC projects under Green Energy Corridor and transmission network expansion for offshore wind & solar parks.

With 100% FDI allowed in the power sector, major players and Indian manufacturers are expanding their HVDC product lines, including converter stations, transformers, cables, and circuit breakers. Besides, India's HVDC product exports are growing, particularly to Africa and the Middle East, but remain behind China in scale and pricing competitiveness.

China leads in ultra-high voltage (UHVDC) technology, with 1,100 kV transmission systems operational, whereas India is still at 800 kV. China controls a dominant share of global HVDC component manufacturing, including power semiconductors, insulated gate bipolar transistors (IGBTs), and thyristors, while India remains dependent on imports.

Scaling up domestic manufacturing for HVDC, investing in R&D for next-gen transmission technology, securing raw material supply chains, and offering more incentives to attract foreign and domestic investment in high-voltage infrastructure could strengthen the transmission sector.