INDIA ENERGY FORUM

20th RENEWABLE ENERGY SUMMIT

Theme: Energy Transition to Net Zero and Aatmanirbhar Bharat

15th November 2022, India Habitat Centre, New Delhi

SOUVENIR

Knowledge Partner

NET ZERO THINK

Supported By

पावरग्रिड POWERGRID

एनटीपीसी NTPC

पी एफ सी PFC

आज़ादी का अमृत महोत्सव

ONE NATION GRID FREQUENCY

पावरग्रिड
POWERGRID

POWERGRID's areas of operations

TRANSMISSION

- Transmission Lines 172,982 ckm
- Sub-stations 267
- Transformation capacity - 486,592 MVA

CONSULTANCY

- Transmission related consultancy to more than 250 domestic clients
- Global footprints in 23 countries catering more than 30 clients
- POWERGRID Academy of Leadership – 550+ courses catering to participants across the world

TELECOM

- Owns and Operates 75,636 km of telecom network
- Leading consultant in NKN and NOFN implementation

FUTURE READY

- Driven by Next Gen Technology
- State-of-the-Art infrastructure

POWERGRID, a Maharatna Public Sector Undertaking (PSU) of the Ministry of Power, Government of India, engaged in project planning, designing, financing, constructing, operating, and maintaining power transmission projects across India and undertakes operations in the Indian telecom infrastructure sector.

POWER GRID CORPORATION OF INDIA LIMITED
(A Government of India Enterprise)
Corporate Office : "Saudamini", Plot No. 2, Sector-29, Gurugram-122001, (Haryana) Tel. : 0124-2571700-719
Registered Office : B-9, Qutab Institutional Area, Katwaria Sarai, New Delhi-110 016.
CIN : L40101DL1989GOI038121 | www.powergrid.in | Follow us :

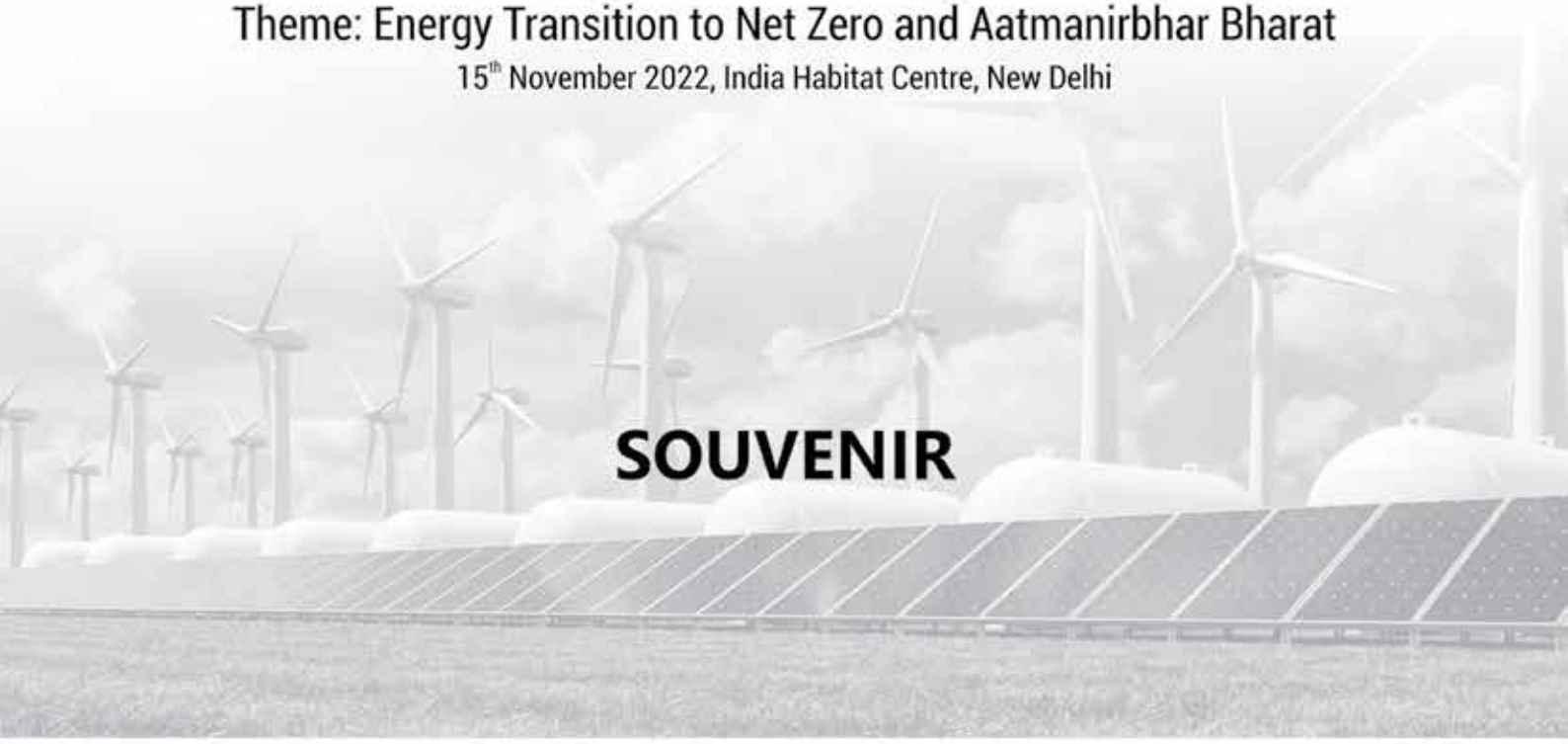
Great Place To Work. Certified 2022 INDIA

INDIA ENERGY FORUM

20th RENEWABLE ENERGY SUMMIT

Theme: Energy Transition to Net Zero and Aatmanirbhar Bharat

15th November 2022, India Habitat Centre, New Delhi



SOUVENIR

Knowledge Partner

NET ZERO THINK

Supported By

पावरग्रिड POWERGRID

एनटीपीसी NTPC

पी एफ सी PFC

Programme

10.00 a.m. – 10.30 a.m.	**Registration and Networking**
10.30 a.m. – 11.45 a.m.	**Inaugural Session**
	• Opening Remarks and Welcome Address by **Shri K S Popli**, Chairman, Renewable Group, IEF and Former CMD, IREDA • Special Address by the **Shri R S Dhillon**, CMD, PFC • Keynote Address by the Guest of Honour **Dr Ajay Mathur**, DG, ISA • Presidential Address by **Shri R V Shahi**, President, IEF and Former Secretary (Power) • Inaugural Address by the Chief Guest **Shri Bhagwanth Khuba**, Hon'bleMinister of State for New & Renewable Energy, Chemical and Fertilisers • Vote of Thanks by **Shri B Bhambhani**, SG, IEF
11.45 a.m. - 12.00 Noon	**Tea Break**
12.00 Noon - 1.15 p.m.	**Panel Discussion on Way Forward to Net Zero**
	Chairman: Shri R V Shahi, President, IEF and Former Secretary (Power)
	Distinguished Panelists: • **Shri Anil Razdan**, Former Secretary (Power) • **Shri Ajay Shankar**, Former Secretary, GOI • **Ms Cecile Fruman**, Regional Director, South Asia Regional Integration and Cooperation,World Bank, Washington • **Shri S. R. Narasimhan**, CMD, POSOCO
1.15 p.m. - 2.00 p.m.	**Lunch Break**
2.00 p.m. – 3.15 p.m.	**Session I on Manufacturing for Aatmanirbhar Bharat, Opportunities, Challenges and Risks Going Forward**
	Chair: Shri A K Jain, Former CMD, REIL
	Distinguished Speakers: • **Shri Girish Tanti**, Executive Vice Chairman, Suzlon Energy • **Dr Harish Ahuja**, President (Strategy & Policy) WaareeGroup • **Shri Vikas Jain**, Mg Director, Insolation Energy • **Shri Harendra Tomar**, Leader-Business Development, Sungrow India Pvt Ltd

3.15 p.m. - 3.30 p.m.	**TEA BREAK**
3.30p.m. - 4.15 p.m.	**Session II on Energy Storage: Key to Realise Clean Energy Transition / Accelerating to Net Zero**
	Chair: Dr Rahul Walawalkar, ED, India Energy Storage Alliance
	Distinguished Speakers: • **Shri Sujit Jena**, Sr Associate, NITI Aayog • **Shri AK Rajput**, CE (R&D) , CEA • **Prof Arun Kumar**, NEEPCO Chair Professor, Hydro and Renewable Energy Department (formerly AHEC), Indian Institute of Technology Roorkee
4.15p.m. - 5.30p.m.	**Session III on Role of New and Commercially Emerging Technologies toward Net Zero Target**
	Chair: Shri Shashi Shekhar, Director General, Independent Green Hydrogen Producers Assn. and FormerSecretary, Ministry of Water Resources, River Development & Ganga Rejuvenation, Govt. of India
	Distinguished Speakers: • **Shri Mohit Bhargava**, CEO, NTPC Renewables Energy Ltd* • **Lt Col. Monish Ahuja (Retd)**, CMD, Punjab Renewable Energy System Pvt Ltd (PRESPL) • **Shri Mohit Bhargava**, CEO, NTPC Renewables Energy Ltd* • **Shri Sunil Jain**, Operating Partner, Essar Capital Advisory India Pvt Ltd • **Dr (Mrs)MaltiGoel,** Hon. Convener, Renewable Energy Group, IEF • **Mrs. Punam Mishra**, Dy. GM – RE Engg, SBD, BHELon "Floating Solar" • **Shri Nimish Bhatia**, MD & CEO, Alucor International, Dubai
5.30 p.m.	**Summing Up and Vote Thanks:** • **Dr (Mrs) Malti Goel**, Hon. Convener, Renewable Energy Group, IEF

*TO BE CONFIRMED

20th RENEWABLE ENERGY SUMMIT

Theme: Energy Transition to Net Zero and Aatmanirbhar Bharat

15th November 2022, India Habitat Centre, New Delhi

Introductory Note

"A new energy security paradigm is needed to maintain reliability and affordability while reducing emissions."

- IEA World Energy Outlook 2022

Decarbonizing energy systems is the primary goal for reducing Greenhouse Gas emissions in a step towards sustainability and net zero. At the same time, reliable and affordable electricity is critical for achieving India's targeted high economic growth to reach 5 trillion Economy in the next decade and a move towards Atmanirbhar Bharat. India is becoming a leading market for renewable energy because of the strong government support and new initiatives taken, such as the launch of the International Solar Alliance in COP-21, aiming to make a transition towards low-cost- low-carbon solar technology. India has a total installed capacity for renewable energy of 165 GW, of which solar power installed capacity is 60.8GW, wind power 41.7GW, bioenergy 10.7GW, small hydro 4.9GW, and large hydro 46.9GW. As a result, India's Energy Intensity of GDP has decreased at an average rate of 3% per annum in the last three years.

Introduction of robust strategies like the National Hydrogen Mission with a focus on Green Hydrogen and establishment of Carbon Markets under the Energy Conservation Act; are leading an energy transition in the country with the Corporate Sector setting an aspirational goal of Green Hydrogen production on 1-1-1 (one US$ for one kg green hydrogen in one decade) and greening of the economy. Soon India will be heading for new carbon markets by catalyzing Agriculture, Land restoration, and Construction sectors with the involvement of a more significant share of Urban - Rural populations.

The BACKGROUND PAPER by our Knowledge Partner "**Net Zero Think (NZT)**" highlights the barriers to investment in RE, steps to be taken for moving ahead in the manufacturing sector for Atmanirbhar Bharat, the relevance of energy storage systems & transmission policies and the role of R&D & innovation in making a transition to net zero – the potent THEME of the 20th Renewable Energy Summit organized by the **INDIA ENERGY FORUM.**

We welcome all eminent experts, speakers, and members of the Forum to deliberate on the critical topics of three Technical Sessions that would lead to recommendations for concrete action in the RE sector.

Dr (Mrs) Malti Goel

Convener, Renewable Energy Group IEF

and Former Scientist 'G', Ministry of Science and Technology, Govt. of India

Energy Transition to Net Zero and Aatmanirbhar Bharat

India's Clean Energy Sector
Growth, Transitioning and Future Prospects

Background Paper

Knowledge Partner

NET ZERO THINK
...YOUR CLIMATE SOLUTIONS PARTNER

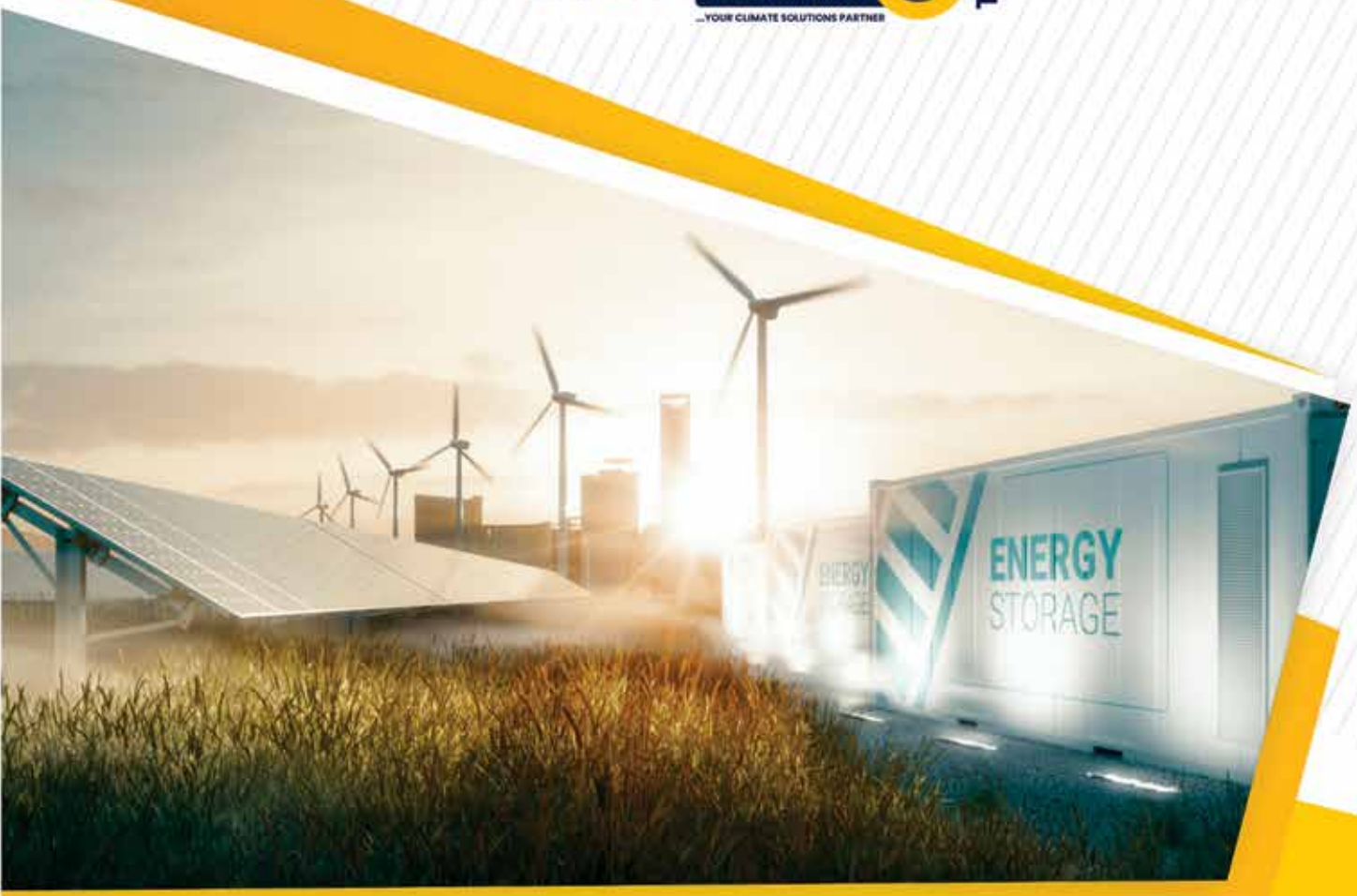


Table of Contents

EXECUTIVE SUMMARY

Key Achievements in India's Clean Energy Sector

- 165GW installed RE capacity (including. large hydro).
- 25% share of RE in electricity generation.
- ~1 billion tonnes emissions averted
- Steep reduction in solar and wind tariffs
- 3X growth in RE installed capacity (exc. large hydro) during 2014-2022
- USD 78 billion of total Investment till date

Energy Transition Goals (2030)

- Non-fossil electricity capacity to reach 500 GW.
- Cumulative electric power installed capacity of 50% from non-fossil source.
- 5 million tonnes of green hydrogen production.
- Increase in emission intensity reduction target of GDP to 45% from earlier commitment of 33-35% from 2005 level.
- 3.4 million green job creation.

Table 1: India's RE Sector at a Glance

Sector	Installed Capacity (GW)	Under Implementation (GW)	Tendered (GW)	Total Installed/Pipeline (GW)
Solar Power	60.8	50.2	25.4	136.4
Wind Power	41.7	11.8	1.7	54.2
Bio Energy	10.7	-----	-----	10.7
Small Hydro	4.9	-----	-----	5.4
Hybrid/RTC/Peaking Bundling	----	0.0	7.9	7.9
RE Excluding Large Hydro	**118.1**	**62.5**	**35.0**	**215.6**
Large Hydro	46.9	14.0	----	60.9
RE including large Hydro	**165.0**	**76.5**	**35.0**	**276.5**

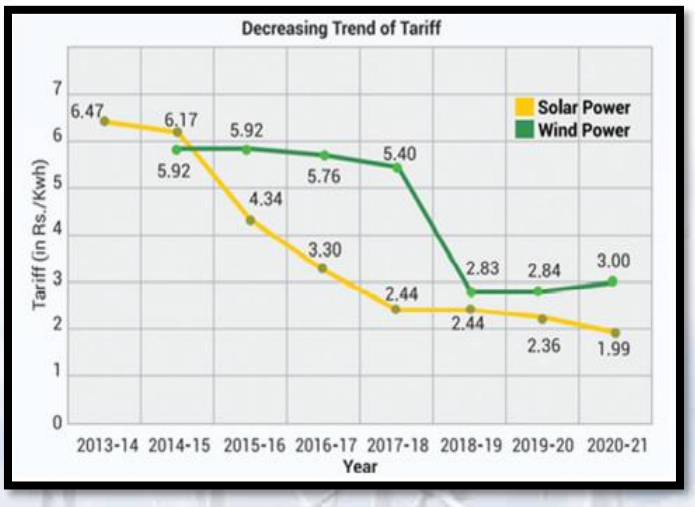


Figure 1: *Statistical representation of RE tariffs*
Source: Ministry of Power Conference Report, 2022

Tariff Reduction achieved in Solar

A significant drop in solar tariff from Rs. 6.47/kWh in 2013–14 to Rs. 1.99/kWh in December 2020

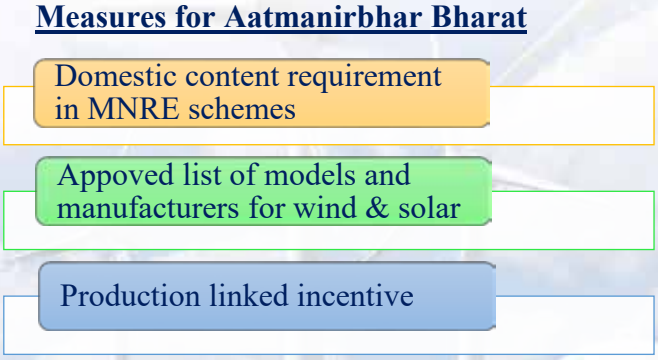


Figure 2*: Aatmanirbhar Bharat - Measures for RE Manufacturing (**Source**: MNRE, 2022)*

Ensuring affordability and access to energy has been at the fore front of the country's energy transition. From 2005 to 2021, India has reduced its carbon intensity by 40%, exceeding the 33–35% goals put forth in the declared 2015 Paris Agreement NDCs.

India has revised the NDCs in August 2022 and set a new target to reduce its carbon intensity by 45% from 33-35% level. Additionally, generation capacity from non-fossil fuel, increased to 50% from earlier declared 45%. The government of India continues to put in measures to promote its renewable energy transition plan. Some special measures to promote the growth of renewable energy include:

- Ensuring Round-the-Clock-Power (RTC) from the RE Power Projects
- Renewable Energy Hybrid Projects
- Solar Cities & Waiver of Inter-State Transmission System Charges

Renewable Purchase Obligations (RPO)

All electricity distribution licenses are now subject to uniform renewable purchase obligations (RPOs), which mandate that a minimum percentage of the total energy they use must come from renewable sources. For the financial year 2021-22, RPO achievement for the whole of India was at ~14.67%. In terms of state compliance, five states namely Karnataka, Andhra Pradesh, Arunachal Pradesh, Rajasthan, and Himachal Pradesh have achieved RPOs in full (100%). Ten other states and UTs (Odisha, Gujarat, Nagaland, Mizoram, Tamil Nadu, Goa, Chhattisgarh, Delhi, Jharkhand, Kerala, and Andaman & Nicobar) achieved between 60-100% compliance ratings. While the remaining states/UTs scored for less than 60% RPO compliance.

Aatmanirbhar Bharat – Measures for Solar Manufacturing

In promoting and meeting the call for India to be self-reliant, it is necessary to aid in empowering the various industries and to enable the country to become independent against the fierce competition in the global supply chain. For this reason, the government of India is pushing "Vocal for Local". Within the renewable energy some initiatives concerning manufacturing sector are listed in Fig.2.

Programme Interventions

PM KUSUM: 10 GW Grid Connected Solar, Installation of 20 lakh off-grid Pumps & Solarisation of 15 lakh grid connected Pump.

SOLAR PARKS: Develop at least 50 solar parks of total 40 GW capacity by 2023- 24.

ROOFTOP: 40 GW Cumulative target and 4 GW in residential sector by 2030.

WIND: 42 GW installed, 10 GW under implementation – Strategy developed for 37 GW Off-shore wind capacity by 2030.

India's Energy Transition Priority:

For India's Energy Transition, Government is working towards the following four key pillars:

Figure 3: *India's Energy Transition Priority*

1. ENERGY AND CLIMATE CHANGE NEXUS AND THE NEED FOR TRANSITION

1.1 Energy Consumption Outlook and Climate Change

With a combination of feasible nonconventional resources like solar, nuclear, wind, and biomass together with conventional resources like coal, nuclear, biomass, natural gas, oil, and hydro, India currently has one of the most diverse power sectors in the world. The amount of energy consumed has more than doubled over two decades, while contributing to more than 10% of the rise in global energy demand. Despite this, India consumes 30% less energy per capita than the rest of the world (0.44 tonnes of oil equivalent [toe] per capita compared to 1.29 toe globally and 2.9 toe on an IEA average).

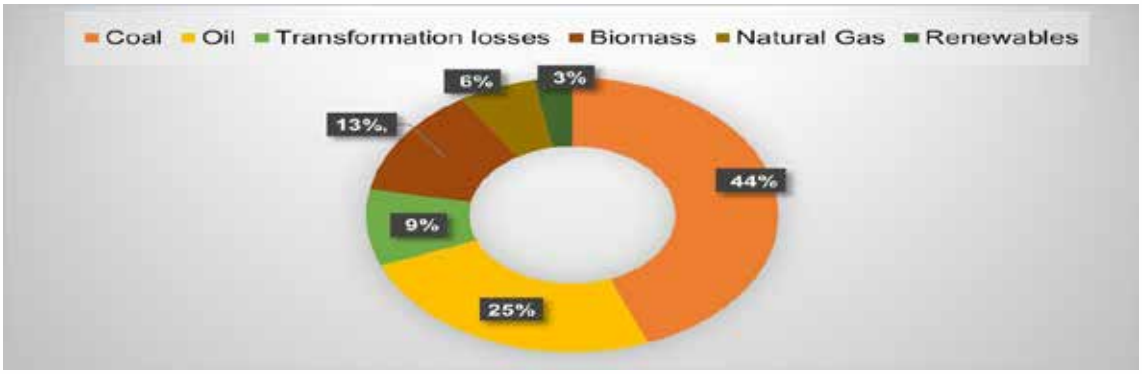


Figure 4: *India Primary Energy Mix 2020* ***Source****: IEA/India Energy Outlook, 2021*

The primary fuels used in India's energy system are coal for power generation, oil for transportation and industry, and biomass for home heating and cooking. The primary energy mix is now dominated by coal and oil, which contributed respectively 44% and 25% in 2020, according to the IEA's "India Energy Outlook 2021". Only 3% of the total primary energy demand is now met by modern renewables. Traditional biomass, which is mostly used as fuel for cooking, is steadily losing market share. The estimated transformation losses have reached to 9%. Over the past two decades, the total primary energy demand has increased at a rate of 4% (CAGR)[1].

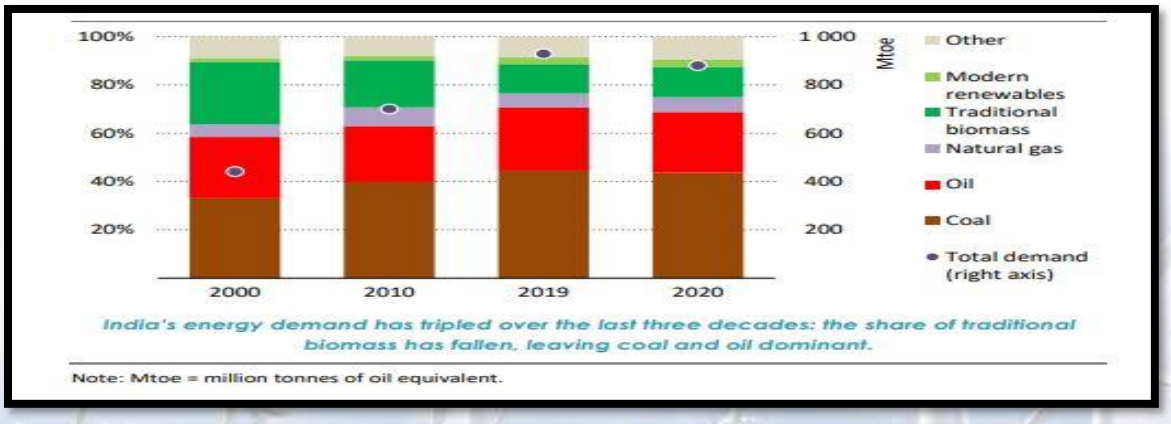


Figure 5: *Total Primary Energy Demand in India,* ***Source****: IEA - India Energy Outlook, 2021.*

[1] EY - Accelerating India's clean energy transition

1.2 Greenhouse Gas Emissions

Globally greenhouse gas emissions are reaching beyond 52.8 Gt CO2e per year which is causing global warming & climate change. Additionally, these emissions also result in extreme weather events, melting of glaciers, sea level rise, biodiversity loss, crop & infrastructure failure, species extinction and direct harm to health & safety. According to the recent IPCC report (March 2022), the global temperature rise by the end of the century is likely to be 2 to 3.7 degrees Celsius if the global emissions, as they stand today, are not curtailed.

Currently, India is the third largest greenhouse gas emitter (3Gt/Year) after USA (6 Gt/Year) & China (15Gt/Year). As per Climate Watch, in 2019 majority of India's estimated GHG emissions were from CO_2 (2.4Gt) followed by CH_4 (658Mt), N_2O (261Mt) and other flue gases (21.74Mt). To the total GHG emissions, **Energy** sector contributed 2.4 GtCO2e (71.35%), **Agriculture** 720 MtCO2e (21.2%), **Industrial Process** 169 Mt CO2e (4.96%) and **Waste** 84.3 MtCO2e (2.48%).

1.3 Commitment toward Energy Transition

India had announced the NAPCC (National Action Plan on Climate Change) in June 2008[2]. The eight primary NAPCC missions serve as the focal point for India's wide collection of policy initiatives to reduce emissions, which are continually updated and supplemented with new ones. India has given commitment to become net zero by 2070 by honourable Prime Minister at COP26.

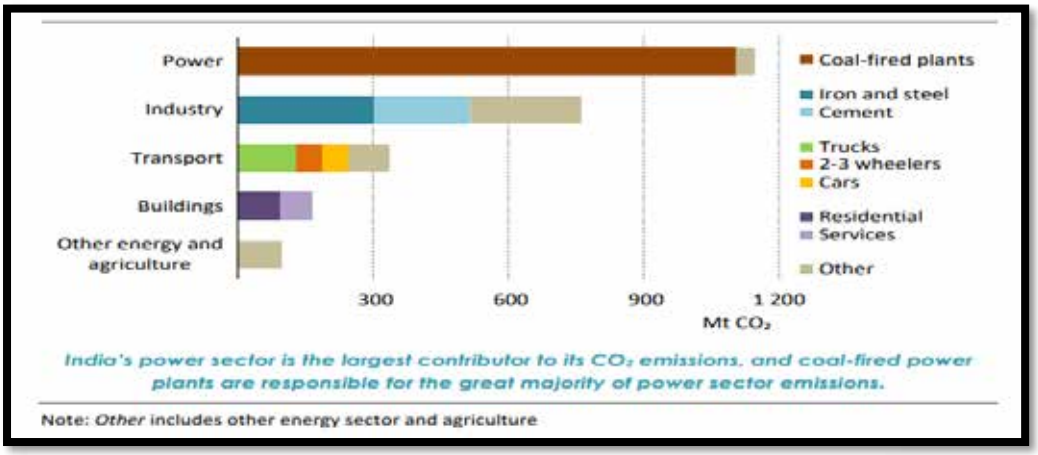


Figure 6: *CO2 emissions from the Indian energy sector,* ***Source:*** *IEA, 2021*

India understands the significance of finding a cost-effective, ecologically friendly solution to the energy-related problems facing the nation and the world. For this reason, the Indian government views the four categories of factors—demand, resource availability and use, capacity building, and improved market mechanisms (Fig. 3) as crucial and helpful in guiding and completing its energy transformation mission. Figure 3 depicts major priority consideration under each factor.

[2] Press Information Bureau, Government of India. "Ministry of Environment and Forests." http://pib.nic.in/release/rel_print_page1.asp?relid=44098. Accessed September 2010. For further information, see: http://pmindia.nic.in/Pg01-52.pdf.

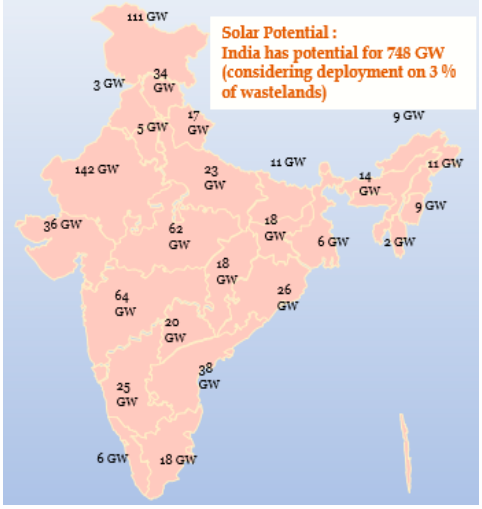
2. CLEAN ENERGY SOURCES AND THEIR STATUS IN INDIA

India is world's 3rd largest renewable energy producer with more than 40% of energy capacity installed in the year till September 2022 (165 GW of 400 GW) coming from renewable sources. India's has revised its Nationally Determined Contributions (NDC) to achieve about 50% of the total installed capacity of electric power from non-fossil fuel-based energy resources by 2030 and to reduce the emissions intensity of its GDP by 45% from 2005 levels. India is on track to accomplish these goals. As on Sep 2022, India has a total installed capacity for renewable energy of 165 GW, of which solar power installed capacity is 60.8GW, wind power 41.7GW, Bio Power 10.7GW, small hydro 4.9GW and large hydro 46.9GW. Further 76.5GW RE capacity addition is under implementation stage & 35 GW has been tendered. As on September 2022 total RE capacity including pipelines has crossed 276.5GW.

2.1 Renewable Energy Contribution to Energy Demand in India

Solar Power

As on September 2022, installed capacity of solar power is 60.8GW, 50.2GW under implementation and 25.4GW tendered. The country's total solar potential has been estimated to be 748GWp based on 3% waste land availability and solar radiation[3].



India's rooftop installation has crossed 6.96GW capacity by September 2022. Most of the capacity is added by Commercial & Industrial power consumers. India's aim is to install 40GW of cumulative rooftop solar power by 2030. Around 3.08 GW capacity allocated to 33 States DISCOMs. Government is also providing up to 40% of Central Finance Assistance to residential sector and promoting decentralised generation of solar power.

Figure 7: *India's Estimated Solar Power Potential* [4]

Natural Gas

With more than threefold increase in anticipated demand by 2040, the India would become the natural gas market with the quickest rate of growth. The government of India has envisaged to increase natural gas's share in the energy mix from its present level of 6.7% to 15% by 2030[5]. The present gas-based generation capacity is 25,000MW, according to the Central Electricity Authority (CEA). However, the utilization of gas-based power plants in

[3] *MNRE annual Report 2021.pdf
[4] *MNRE annual Report 2021.pdf
[5] BP Statistical Survey

India is low. The excessive reliance on imports, the high and fluctuating prices, and the limited gas infrastructure are obstacles to expanding the use of natural gas.

Green Hydrogen

Understanding the importance of hydrogen as a fuel across different sectors, India formed the national hydrogen energy board as early as 2003 followed by the formulation of a national hydrogen roadmap in 2006 by the Ministry of New and Renewable Energy (MNRE). India's annual hydrogen consumption of 7 million tonnes in 2020 is one of the largest after China (24 million tonnes in 2020) and the United States (11 million tonnes in 2020) and is expected to increase even further over the next few decades (IRENA, 2022). Currently, in its path towards decarbonization, India is looking to expand the production of hydrogen via the process of electrolysis, using zero-carbon electricity ("green hydrogen") or in a low-carbon fashion using natural gas reforming plus CCS ("blue hydrogen") if deployed in a manner that achieves near-total CO_2 capture and very low methane leakage. To reduce the high dependency on natural gas and fossil fuels for hydrogen production and to transition towards a greener economy, the government of India launched the National Hydrogen Mission (NHM) on 15th August 2021.

The aim of the mission is to establish India as a global hub in green hydrogen production and export. Transition to green hydrogen (GH) and green ammonia (GA) will also help India meet its COP26 net-zero commitments and targets and help reduce emissions across all sectors. The announcement of the Green Hydrogen Policy on 17th February 2022, is the "Phase 1" of the policy and a positive step towards realizing the goals of NHM. Based on the objectives and to incentivise producers, a 25-year waiver for inter-state transmission charges, RPO to be granted for hydrogen manufacturers, manufactures can establish their own renewable capacities or purchase renewable power from anywhere and producers of green hydrogen will be granted priority access to grid among others[6]. As stipulated, the green hydrogen mission can succeed through strategies like green hydrogen purchase mandates to increase demand, extension of PLI-style programs for producing electrolysers, a focus on including the utilization of oxygen produced during electrolysis, the supply of water for the electrolyser, and other factors to smoothen the manufacturing process[7].

Wind Power

As at the end of September 2022, the nation has the fourth-highest installed wind capacity in the world, totalling 41.7GW. Under implementation 11.8GW and Tendered 1.7GW. Total wind power installation including pipeline capacity as on Sep 2022 is 54.2GW. According to the most recent study, the country's cumulative onshore wind power possibilities are 302.25GW and 695.50 GW at 100 meters and 120 meters above ground level, respectively[8]. Also, the country has more than 890 installed wind monitoring stations. Nevertheless, most of the country's wind potential exists in seven windy States as shown below:

[6] Green Hydrogen Policy 2022, Ministry of Power
[7] EY- Growth of India's Clean Energy Sector
[8] *MNRE annual Report 2021.pdf

Table 2: Wind Power Potential in India at 100 meters and 120 meters, above ground level

State	Onshore Wind Power Potential at 100m above ground level (GW)	Onshore Wind Power Potential at 120m above ground level (GW)
Andhra Pradesh	44.23	74.90
Gujarat	84.43	142.56
Karnataka	55.86	124.15
Madhya Pradesh	10.48	15.40
Maharashtra	45.39	98.21
Rajasthan	18.77	127.75
Tamil Nadu	33.80	68.75
Total (7 windy States)	292.97	651.72
Other States	**9.28**	**43.78**
All India Total	**302.25**	**695.50**

Source: MNRE, India

Modern technologies are now available for production of wind turbines thanks to advancements in the technology of wind turbine generators. Strong domestic manufacturing capabilities for wind energy turbines and their components in the nation have allowed for localization of about 75%. Currently India has 14nos of Manufacturers who are manufacturing 32 types of WTGs. India Exports more than 500MW/annum wind turbine components.

Offshore Wind Power

Key developments in India's offshore wind power are listed below:

- Offshore wind energy potential: about 70 GW within 2 identified zones on Gujarat and Tamil Nadu coasts
- Strategy for offshore wind development issued in July 2022. Three models of development of offshore wind projects
- Gujarat and Tamil Nadu have consented to buy power from Offshore wind projects
- Planning of transmission infrastructure for 10 GW capacity completed
- Assistance sought for 3GW offshore projects- Rs 14300 crore

A wind RPO was created and went into effect for all electricity produced from wind energy projects after March 31, 2022, in recognition of the potential wind energy may bring to India's energy mix and energy transformation journey. In terms of wind RPO, the Ministry of Power has set forth a roadmap for wind energy that extends through 2021–2022. The trend requires state to meet 0.81% wind RPO for 2022–2023 and anticipates a 6.94% RPO by 2029–2030.

Small Hydropower (SHP)

In India, around 40% of all electricity was produced in the late 1970s solely by hydropower. Hydropower's contribution to the production of electricity has decreased to about 10% even though its supply has continually increased[9]. The development of hydropower projects with a capacity of up to 25MW, known as Small Hydro Power (SHP) Projects, falls within the purview of the Ministry of New and Renewable Energy (MNRE). 7,133 locations spread throughout have an estimated 21,133.65MW of small, mini, and micro hydel plant capacity

[9]Ministry of New and Renewable Energy: Overview of Wind Energy: https://mnre.gov.in/wind/current-status

in the nation. As part of the broader goal of generating 175,000MW of cumulative grid-connected renewable energy power projects, the national target for SHP is to reach a cumulative capacity of 5,000MW by 2022[10]. By the end of September 2022, hydropower projects of combined capacity of 4.9GW have been installed[11]. Additionally, projects with a combined capacity of 0.5GW are in various phases of development

Table 3: SHP Actual Physical Achievement

Actual physical achievement (Till Sep 2022)	Under Implementation (Till Sep 2022)
4.9GW	**0.5GW**

Source: *MNRE Report 2020-21*

The hydropower purchase obligation (HPO) went into effect for all electricity produced from large hydropower commissioned after 8th March 2019. The Ministry of Power trajectory indicates that states will have to meet their HPOs of 0.35% from 2022-23 whiles anticipating an increase to 2.82% HPO as at 2029-30.

Bioenergy

Combined cycle plants that use bagasse residue from India's substantial sugar industry are the main source of biomass power. To recover energy from biomass, including bagasse, agricultural by-products such as shells, husks, and de-oiled cakes, as well as wood from designated energy plantations, and the ministry has been supporting the Biomass Power and Bagasse Co-generation Program. About 18,000MW of electricity could be produced from agricultural and agro-industrial leftovers. The potential of excess power generation by bagasse cogeneration in sugar mills is estimated at roughly 8,000MW with gradually increased steam temperature and pressure, efficient project configuration in new sugar mills, and modernization of existing ones. Therefore, around 26,000MW of biomass power is thought to be the overall potential. Up till September 2022, biomass IPP and bagasse cogeneration-based power plants with a combined capacity of 10.7 GW were installed in the nation. India has around 540 sugar mills, of which over 360 have installed cogeneration power plants with a combined capacity of 7547MW[12].

Maharashtra, Karnataka, Uttar Pradesh, Tamil Nadu, and Andhra Pradesh are the states that have assumed leadership roles in the deployment of bagasse cogeneration plants. Chhattisgarh, Madhya Pradesh, Gujarat, Rajasthan, and Tamil Nadu are the top States for biomass power projects.

[10] *MNRE annual Report 2021.pdf
[11] *MNRE annual Report 2021.pdf
[12] MNRE Report 2020-21

Adopting adequate financial and fiscal measures on a regular basis to support the growth and promotion of bioenergy applications and their use in various industries is part of the country's policy to promote bioenergy.

Focus has been placed on advancing the development of a vibrant and strong bioenergy market that makes use of years of expertise, innovation, and technological advancements to offer sustainability and livelihood benefits. It has been intended to make interventions that address the following issues in order to realize these strategies: Support for new and innovative applications, Availability of capital at scale, Availability of feedstock and end-to-end supply chain management Promoting research, development, and innovation to increase productivity, maximize use, and produce side effects

Other Renewable Energy Sources

In addition to the aforementioned being crucial for achieving net zero emissions by 2070, other renewable energy sources, including solar thermal, geothermal, wave & tidal energy are also crucial for supplying clean energy for particular uses in remote locations with few other options. Several pilot projects are being implemented in order to meet the decentralized power needs of remote and isolated areas while also creating employment and livelihood opportunities.

3. DRIVERS AND BARRIERS FOR CLEAN ENERGY INVESTMENT IN INDIA

3.1 Drivers for Clean Energy Investment

Climate Change - witnessed increasingly in extreme weather events - is now the biggest risk threatening energy and financial markets, and vulnerable people and communities. To mitigate this climate risk, India has set ambitious targets which is enabling Clean Energy Investment across the country.

3.1.1 Developing Clean Energy Sector and Bolstering Macroeconomic Foundations

In terms of national renewable energy targets, India's RE target is among the highest to achieve 500GW by 2030.

The estimated capacity addition across various technologies is listed in table 5.

Table 5: An estimation of RE capacity addition across various technologies

Sr No	Particular	Capacity (GW)
1	Already Commissioned (as on 31.08.2022)	162.9
2	66.5 GW solar & wind capacity to be integrated to ISTS (6.278 GW capacity commissioned)	60.2
3	Additional 236.58 GW solar & wind capacity by 2030 (55.08 GW +181.5 GW)- transmission schemes under approval/ bidding	236.6
4	Anticipated Hydro Capacity Addition by 2030	16.1
5	Anticipated pumped storage capacity Addition by 2030	9.3
6	Additional Roof top solar capacity by 2030	32
7	Total (RE) in 2030	517.1

*Additional RE Potential areas are also being identified for catering to increase in electricity demand on account of Green Hydrogen production & data centres.

Source: *Ministry of Power Conference paper October 2022*

These goals are supported by supportive laws and financial inducements, such as subsidies reduced tariffs, a grid access guarantee, tax breaks, and net metering policies.

Key policy drivers responsible for development of RE in India are:

- Electricity (Promotion of generation of Electricity from Must-Run Power Plant) Rules, 2021
- Waiver of ISTS charges and losses on transmission of the electricity generated from solar and wind

- Electricity (Promoting Renewable Energy through Green Energy open Access) Rules, 2022
- National Electric Mobility Mission Plan, 2020
- Renewable Purchase Obligation (RPO) guidelines, 2022
- Energy Conservation (Amendment) bill, 2022

India is one of the top 3 countries in terms of new investments in renewable energy because of the set goals and supporting policies.

3.1.2 Open Access Transmission and Distribution

With energy being distributed to consumers through open access, thus sourcing through third party projects, as a result of the transition by Indian businesses toward clean energy. The Ministry of Powers scheme (Promoting Renewable Energy through Green Energy Open Access) further enhance open access for green energy. Effort has been made to address some practical problems that have made it difficult for interested customers to switch to renewable energy. This comprises:

- Additionally, some states place restrictions on the types of feeders and the voltage standards that limit consumers' access to open access power sources.
- Depending on the state, there may be differences in who may use the facility and the length of time that energy can be deposited (captive versus third party consumers). The Green Energy Open Access Rules establish a standard facility for at least monthly green energy banking.
- For consumers seeking to obtain energy through open access, indirect entry hurdles such as documentation requirements may also be a deterrent. In order to speed up the approval process, the Green Energy Open Access Rules call for a single window to be established and run by a Central Nodal Agency.

India's shift to renewable energy can be accelerated by the simplicity of green energy distribution and transmission through open access. Establishing a standard 100 kW load minimum for open access users, allowing open access at all voltage levels and a State-by-state uniformity in the definitions of short-, medium-, and long-term open access can help to promote open access transmission and distribution.

3.1.3 Other Factors Driving Renewable Energy in India

- Energy Security Concerns
- Climate Change
- Increasing Cost Competitiveness of Renewable Energy Technology
- Favourable Foreign Direct Investment Policy
- Distributed Electricity Demand.
- Vast Untapped Renewable Energy Resource Potential

3.2 Investment Challenges

The small transaction size for distributed energy projects, the off-credit taker's rating, the lack of transparent business models for rooftop solar, and the market's disaggregated character are the main obstacles to investment in renewable energy projects in India.

The DISCOMs in India are leading the way in solar PV investment. However, due to poor payment discipline, large commercial and technical electricity losses and ensuing financial losses, cross-subsidised electricity rates that do not cover costs, and a lack of metering and invoicing, their financial sustainability as an off-taker has come under strain. Accumulated losses of DISCOMS as on March 2021 were INR 5.16 Lakh Crore, therefore, power generation businesses are facing huge payment delay of energy bills. Project developers continue to face a significant risk related to power purchase uncertainty, which makes it difficult to control the cost of energy transitions.

Table 6**: **Risks for Renewable Investment in India

Risk	Description of Risk
Power prices	States expect low power prices from renewables, with some setting ceilings near INR 3/kWh, but developers face uncertainty over technology prices and duties.
Bankability of PPAs	Delays in the signing of PPAs or cancellations; higher-than-expected project costs relative to a fixed-price contract.
Contract renegotiation	States may seek to renegotiate power purchase contracts after seeing lower prices elsewhere.
Transmission infrastructure	Insufficient exchange of electricity and system services across states, which can hamper balancing
Financing for small-scale project	Lack of frameworks for evaluating creditworthiness of small companies; limited capacity of local banks, which prefer larger transactions.
Transparency of asset-level risks	Lack of ongoing metrics for lenders to assess susceptibility of assets to become stressed.
Power purchase	Delays in the payment of power purchase and curtailment by off-takers.

***Source:** IEA (2018b), World Energy Investment Report 2018.*

3.3 Government Support Initiatives

3.3.1 Regulations on Renewable Purchase Obligations.

All electricity distribution licenses are now subject to uniform renewable purchase obligations (RPOs), which mandate that a minimum percentage of the total energy they use must come from renewable sources. The RPOs mandate that some consumers, energy producers, and DISCOMs get a portion of their electricity from renewable sources. The State Electricity Regulatory Commissions determine RPO trajectories and keep an eye on compliance.

Ministry of Power issued an order on the new RPO requirement on 22nd July 2022 to promote generation from wind, hydro and storage projects and meeting the emission reduction targets by 2030.

Key Points covered in this order are listed below:

- The RPO trajectory till 2029-30 issued on 22nd July 2022 obligates 43.33 % of total consumption through RE sources by 2030.

- Out of 43.33%, 4% shall be from either Solar/Wind along with Energy storage or through standalone Energy Storage Systems.
- Energy storage obligation has been introduced to promote development of ESS in the country
- Fungibility among solar and other sources
- Hydro also covered in fulfilment of RPO
- States are requested to follow the RPO trajectory.

As per new RPO trajectory wind RPO would reach to 6.94% and Hydro RPO to 2.82% by 2030 (Table 7).

Table 7: RPO Trajectory beyond 2021-22 up to 2029-30[13]

Year	Wind RPO	HPO	Other RPO	Total RPO
2022-23	0.81%	0.35%	23.44%	24.61%
2023-24	1.60%	0.66%	24.81%	27.08%
2024-25	2.46%	1.08%	26.37%	29.91%
2025-26	3.36%	1.48%	28.17%	33.01%
2026 -27	4.29%	1.80%	29.86%	35.95%
2027-28	5.23%	2.15%	31.43%	38.81%
2028-29	6.16%	2.51%	32.69%	41.36%
2029-30	6.94%	2.82%	33.57%	43.33%

***Source**: MNRE 2022*

To promote storage the percentage of total energy consumed shall be wind/solar energy along with /through storage. The storage trajectory by 2030 is listed in table 8.

Table 8**: **Storage Trajectory by 2030[14]

Year	Storage on Energy Basis
2023-24	1.0%
2024-25	1.5%
2025-26	2.0%
2026 -27	2.5%
2027-28	3.0%
2028-29	3.5%
2029-30	4.0%

[13] Note: To be met only by energy produced from Wind Power Projects (WPPs) commissioned after 31 March 2022. @To be met only by energy produced from LHPs (including PSPs) commissioned after 8th March 2019. #May be met by energy produced from any RE power project other than Projects considered under Wind RPO and HPO PPTs of the Power Ministers conference at Udaipur.pdf

[14]https://powermin.gov.in/sites/default/files/Renewable_Purchase_Obligation_and_Energy_Storage_Obligation_Trajectory_till_2029_30.pdf

4. MANUFACTURING FOR ATMANIRBHAR BHARAT, OPPORTUNITIES, CHALLENGES AND RISKS GOING FORWARD

Aatmanirbhar Bharat aims to revive all aspects of the economy, including demand, supply, and manufacturing. The overall restoration of the Indian economy is the emphasis of this endeavour, which includes financial help and skill-development initiatives. A Rs. 20 lakh crores stimulus package was proposed as a reform measure.

The five pillars of Aatmanirbhar Bharat focus on:

- Economy– an economy that brings Quantum Jump rather than Incremental change.
- Infrastructure– represents modern India
- System– Technology-driven systems fulfil the needs of the 21st century
- Demography–Vibrant Demography of the largest democracy.
- Demand–Full utilization of the power of demand & supply

India's 6.3 crore micro, small, and medium-sized businesses (MSMEs) account for roughly 29% of the GDP of the nation. Industry faces difficulties in scaling up, anaemic growth, and a lack of job possibilities. MSMEs face challenges due to lack of access to capital and technological know-how. The government's "Make in India" initiative aims to create a manufacturing powerhouse in the country. Approximately 37% of MSMEs are found in the manufacturing sector. In the event of boosting manufacturing output, MSME will likely play a major role in doing so. To sell the items, a marketplace is also necessary. The chances for selling have never been greater thanks to the development of e-commerce and the Government e-commerce Marketplace (GeM). In addition, it is simple to spot developing trends due to the ease of information access. India is now placed 63rd in terms of ease of doing business, up one spot from last year. Plans like PLI projects are anticipated to boost the nation's manufacturing output.

4.1 Aatmanirbhar Bharat and Domestic Manufacturing Capacity of Renewable Energy

India has adequate manufacturing facilities for wind energy, however the manufacturing capacity for solar cell production is only about 2.5 GW, which is expected to increase about 18 GW by 2023. The manufacturing capacity of solar modules is about 18 GW which is expected to increase 36 GW by 2023. The Ministry has been releasing policies to encourage domestic PV manufacture regularly to increase the capacity for domestic manufacturing. Among the projects are:

- By mandating the use of local cells and modules in programs like PM-KUSUM, Solar Rooftops, and CPSU schemes, the Ministry has created a captive market for domestic producers of more than 36 GW over the next two to three years. Additionally, only domestic sources may be used by Public Industry Enterprises to purchase commodities relevant to the RE sector.
- Additionally, only domestic sources may be used by Public Industry Enterprises to purchase commodities relevant to the RE sector.
- The government has established a Performance Linked Incentive (PLI) program to promote the development of high-efficiency solar modules. The import of solar cells and

modules is subject to a Safeguard Duty to defend domestic producers from low-cost imports.

- A Project Development Cell (PDC) has been established in the Ministry to support and assist investors in setting up manufacturing operations in India.
- The Government has announced an advanced trajectory of Basic Customs Duty (BCD) on solar cells & modules in order to provide investors with a long-term view. Additionally, the BCD rates for solar inverters and solar lamps have gone raised.

4.2 Opportunities for Manufacturing led by Aatmanirbhar Bharat

Aatmanirbhar Bharat investigates ways that communities in rural India can generate revenue through innovations and open up new work options. Due to the opportunity to "paint green" the economic sectors that have the greatest influence on sustainable development, Aatmanirbhar Bharat will integrate India with the rest of the globe.

The Aatmanirbhar Bharat revitalization package's emphasis on improving coal use efficiency is one of its key components. INR 500 billion would be given to coal to build infrastructure. The Indian government has promoted coal gasification as an environmentally favourable practice[15]. However, it encourages green consumerism and provides incentives for the production of solar photovoltaics and improved battery storage and other renewable energy models as a way to promote Indian energy transition. Aatmanirbhar Bharat has emphasized the significance of MSMEs for the restoration of the Indian economy. 3.0 lakh crore of the campaign's budget has been set aside for MSMEs in the form of collateral-free loan facilities.

4.2.1 Challenges and Risk

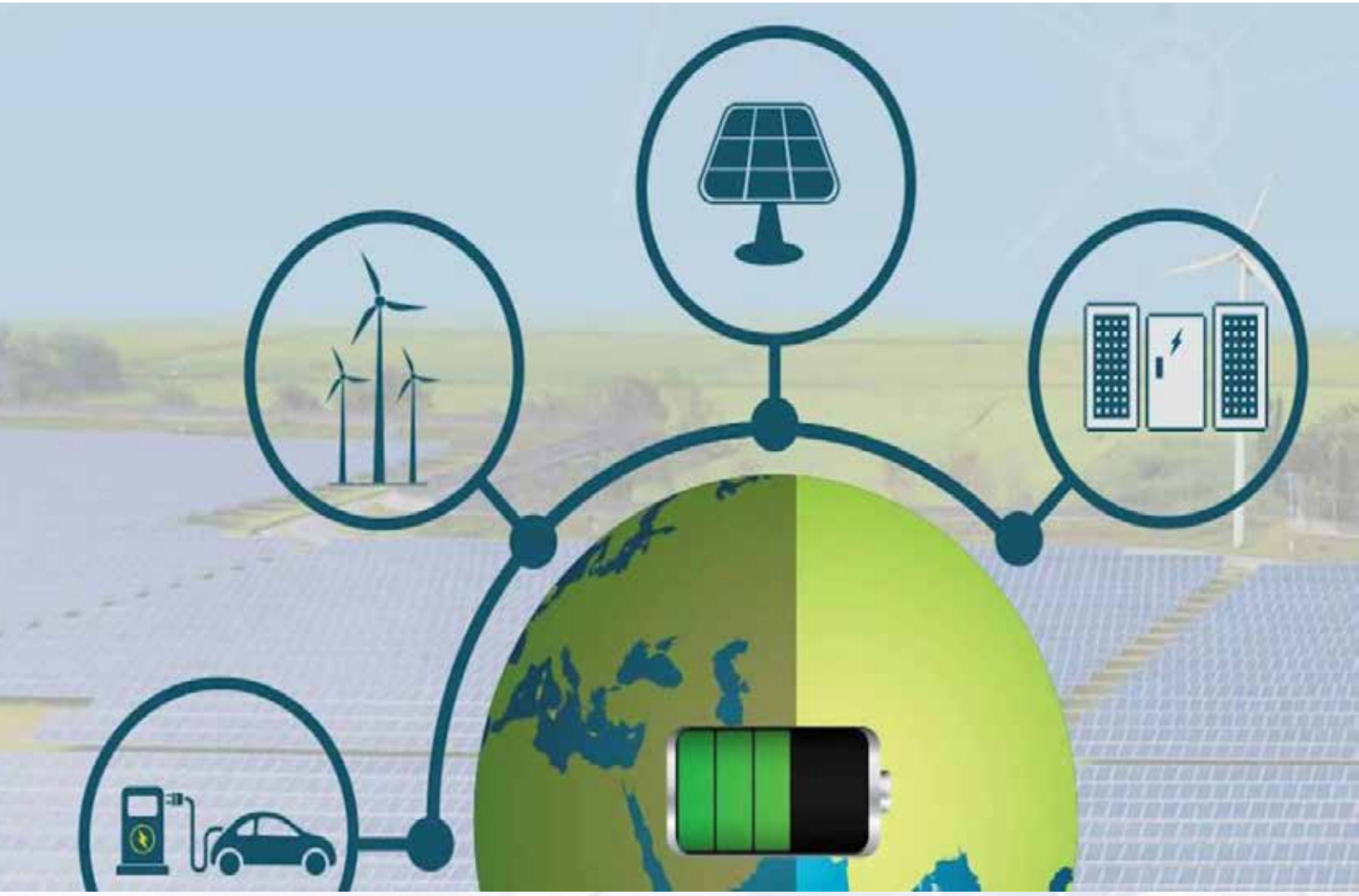
Modern technology, robots, industrial automation, and artificial intelligence (AI) are changing the nature of industrial work and eliminating numerous employments. New ideas are required to solve ongoing and potential problems in the Indian job market. The air pollution and climate change crises, are not adequately addressed in Aatmanirbhar Bharat. India needs to disclose the approach it intends to take on climate change and air pollution[16].India is somewhat reliant on nations like China for supply chain and production in many industries. Being independent in these areas is crucial right now. Import disruptions, delays, impacted logistics, reaching clients, and lower returns on investment are the major supply chain concerns. It inhibits the economy's ability to produce goods and services and manufacture them[17].

[24,25] Bhattacharji, Chetan. ""“Aatmanirbhar Bharat: Missing a Focus on Air Pollution and Climate Change," Observer Research Foundation, no. 375 (July 2020

[17] Gautam R. Patel, B. M. Christian, H. C. Patel and N. B. Pawar. "Gobar Bank: The Pace towards “Aatmanirbhar BHARAT”." Biotica Research Today 2, no. 10 (2020): 1088-1091.

4.2.2 Way Forward

Aatmanirbhar Bharat -led research may be helpful in situations where new norms are being established in uncharted territory. Foreign businesses frequently engage in unfair rivalry with Indian MSMEs and other businesses. Global bids would thus not be accepted in government procurement bids up to Rs 200 crores, will be a step in the direction of an independent India. promoting e-market connection for MSMEs as a substitute for trade shows and exhibits is crucial[18]. The working population in India would need to upskill for new employment that would arise from technological breakthroughs. This is a crucial step in the direction of Aatmanirbhar Bharat. All of the issues that organizations' supply chains are currently facing will be resolved if these options are adopted consistently[19].



[18] Aatmanirbhar Bharat Abhiyan. https:// Aatmanirbharbharat.mygov.in/ .

[19] Gautam R. Patel, B. M. Christian, H. C. Patel and N. B. Pawar. "Gobar Bank: The Pace towards "Aatmanirbhar BHARAT"." Biotica Research Today 2, no. 10 (2020): 1088-1091.

5. ENERGY STORAGE - KEY TO REALISE ENERGY TRANSITION AND ACCELERATING TO NET ZERO

5.1 India's Energy Storage System (ESS) Technologies and Capacity

5.1.1 Pumped Storage Hydropower (PSH)

India has a substantial PSH potential and significant hydro reservoir capacity, both of which are still unrealized (MNRE, 2015). In the country, 3.3 GW of the 4.8 GW existing pumped storage hydro capacity is in use; the 90 GW total anticipated pumped storage hydro potential (CEA, 2019). Around 120 GW of PSH are located across 120 sites in India[20]. According to the Pumped Storage Hydropower International Forum, only nine plants totalling 4,785 MW have been commissioned in India[21], and another three plants totalling 1,580 MW are now under development. Additionally, 12 PSH projects (public and private) totalling 10,000 MW in installed capacity are either undergoing pre-feasibility studies, thorough surveys, and investigations, detailed project reports, or getting clearances[22].

Table 9: Pumped Storage Hydropower (PSH) capacity (≥ 25 MW)

Station	Capacity(MW)	MW	State	Status
Ghatghar	2 x 125		Maharashtra	Operational
Nagarjuna Sagar	7 x 100.8	705.60	Telangana	Operational
Kadamparai	4x 100	400	Tamil Nadu	Operational
Bhira	1x 150	150	Maharashtra	Operational
Srisailam	6 x 150	900	Telangana	Operational
Puria	4 x225	900	West Bengal	Operational
Total operational capacity		**3305.60**		
Kadana	4 x 60		Gujarat	Not Operational
Panchet Hill	1 x 40		DVC	Not Operational
Sardar Saravar	6 x 200		Gujarat	Not Operational

Source: CEA (2019c), Pumped Storage Development in India (Installed Capacity above 25MW), www.cea.nic.in/reports/monthly/hydro/2019/pump_storage-01.pdf.

5.1.1.1 PSH Systems Practiced in India

Conventional PSH: Both upper and lower reservoirs to be constructed are on the natural river course

[20] Pumped Storage Hydropower International Forum: Policy and Market Frameworks Working Group- September 2021

[21] Pumped Storage Hydropower International Forum: Policy and Market Frameworks Working Group- September 2021

[22] Pumped Storage Hydropower International Forum: Policy and Market Frameworks Working Group- September 2021

Off-Stream PSH

- Open Loop PSH: All newly constructed components (including at least one reservoir) are located away from the river stream and utilizing one of the existing reservoirs which can be on the river stream
- Off-Stream Closed Loop PSP: Both upper and lower reservoirs which are to be constructed newly are away from the natural river course.

5.1.2 Battery Storage

The opportunity for battery energy storage systems to play a bigger part in supplying power system flexibility is being created by the significant drop in worldwide battery technology costs. Additionally, battery storage will be crucial. The National Mission on Transformative Mobility and Battery Storage were launched in 2019 to be a competitive battery producer.

Battery developments have been modest and few thus far in India. Utility-scale battery deployment got underway in 2017 with a power grid initiative. The 10 MW battery installed by AES Mitsubishi is one of the largest battery projects. Nine utility-scale battery storage projects are also anticipated to start up in 2019. To meet its energy needs by 2030, India will require 34 GW of grid-connected batteries with a capacity of 136 gigawatt hours (GWh), according to the CEA's draft assessment of the ideal generating mix for that year (CEA, 2019d). According to the draft, Energy Storage System Roadmap for India (2019-32) by the India Smart Grid Forum and India Energy Storage Alliance, the market for grid-connected battery storage is anticipated to reach 62 GWh by 2027. (ISGF, 2019).

Table 10: Status of Battery Energy Storage System[23]

	Location	Capacity
Above 5 MW		
	TPDDL, Rohini, Delhi	10MW/10MWh
	Sun Temple, Mehsana, Gujarat	19.2MWh
	Dollygunj and Attampahad South Andaman	16MW/8MWh
Under 5 MW		
	BHEL R&D Campus, Hyderabad	200 kWh Flow Battery, 300 KWh Advanced Lead Acid and 500 KWh Li-ion
	Bangalore	400KWh
	Puducherry	500KW/250KWh (Li-ion)
	Chennai	270KWh ph

Source: *MNRE Conference Report 2022*

In the Union Territory of Lakshadweep, four distinct islands are home to Solar Energy Corporation of India Limited (SECI) solar PV power facilities with a combined capacity of 1.95 MW and battery energy storage systems with a combined capacity of 2.15 MWh.

[23] PPTs of the Power Ministers conference at Udaipur.pdf

Table 11: Capacities of Solar PV Plants and Battery Energy Storage Systems in Lakshadweep

Island in UT of Lakshadweep	Solar PV Capacity (KWp)	Battery Energy Storage System Capacity (KWh)
Kavaratti	1400	1400
Agatti	300	0
Bangaram	150	450
Thinnakara	100	300
Total	**1950**	**2150**

Source: *MNRE Report 2020-21*

Table 12: Identification of the CPSUs for Development of PSPs

Agency	Number of projects	Capacity (in MW)
NHPC	10	14700
SJVNL	11	12745
THDCIL	10	12555
NEEPCO	10	14880
DVC	4	5010
BBMB	1	1800
NTPC	9	11550
Total	**55**	**73240**

Source: *MNRE Conference Report, 2022*

5.2 Relevance to Renewables and Net Zero

As the number of variable renewable energy sources rises storage technologies become relevant. PSH continues to be the most often used utility-scale storage option both in India and internationally. ESS can also be used for grid balancing services that provide fast response ramp up and down, peaking power support, enhancing flexibility in the power system operations, firming up of RE power generation at the source, energy shifting, etc. Grid integration and the balancing of variable generation sources can benefit greatly from energy storage. Residential, commercial, and industrial consumers who use energy storage systems in conjunction with renewable energy sources may experience an improvement in the quality and dependability of their power supply. Additionally, this would enable emergency power applications to use less diesel. In terms of cost and performance evaluation, energy storage is the primary component of EVs.

The country's reliance on imported fossil fuels and energy storage systems would be greatly reduced by the push for electric mobility using indigenous, contemporary, and reliable energy storage.

5.2.1 Some Measures taken up and proposed for the Promotion of Storage

- Waiver of ISTS Charges provided in full up to 30.06.2025 and in a reduced graded manner vide MoP order dated 23rd November 2021.
- Legal Status for Energy Storage Systems issued by MoP on 29th January 2022.
- RE Bundling: Scheme for Scheduling of Thermal/ Hydro Power Stations through bundling with Renewable energy and Hydro Power notified vide MoP order dated 12th April 2022.
- Renewable Purchase Obligations (43.33% by 2029-30) and Energy Storage Obligations (4% by 2029-30).
- Prioritization of Off-River PSPs Considering the benefits of wider Geographical/ Locational flexibility, lesser forest, environmental and R&R issues, lower gestation period, and lower cost viz-a-viz river-based schemes, the category of Off-Stream/ River PSPs need to be prioritized for faster implementation & lower tariff benefits.

5.3 Smart Grid

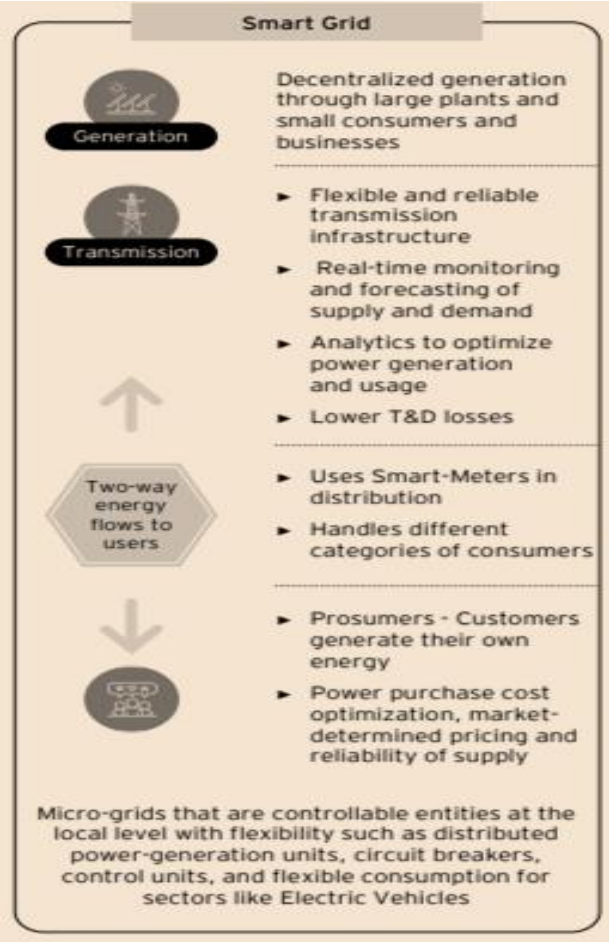


Figure 8:*Energy distribution processes through Smart grid*

Source*: EY- Decarbonization of India's energy sector*

Electricity networks are made more reliable and open to input from distributed renewable energy sources thanks to the smart grid (SG). While ensuring high development and a low carbon economy, and serve as a catalyse change to address shortcomings in the distribution sector operations. The grids are challenged due to Probable growth in energy demand and a shift in its composition and new industries including energy storage system integration and resilience to climate change. The Ministry of Power (MoP) started the National Smart Grid Mission as a pilot program in 12 locations around the nation to make use of the Smart Grid's advantages. The Virtual Smart Grid Knowledge Centre, which was established in March 2022, serves as a showcase for cutting-edge power distribution technology. It also provides service offerings that might be greatly expanded without being constrained by physical area and reaches more users even when mobility is disrupted.

Smart Grid rollout can be improved by government through creative strategy and specifying the standards for SG, put an emphasis on enhancing the capability of DISCOMS through investments in skilled labour and digitalization, Boost acceptance and innovation of SG solutions by offering rewards and create cost-sharing models that include state governments, DISCOMS, power producers, and consumers.

6. ROLE OF NEW AND COMMERCIALLY EMERGING TECHNOLOGIES TO NET ZERO TARGET

6.1 Research, Development, and Demonstration (RD&D) and Innovations in India

India's rank in Global Innovation Index was 46th in 2021; India's spending in RD&D requires financial support which is currently lesser than 1% of GDP. The Ministry offers financial support to the government, non-profit research institutions, and NGOs up to 100% and the Indian industry up to 50%.

The projects in the fields of solar thermal, solar photovoltaic, biogas, wind, wind-hybrid, energy storage, small hydropower, hydrogen and fuel cells, geothermal, etc. that fall under the identified R&D emphasis area of the Ministry are sponsored for RD&D activities. In some instances, sector-specific policy documents lay out government initiatives and embed RD&D activities in broader national policy plans, such as the National Offshore Wind Energy Policy (MNRE, 2015), the National Policy on Biofuels (MoPNG, 2018a), and the India Cooling Action Plan (ICAP) (MoEFCC, 2019).

6.2 Solar Research, Design, and Development

The Union Budget 2022-23 has provided a budgetary allocation of ₹3365 crore for the solar power sector, including both grid-interactive and off-grid projects. This is a 29 per cent increase over the previous year budget of ₹2606 crore. The budget has given a major push to the solar energy sector under renewable energy with an additional allocation of ₹19,500 crore for production linked incentives for manufacturing of high efficiency solar photo voltaic modules. The budget ensures the domestic manufacturing required for achieving the ambitious goal of 280 GW of installed solar capacity by 2030. The budget also provides for Sovereign Green Bonds to be issued for mobilizing resources for green infrastructure.

6.3 Relevance of Commercial Technologies to Achieving Net Zero

About half of the total CO_2 reductions can come from four commercial technical value chains: technologies for widely electrifying end-use industries (such as advanced batteries); carbon capture, utilization, and storage (CCUS); hydrogen and fuels connected to hydrogen; and bioenergy.[24] A significant technological revolution in the energy sector is necessary for an energy sector transition to net-zero CO_2 emissions by 2070 of the type envisioned in the Sustainable Development Scenario.

6.3.1 Electrification of end-use sectors

For decarbonization, more efficient use of clean electricity is essential. In the Sustainable Development Scenario, the share of electricity in final energy demand increases from one-fifth today to almost 50% in 2070[25], accounting for about a fifth of total CO_2 savings. As the power sector fully decarbonizes, electrification's contribution to emissions reductions rises. By 2070, electrification will be the main driver of CO_2 reduction, contributing 20% of total savings compared to the Stated Policies Scenario (IEA, 2020).

[24] https://www.iea.org/reports/energy-technology-perspectives-2020/technology-needs-for-net-zero-emissions
[25] https://www.iea.org/reports/energy-technology-perspectives-2020/technology-needs-for-net-zero-emissions

6.3.2 Carbon Capture, Utilization, and Storage (CCUS)

With 15% of the total reduction, CCUS contributes the fourth-highest amount to cumulative emissions reductions in 2070[26]. The use of CCUS technology can lower the emissions produced by fossil-fired power stations and industrial facilities, produce negative emissions, and eventually generate CO2 that is carbon-neutral and can be used to make fuels. In the Sustainable Development Scenario, bioenergy with carbon capture and direct air capture produce 5mb/d of clean aviation fuels or 3Gt of negative emissions in combination with storage in 2070.

6.3.3 Hydrogen as Fuel

Synthetic fuels like ammonia and low-carbon hydrogen are also available. In comparison to the Stated Policies Scenario, the usage of alternative fuels grows over time across many industries and contributes 6% of total emissions savings by 2070. In 2070, the amount of hydrogen produced worldwide increases seven-fold to 520 Mt. The usage of hydrogen increases across all industries and accounts for 13% of global energy demand in 2070. Today's demonstration and prototype stage technological advancements make hydrogen and hydrogen-based fuels crucial for decarbonizing heavy trucks, aviation, and shipping, as well as for producing chemicals and steel.

6.3.4 Sustainable Bioenergy

The primary energy demand for sustainable biomass doubles to 20% in 2070[27], indicating the adaptability and technological preparedness of much of the associated business chain. It is utilized to produce power and heat as well as biofuels for transportation; in both instances, CCUS is usually paired with it. 12% of the overall emissions reductions in the Sustainable Development Scenario are provided by bioenergy[28]. While sustainably produced bioenergy is crucial in the Sustainable Development Scenario for reducing emissions in the short term, for instance in transportation, it also has extra promise in other areas of the energy sector, such as industrial uses. Whiles, these technologies are central to emissions reduction as we journey toward net zero. However, many of their value chains are still in the development stage, and altogether, they are less advanced than renewable energy sources, nuclear power, and technologies that increase the efficiency of using fossil fuels.

India passed amendment in August 2022 to its Energy Conservation Act that allows for the establishment of a carbon market, making it easier for the government to improve energy-related standards for appliances and for the environmental performance of buildings.

[26] https://www.iea.org/reports/energy-technology-perspectives-2020/technology-needs-for-net-zero-emissions
[27] https://www.iea.org/reports/energy-technology-perspectives-2020/technology-needs-for-net-zero-emissions
[28] https://www.iea.org/reports/energy-technology-perspectives-2020/technology-needs-for-net-zero-emissions

7. CONCLUSION

7.1 Enabling a Just Transition towards Clean Energy Utilization

People and businesses involved in the coal value chain will experience economic and financial stress as a result of the transition between renewable energy and the long-shrinking coal industry. Coal and petroleum industries, communities, and employees in India will be exposed to significant losses in income and standard of living. This reduces the amount of money that passes through these local economies directly. It also has an impact on social services, the retail and food services industries, and other related sectors[29]. The solutions will need to be tailored to fit the needs of particular communities and sectors through transition planning, ongoing communication, resource mobilization and financial planning. Without a suitable mechanism, the shift will produce more losses than winners, upsetting the social, environmental, and economic structure of the nation[30].

Policy packages should identify Just Transition paths and a governance structure with enough institutional capacity to carry out the measures needed to ensure social inclusion and livelihood protection. Just Transition can be sped up through company diversification in the coal/petroleum industry and economic diversification for communities dependent on coal. Ensuring that re-skilling, redeployment, and realignment of livelihoods follow an orderly direction and enjoy broad public acceptance will require dialogues at the Central, State, and local government levels as well as active engagement with communities, labour unions, and civil society organizations[31].

7.2 Clean Energy and Economic, Social and Environmental Development

In India, using renewable energy is primarily done to advance economic growth, increase energy security, increase access to electricity, and slow down climate change. India is becoming one of the top leaders in the most lucrative markets for renewable energy in the world because of strong government support and the increasingly favourable economic environment. As of FY21, the solar sector (utility-scale and rooftop solar) continued to employ the majority of this workforce with a 77 per cent share (85,900) while the wind sector accounted for 23 per cent (25,500)[32]. In addition, to reach its objective of 500 GW of non-fossil energy generation capacity by 2030, India adding 238 GW of solar and 101 GW of new wind capacity could potentially result in the creation of 3.4 million employment[33].

[29] ey-skill-action-plan-to-fuel-transition-from-coal-to-renewable-energy-in-india.pdf
[30] ey-skill-action-plan-to-fuel-transition-from-coal-to-renewable-energy-in-india.pdf
[31] ey-accelerating-indias-clean-energy.pdf
[32] https://www.ceew.in/publications/indias-expanding-clean-energy-workforce
[33] https://www.ceew.in/sites/default/files/Green-Jobs-Report-Jan27.pdf

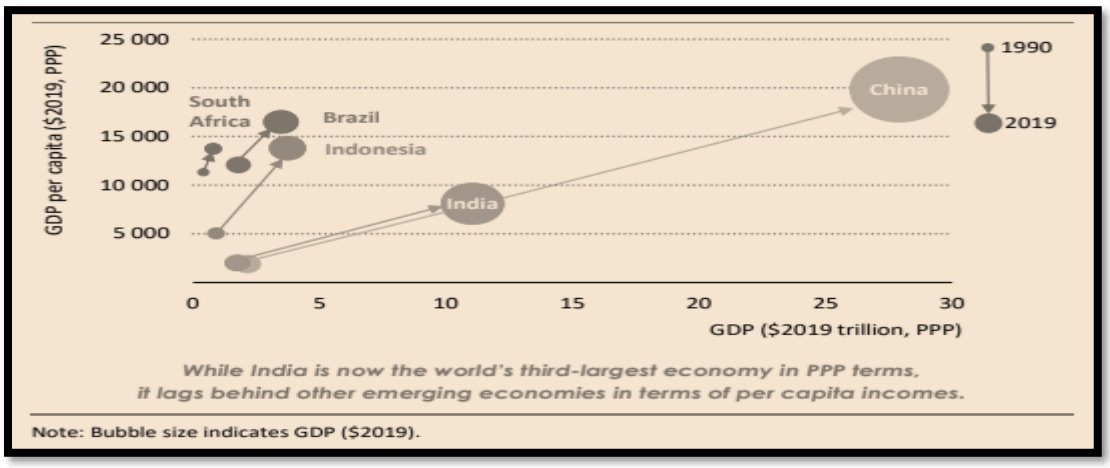


Figure 9: *GDP and GDP per capita for selected countries, 1990 and 2019*
Source*: IEA-India Energy Outlook 2021*

To fulfil the need for energy-efficient lighting, for instance, the government's LED program has dramatically lowered the price of the products on the worldwide market and helped create local manufacturing jobs whiles reducing emissions. Increased energy efficiency and the use of alternative sources of energy such as renewable energy portfolios can reduce pollution, especially the air population which has been a major government concern. Initiatives like electrification and modal shifts in transportation play a role in improving the environment and reducing overall country CO_2 emission contribution. The widespread adoption of clean cooking fuels and a more consistent and stable supply of electricity, exemplified by projects such as the rural micro grids and decentralized RE systems under PM–KUSUM, improves the economic and social development of consumers. There is a chance to increase the use of agricultural wastes in the generation of bio-based fuels and power in agricultural areas of northern India where burning agricultural residues is a major cause of wintertime air pollution.

India has made significant economic reforms that started the country's transition to a market- and services-based economy. This changed the course of its growth, raising per capita incomes, luring more private and international investment, fostering competition, and producing new manufacturing capacity, new service sector businesses, productivity increases, and a decline in the poverty rate. Energy demand has increased along with the economy's expansion, which in turn has fuelled India's economic expansion. According to the 2021 India energy outlook report throughout the course of these three decades, India's GDP energy intensity has increased at an average rate of 3% per year, which means that less energy is now needed on average to produce a new unit of economic production. This has happened as a result of the expansion of the Indian service industry, advancements in energy efficiency, and a shift away from outdated fuels like biomass for heating & cooking applications.

Nevertheless, the environmental and social concerns of renewable energy possess great concern as much as the positive impact. The rivalry between humans and wildlife for available land and water, as well as GHG emissions and other air pollutants during the production or operation of renewable energy technologies, are only a few examples of environmental and related social costs. The cost must be taken into consideration and weighed fairly against the environmental effects of alternative energy sources.

Carbon Market and India

Carbon markets can play a very critical role in India's journey to achieve its net zero and decarbonization goals as well as additional generation of revenue streams. India can achieve a carbon market potential of $30 to $50 billion by 2050 (at a conservation price of $15 per carbon credit) by catalysing certain key sectors such as agriculture, land restoration activities, and reducing emissions from deforestation and forest degradation. Participation in carbon market will empower local communities by:

- Generation of additional income stream for smallholder farmers, while cocreating livelihood opportunities for local communities.
- Protection of biodiversity, improvement of farm productivity, micro climate restoration, soil erosion prevention etc. can be associated benefits, local community can obtain.

7.3 Contribution of Net Zero Think Pvt Ltd. Toward Net Zero Transition

NET ZERO THINK (NZT) specializes in providing climate-centric net-zero solutions for Energy, infrastructure, Transport, Agriculture & Water Sectors by utilizing Artificial Intelligence & Machine Learning Platforms. It has a multidisciplinary team of professionals who together have over 100 years of experience in implementing clean-tech solutions across the manufacturing, defense, energy, IT, Insurance, & Finance sector. NET ZERO THINK is present in India and expanding its services across Asia, Africa, the Middle East, and Island Nations.

NZT services and solutions are focussed on 3 Key Pillars of Decarbonisation

- **Measure:** Determine coverage of emissions, Create Initial GHG Accounting and Inventory, Set Baselines and Determine Targets
- **Reduce**: Look into improvements to streamline operations, Increase the amount of RE output and ensure third-party assurance for emissions
- **Offset**: Examine nature-based & technological solutions, Ensure third party assurance/ credit

NET ZERO THINK is providing innovative solutions in the areas of Climate Change Impact Assessment; Green House Gas Accounting; Scope 3 Emissions, Green Hydrogen & Storage, BRSR/GRI reporting and Carbon Credit Advisory.

Subscribe to our newsletter : https://www.linkedin.com/newsletters/net-zero-6964091907949948928/

NET ZERO THINK
...YOUR CLIMATE SOLUTIONS PARTNER

Contact us

Kokarya Business Synergy Centre, Nagananda Commercial Complex, 2nd Floor, Jayanagar 9th Block, Bengaluru - 560041

support@netzerothink.com +918240615694 https://netzerothink.com/

INDIA ENERGY FORUM

Distinguished Speakers

Offshore Wind Energy

A Smart Move in Energy Transition for Atmanirbhar Bharat

- Monopiles and Transition Pieces
- Mission Equipment
- Crane Pedestals
- Lifting Tools
- Sea Fastening Equipment
- Operation and Maintainance Services


Design


Engineering


Welding


Machining


Assembly


Hydraulics


Control System


Commissioning

ALUCOR Headquarters
N300 Street Jebel Ali Dubai
United Arab Emirates
Phone: +971 (0) 4 883 1667
Email: info@alucor.com
www.alucor.com

ALUCOR

Shri Bhagwanath Khuba

Hon'ble Minister of State for New and Renewable Energy and Chemical and Fertilizers

Shri Khuba is B.E (Mech) from Sree Siddaganga Institute of Technology, Tumkur (Karnataka). He has held important positions in the Governments of India

Positions held

- Member to 16th Lok Sabha.
- Member, Standing Committee on Social Justice and Empowerment;
- Member, Committee on Provision of Computers to Members of Lok Sabha;
- Member, Consultative Committee, Ministry of Railways;
- Member, Standing Committee on Food, Consumer Affairs and Publication Distribtuion;
- Member, The Council for Schools of Planning and Architecture,
- Member, Standing Committee on Agriculture

He is holding the position of Union Minister of State since 7th July 2021.

Dr Ajay Mathur

DG, International Solar Alliance

Dr Ajay Mathur is the Director General of the International Solar Alliance. He earlier headed The Energy and Resources Institute (TERI), and the Indian Bureau of Energy Efficiency (BEE), and was responsible for mainstreaming energy efficiency in houses, offices and industries through a number of innovative initiatives. He was a leading climate change negotiator, and was the Indian spokesperson at the Paris climate negotiations. He served as the interim Director of the Green Climate Fund during its foundational period. At TERI, he has spearheaded the move to accelerate action towards a low-carbon and cleaner economy through the adoption of renewable energy in the Indian electricity sector, enhancing efficiency in buildings and industry, and promoting environmental quality through recycling of material wastes and biotechnology-based solutions. He also anchored the annual World Sustainable Development Summits during his tenure at TERI. He was also member of Indian Prime Minister's Council on Climate Change and co-chairs of the global Energy Transitions Commission.

Shri Ravinder Singh Dhillon

CMD, PFC

Shri Ravinder Singh Dhillon, 57 years, is the Chairman and Managing Director (CMD) of PFC. As CMD, PFC he is spearheading entire operations of PFC and also playing a critical role in implementation of key power sector initiatives of Govt. of India, namely Liquidity Package to Power Sector under Atmanirbhar Bharat Scheme, Integrated Power Development Scheme, 24X7 Power for All, Ultra Mega Power Projects, Independent Transmission Projects and Ujjwal Discom Assurance Yojana.

He has over 35 years of varied experience spread across the entire value chain of power sector. His diverse work experience covers 3 years in Bharat Heavy Electricals Ltd. designing power generating equipment, 6 yrs in Central Electricity Authority with macro level planning of power systems, and 26 yrs in PFC, playing a key role in project appraisal, financial modeling, project monitoring & stressed asset resolution.

Prior to being appointed as the Chairman and Managing Director of PFC, Mr. Dhillon held the post of Director (Projects), where he was responsible for business growth & asset quality. Under his leadership, PFC increased its focus on Renewable Energy business and refinancing of commissioned assets. He has also spearheaded PFC's business diversification efforts both by cross border funding and expanding business into new market segments.

Shri Dhillon holds B.E. (Electrical) degree from Thapar Institute of Engg. & Tech., and M. Tech. in Power Systems from IIT Delhi.

Ms Cecile Fruman

Regional Director, South Asia Regional Integration and Cooperation, World Bank, Washington

Cecile Fruman is Director, Regional Integration and Engagement in the South Asia Region (SAR). She is responsible for fostering collaborative activities amongst SAR countries and managing partnerships and engagements with SAR and global development partners.

Previously, Cecile was Senior Manager for Financial Intermediary Funds (FIFs) and Partner Relations in the Development Finance Vice-Presidency (DFi) where she oversaw a portfolio of FIFs that disbursed in the order of $6 billion a year in grants for key global development priorities to multiple implementation agencies and coordinated the World Bank's strategic engagement with development partners.

Cecile has dedicated her career to international development with a focus on private sector solutions. She was a Director in the World Bank Group's Trade & Competitiveness (T&C) Global Practice, a joint practice of IFC and World Bank, leading a $5 billion lending portfolio and a vibrant portfolio of analytical and advisory work and trust funds. She was also a manager in the World Bank Group Investment Climate Department for several years, leading new business in the areas of climate change, infrastructure, PPPs, health and education, e-Government solutions, and competition. She has deep experience in strategy development, knowledge management, results measurement, portfolio management, partnerships and donor relations. Cecile served as Manager of the World Bank Change Team in 2013.

Shri R V Shahi

President, India Energy Forum

Shri R.V. Shahi is the President, India Energy Forum & Chairman of Energy Infratech Private Limited. He previously served as the Secretary to the Government of India in the Ministry of Power and formerly the CMD of Bombay Suburban Electric Supply Limited.He was Secretary to the Government of India in the Ministry of Power, India from 2002–2007, the longest-serving Power Secretary in Indian history. Prior to taking over the Indian Power Sector as Secretary, R.V. Shahi was Chairman and Managing Director of BSES Ltd (the predecessor company to Reliance Energy) from 1994 to 2002, which he transformed from a small distribution utility to a multi–unit fully integrated power utility having generation, transmission and distribution. BSES subsequently became Reliance Energy. Shahi became Chairman of Energy Infratech Pvt. Limited, an Engineering & Project Development Consulting Company, with a staff of more than 350 people.

Mr Shahi graduated in mechanical engineering from the National Institute of Technology, Jamshedpur. He then earned post-graduate degrees: industrial engineering, business management, and a diploma in advanced industrial management (Delft, Holland). He is a Fellow of the World Academy of Productivity Sciences, a Fellow of Institution of Engineers, a Fellow of International Institute of Electrical Engineers, and a Fellow of the Indian National Academy of Engineering.

Shri KS Popli

Chairman, Renewable Group, IEF and Former CMD, IREDA

Mr Popli has more than 40 years of experience in Power and Renewable energy sector. During last 40 years he served in various positions in NHPC, PFC and Ireda.

Under his leadership as CMD, Ireda grew exponentially in all parameters. He introduced various new financial products helping the Organisation and the sector as a whole and making access to finance easier for RE Entrepreneurs.

He also facilitated and signed long term lines of credit with Mulilateral and Bi lateral Dev Banks to access low cost and long term credit to help the Sector.

His contribution to financing RE Projects was well recognised by the Industry. He is an Electrical Engineer with added qualifications in Law, Management and Finance. After very successful tenure with IREDA he worked for two years as Advisor with International Solar Alliance for raising corpus and facilitating financing for member Countries . He is at present a co founder and Director of an NBFC and Independent Director on Board of few other Cos.

Shri Anil Razdan

Secretary Power and Special Secretary / Additional Secretary, Petroleum and Natural Gas to the Government of India.

He has worked as Joint Secretary Power, Director Energy Management Centre (now Bureau of Energy Efficiency) and Director/Joint Secretary Atomic Energy, Government of India. He was Principal Secretary to the Government of Haryana in the Irrigation, Power, and Public Works Departments, besides Chairman Haryana Power Generation Corporation, Chief Administrator Haryana Urban Development Authority and Director Town and Country Planning, Director School Education, Director Public Relations (Information) and Tourism and Press Secretary to Chief Minister Haryana.

Mr Razdan has been Chairman-cum- Managing Director of North East Electric Power Corporation, and a Board Member of Oil and Natural Gas Corporation, Gas Authority of India, Indian Oil, Powergrid, National Hydroelectric Power Corporation, Rural Electrification Corporation, Power Finance Corporation, Bhakra Beas Management Board, Haryana State Electricity Board, Tala Hydro Power Authority Bhutan, Bharat Electronics Ltd., Hindustan Petroleum Corporation and various other Corporations.

A National Science Talent Scholar alumnus of St. Stephen's College Delhi University in Physics, a University and National Merit Scholar in Law from Law Faculty, Delhi University, he is a recipient of Hiralal Daga Gold Medal in Law.

Mr Razdan has also been a Visiting Fellow at the University of Oxford for Energy and Sustainable Development: Global & Indian Perspectives. He represented India at various international energy fora like IEA and CSLF. He chaired a global study on Energy for Megacities by the World Energy Council, and is Scientific Consultant for Energy Technologies to the Office of the Principal Scientific Adviser to Government of India and Independent Director, Power Trading Corporation of India, Minerals and Metals Trading Corporation. He is past President of India Energy Forum.

Shri Ajay Shankar

Distinguished Fellow, The Energy & Resource Institute

Shri Ajay Shankar retired as Secretary Department of Industrial Policy and Promotion (DIPP). He also served the National Manufacturing Competitiveness Council (NMCC) as Member Secretary for three years. He was the Chairman of the National Productivity Council and of the Quality Council of India and gave greater momentum to their activities. He initiated the setting up of Invest India.

Shri Ajay Shankar played a crucial role in putting together the stimulus packages at the time of the global economic crisis of 2008 which enabled the Indian economy to recover in a short time and again grow at over 8%. The plan for the ambitious Delhi-Mumbai Industrial Corridor Project was developed under his stewardship. The FDI policy was further liberalized and rationalized. During his tenure in NMCC he provided useful inputs to the Government for National Skill Mission, Facilitating Start-ups, Reform of Labour Laws and reducing the Regulatory burden on enterprises.

Earlier, Shri Ajay Shankar served as Joint Secretary and then Additional Secretary in the Ministry of Power, CEO Greater NOIDA Industrial Development Authority, Secretary to Lt. Governor of Delhi for about five years and also Principal Adviser in the Planning Commission. Shri Ajay Shankar has been a public policy scholar at the Woodrow Wilson Centre in Washington D.C. USA. He has a Masters in Political Science from Allahabad University and a Masters in Economics from Georgetown University, Washington D.C.

Shri A K Jain

Former CMD, Rajasthan Electronics & Instrumentation Ltd.

Served as Mg Director for 9 years 2011-2020 at REIL-Mini-Ratna CPSE of Govt of India, CMDM IL & CMD HSL-SSL in Additional Charge, Six Sigma Black Belt. Recipient of Most Prestigious SCOPE Award (Individual Leadership Cateogry) and in Mini Ratna CPSE category from Hon'ble President and National Energy Conservation Awards (Twice) from Hon'ble President, Super Boss of the year, Corporate Leader, Best Employer and an Institute of Engineer's Eminent Engineer and Centenary Year Awards Winner. An active member and on council at CII, IDA, PHDCCI and MNIT, providing a vast array of technical, professional, and supporting services to the society & nation. He is Vice Chairman IDANZ, Director, Insolation Energy (North India Leading Solar Module Manufacturer) & been member of National Committee on Electrotechnology in Mobility (ETD-51) and Solar Photovoltaic Energy Systems Sectional Committee (ETD28).

During 9 years at REIL as MD, his dynamic leadership and out –of-box approach resulted rapid growth 3 times top line and 7 times bottomline and benefitted 6 crore citizens and over 3 lac villages and emerging as Largest off-grid solution provider and largest Milk Asia analyser deployer in the country. Under his dynamic leadersip, the pioneer effort resulted into successfully setup 200 charging stations at Delhi, Jaipur and Chandigarh followed by 1270 charging stations in 6 cities and 3 highways under FAME India scheme of Department of Heavy Industry.

Widely travelled for mutually sharing knowledge and policy intervention to USA, Europe, South Afrika, Asia and neighbouring countries.

Dr. Rahul Walawalkar

ED, India Energy Storage Alliance

Dr. Rahul Walawalkar, President and MD; Customized Energy Solutions (India) Dr. Rahul Walawalkar is President & MD of Customized Energy Solutions India Pvt. Ltd. He leads the Emerging Technologies domain for Customized Energy Solutions globally, which under his leadership has emerged as a thought leader in the areas of energy storage, renewables, demand response, electric vehicles, and smart grid technologies.

A strong votary of improving energy storage and e-mobility in India, Rahul founded the India Energy Storage Alliance in 2012 and continues to serve as its President. He served as board member for Energy Storage Association, USA during 2009-15 and as the Chair for Global Energy Storage Alliance during 2018-20.

In 2022, NITI Aayog selected Rahul to serve on Technical Advisory Committee: Energy Sector Evaluation as part of the Development Monitoring and Evaluation Office of NITI Aayog. Under Rahul's leadership, Customized Energy Solutions' has received numerous awards including IPPAI Power Innovation Award for creation of India Energy Storage Alliance in 2016-17, Brad Roberts Award for outstanding industry contribution by Energy Storage Association (USA) in 2016, USAID's PACEsetter Fund Award for MICRO initiative in 2016 & 2019 and CII Innovative Energy Services Award for Tata Power Demand Response program in 2012. In 2020, Rahul received the 'Global Young Entrepreneur Excellence Award' for his valuable contribution & leadership in the field of energy storage and renewable energy at the World Renewable Energy Technology Congress.

Rahul holds a Ph.D. in Engineering and Public Policy from Carnegie Mellon University and Master's degree in Energy Management from NYIT, United States and B.E. from Walchand College of Engineering, India.

Shri Mohit Bhargava

CEO, NTPC Renewables Energy Ltd

Sh. MohitBhargava, Executive Director, is the Head of the Renewable Energy Division at NTPC Limited, a Maharatna company and the leader in Indian power sector (NTPC is currently ranked the 12th largest power generating company globally).

He is also the CEO of NTPC's wholly owned subsidiaries – NTPC Renewable Energy Limited (NREL) and NTPC VidyutVyapar Nigam Limited (NVVNL) and is the nominee Director of NTPC on the Boards of its two JV companies, NTPC GE Services Limited and Meja Urja Nigam Limited. He is an Electrical Engineer by qualification and has undergone Leadership training at Harvard Business School in Boston and S P Jain Institute in Singapore. He has a rich experience of over 30 years in the power sector.

As Head of Renewable Energy, he is instrumental in making NTPC competitive and won several bids by competing with various players in the sector thereby creating a strong pipeline of projects. Under his leadership, within a short span of eighteen months, NTPC's RE project pipeline has increased ten times. During this period, NTPC has also set a benchmark of lowest tariff in India by winning a solar bid @ INR 1.99 / kWh, which broke Rs.2 barrier for the first time and set a new benchmark in the sector.

He is spearheading NTPC's Energy Transition program which is centred around reducing NTPC's carbon intensity. He is also leading initiatives of e-mobility, green hydrogen and waste management solutions.

He is currently on the Clean Energy Ministerial Hydrogen initiative advisory group coordinated by IEA. He was a distinguished speaker at the World Economic Forum- Global Energy Transition Meet held concurrent to the 24th World Energy Congress, Abu Dhabi in 2019. He also participated in WEF meetings such as Electricity Industry Action Group Summer Governors Meeting on 'System Value Framework-India Market Specific Analysis'.

Dr Harish Ahuja

President, Strategy & Policy for Waaree Group(www.waaree.com)

Dr Harish Ahuja as a President, Waaree group is responsible for the company's corporate strategy, policy advocacy, public & regulatory affairs.

Prior to realizing and exploiting his entrepreneurial competencies as founder & CEO, India go solar, Dr Harish Ahuja, Civil Servant (UT cadre, 1997 batch) was posted as Joint Secretary, Department of Power, Government of Delhi. In his more than two-decade long career, Harish has efficiently managed and renovated his professional semblance, from being a civil servant to an entrepreneur. He has served as a civil servant for 15 years and has held a host of senior administrative positions with the Government of India, not only the in-capital state, but also in states as far as the Andaman and Nicobar Islands.

He was also the Director (Finance & Law) in Joint Electricity Regulatory Commission for Union Territories & State of Goa, Ministry of Power, Govt. of India.

Shri Shashi Shekhar

Director General, Independent Green Hydrogen Producers Assn.

Mr Shashi Shekhar, a retired IAS officer of Tamil Nadu Cadre, had held various positions in the State and the Central Government. He was joint Secretary, Ministry of Power, and was associated with preparing the Energy Conservation Bill that became an Act in 2002. He was the first Director-General of the Bureau of Energy Efficiency. He spent more than 10 years in the power and renewable energy sector, while in the Government. He presented many papers in international forums on power sector development and climate change. He prepared the 12th Plan draft document of the Ministry of New & Renewable Energy wherein for the first time he advocated wind and solar energy to acquire market orientation. He also worked in the Ministry of Environment & Forest as Additional Secretary and Chairman of the Central Pollution Control Board. He retired in December 2016 as Secretary, Ministry of Water Resources, River Development & Ganga Rejuvenation, Govt. of India. During this period, he initiated far-reaching reforms in the water sector. Currently, he works for policy advocacy, business strategy, and development for solar power, green hydrogen, regulatory issues, IT-based solution for the power sector including RE integration. He is the Director General of Independent Green Hydrogen Producers Association (IGHPA).

Shri Ashok Kumar Rajput

CE (R&D) , CEA

Mr Rajput is M Tech (Power System) from IIT, Delhi and B. Tech in Electrical Engineering from GBPUA&T, Pantnagar (Uttarakhand). He qualified Energy Manager programme from BEE.

Career Progress

He started the career with NTPC as Engineer (O&M) and served at Ramagundam and Badarpur Thermal Power Station. Thereafter working continuously in CEA and at present working as CE (R&D).

Shri Harendra Tomar

Leader-Business Development, Sungrow India Pvt Ltd

Harendra Tomar is Leading Business Development for Solar PV Inverter and Battery Energy Storage business at Sungrow India. He is having total experience of >16 years in renewable energy/power industry with different companies including CPSU (i. e. SECI) and has been associated with Sungrow for more than 5 years. At Sungrow, he is responsible for co-ordination with Developers/EPCs specifically Govt agencies, market/policy feedback and support sales and tech team for business acquisition.

Shri S R Narasimhan

Chairman & Managing Director, POSOCO

Shri S R Narasimhan (DIN: 08290520) is the Chairman and Managing Director of our Company. Prior to this assignment, he was Director (System Operation) since Nov'18 and responsible for reliable and economic operation of the All India electricity grid which is also connected to the neighbouring countries of Bhutan, Nepal and Bangladesh. Shri S R Narasimhan has a Bachelor's degree in Electrical Engineering and a Master's in Business Administration (MBA) in Finance. He has over three decades' experience in power system operation spread across CEA, POWERGRID and POSOCO after an initial stint with BHEL.

After a 23-year stint at Northern Regional Load Despatch Centre (NRLDC), New Delhi and Western Regional Load Despatch Centre, Mumbai, Shri Narasimhan joined National Load Despatch Centre (NLDC) in July 2011 and was later elevated as Executive Director (NLDC).

Shri S R Narasimhan has contributed to several Expert Committees at the Government and regulatory levels in different areas ranging from system operation, grid integration of Renewable Energy (RE) resources and optimization to institution building. He is a Fellow of the Institution of Engineers, India, Senior Member of IEEE and a Distinguished Member of CIGRE.

He had been assigned the Additional Charge of post of Director (System Operation) as well as Director (Human Resources) by Ministry of Power. Shri Narasimhanassumed the charge of the post of Chairman and Managing Director, POSOCO w.e.f. 25th March, 2022.

Shri Sunil Jain

Operating Partner, Essar Capital Advisory India Pvt Ltd

Sunil has over three decades of experience across industries including renewable energy, automotive, infrastructure, manufacturing and cleantech. Currently he is an Operating Partner at Essar Capital Advisory India Private Limited.

He specializes in creating new businesses and taking the start-ups to scale. Prior to Essar, he was the CEO & ED at Hero Future Energies, which is one of India's leading Renewable energy companies with a portfolio of almost 2 GW across wind and solar assets both operational and under development. Under his leadership, the company grew into one of the largest IPPs in India. Prior to Hero, he played an instrumental role in establishing Green Infra Limited and making it achieve a prominent position in the industry amongst renewable IPPs in India.

Sunil is currently the Chairman, Energy Council, NRC at Indo-American Chamber of Commerce and Chairman at Indian Renewable Energy Alliance, a pan India association representing all the leading IPPs in the country. Previously, he has also served as President, Wind Independent Power Producers Association (WIPPA). For his achievements and contributions towards renewable energy and sustainability, he was awarded the Excellence Award in the year 2012 by "Energy and Environment Foundation". His academic research paper on "Sustainability and Renewable Consumption Obligation" has been presented at forums of international repute. He has authored numerous articles about the sector and has been featured in leading publications.

He is an alumnus from the prestigious Birla Institute of Technology, Mesra, Ranchi, where he attained his engineering degree and holds MBA from Faculty of Management Studies, Delhi University.

Shri Vikas Jain

ED, India Energy Storage Alliance

Vikas Jain, aged 45 ,Engineering Graduate from North Maharashtra University, Jalgaon, is the Promoter and Managing Director of Insolation Energy Ltd. He has more than two decades of experience and has exceptional skills to build a technology driven enterprise and is Founder-Director of eminent business houses like Fluidcon Engineers and Pink City Pipe Fitting Pvt. Ltd. etc.

He is instrumental in making our company as the largest solar module manufacturing company in Rajasthan. He is credited with making our company a 100 % quality adherence house and understands the role of technology in the solar sector. He keeps himself abreast with latest technology trends and innovations. He has influenced high standards of excellence in the areas of innovation, manufacturing, operations, capacities enhancement, and executing profitable integration. He initiated and executed a strategic and comprehensive restructuring process in the company that dramatically transformed our company and led to social transformation and service quality improvement. His vision and business expertise have led our company to new heights. He is credited with making our company, one of the most recognized, innovative, quality driven enterprise.

He is actively involved in various social activities such as Free Education to Children, Free food distribution to needy people, Old aged Home, etc.

Awards & Accolades

As the Managing Director of the group, he actively oversees the operations of the group and INA has won various recognitions under his leadership, few namely,

- Distinguished Entrepreneur Award In MSME Category By PHDCCI – 2022
- RADIO CITY BUSINESS TITAN AWARDS, DUBAI – 2022 EXCELLENCE IN SOLAR PANEL MANUFACTURING
- Leader in Renewable Energy in Rajasthan 2022 – IIAA
- Leading MSME Indian Module Manufacturer 2022- EQ
- Youth Icon 2021 – FORTI
- The Best Employer 2021 – The Employers Association of Rajasthan
- Rajasthan Industrial Icon 2021 – The Times of India

Lt Col Monish Ahuja (Retd)

Chairman & Managing Director

Punjab Renewable Energy Systems Private Limited (PRESPL)

Chairman, Confederation of Biomass Energy Industry of India (CBEII) President, CLEAN

Lt Col Monish Ahuja (Retd) is the Chairman & Managing Director of M/s Punjab Renewable Energy Systems Private Limited (PRESPL) andChairman, Confederation of Biomass Energy Industry of India (CBEII)

He is an alumnus of the prestigious National Defence Academy, Khadakwasla, Pune and PG(M.Tech) in Nuclear Technology from Bhabha Atomic Research Centre.

PRESPL is the leading biomass supply chain management company in India with a forward integration of biomass densification, energy utility service provider & project developer in Bioenergy sector.

Shri Sujit Jena

Sr Associate, NITI Aayog

Education- Bachelor in Engineering (Mechanical); MBA (Finance), CFA

Mr. Sujit is presently working with NITI Aayog as Senior Associate. He has 9+ years of work experience in Project Finance, Investment banking and Public Policy side with core focus on Infrastructure, PPP and Clean Energy Initiatives (EVs, Batteries, Renewable).

In NITI Aayog, he is looking after "Battery StorageProgram" and also part of the core team driving the "National Monetization Program" (NMP) as mandated by Union Budget 2021.

He has a keen interest inpolicy reforms measures for infrastructure and energy efficiency ranging from policy advocacy, procedural reforms initiative, formulation and structuring and on ground implementation.

Apart from work he has a strong proclivity toward Sports, Politics, and Cinema.

Shri Nimish Bhatia

MD & CEO, Alucor International, Dubai

Nimish Bhatia has been with ALUCOR since 2007 and currently serves as its President & CEO. He holds an undergraduate degree in engineering from Michigan State University and an MBA from the University of Texas at Austin. Nimish began his career at Motorola in the United States where he held numerous key positions in the engineering, marketing, and business development departments. In his present role at ALUCOR, Nimish has quadrupled the size of its business, and increased its presence from the United Arab Emirates to six new countries including Saudi Arabia, Bahrain, Oman, India, Netherlands & Germany. His vision has allowed ALUCOR to achieve exponential growth in the offshore wind industry by providing manufacturing of custom-engineered solutions for the installation of offshore wind farms in Europe & North America.

Mrs. Punam Mishra

Dy. GM – RE Engg, SBD, BHEL

PV (Systems & Proposal) & BESS Engineering group

Educational qualifications: B. Tech-Hons (Mechanical Engineering) from RGPV University.

At BHEL since 2002 –

Worked in various domains like Design and Analysis of Hydro Turbines and presently working in the field of Solar PV systems, Design and execution of PV Power plants.

Was Engineering and Quality Coordinator for three prestigious NTPC Floating projects .

Presently heading PV System Engg along with Proposal Engineering and BESS Engineering in Solar Business Division BHEL Bangalore.

www.pfcindia.com

PFC IS NOW MAHARATNA

THE HIGHEST RECOGNITION FOR A CPSE

Ranked 365th in the World in terms of Assets as per 'Forbes Global 2021'

₹59,350 cr Net worth

Highest Ever Net Profit of ₹10,022 cr in FY 2021-22

Products & Services

Project Term Loans | Debt Refinancing | E-Mobility
Renewables | Funding for Government Initiatives

Source of Funding

Domestic Bonds | RTL from Banks / FIs | Foreign Currency Loans/ Bonds u/s 144A/RegS
Capital Gains Tax Exemption Bonds u/s 54EC of the Income Tax Act

POWER FINANCE CORPORATION LTD.

(A Maharatna Company)

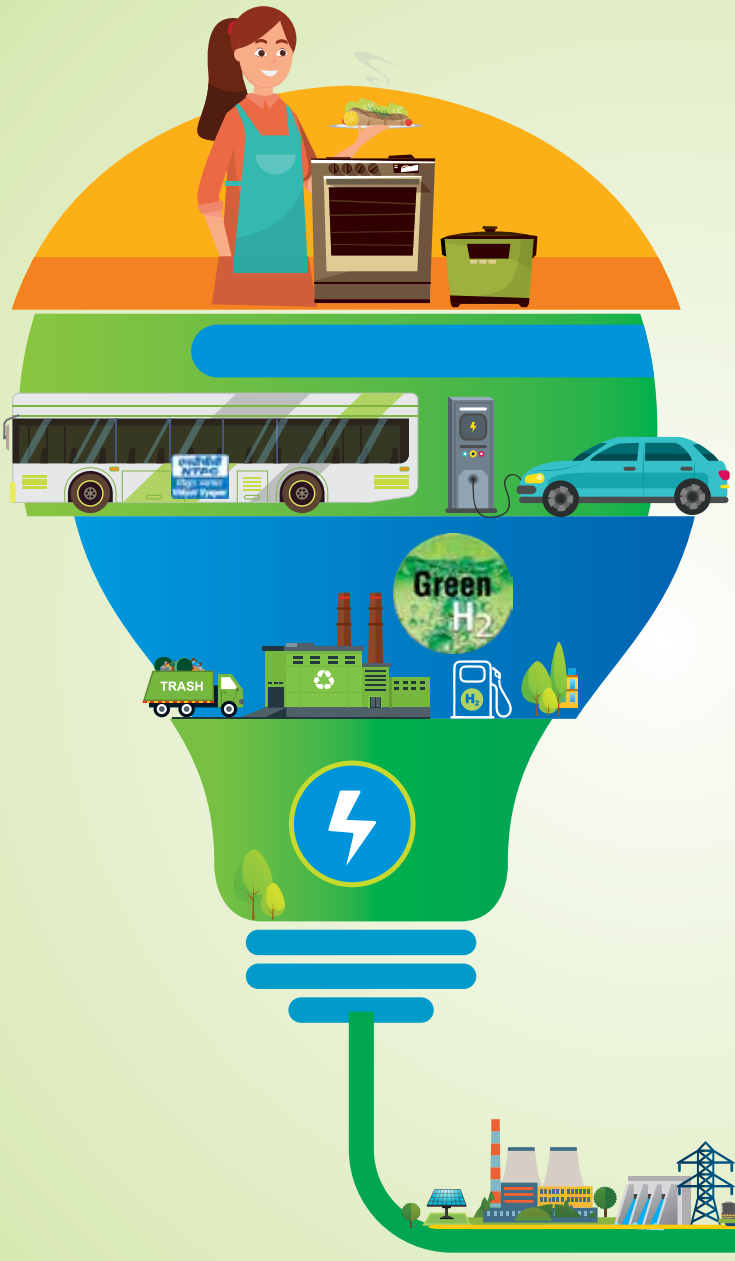
Follow us on /pfclindia

Funding For A Brighter Tomorrow

एनटीपीसी
NTPC

Azadi Ka Amrit Mahotsav

Transforming into a "Sustainable Integrated Energy Company"



India's largest Power Company, NTPC is venturing into new business areas - e-mobility, Waste to Energy, Power Distribution and Green Hydrogen.

One of the 'Great Place to Work for' in India