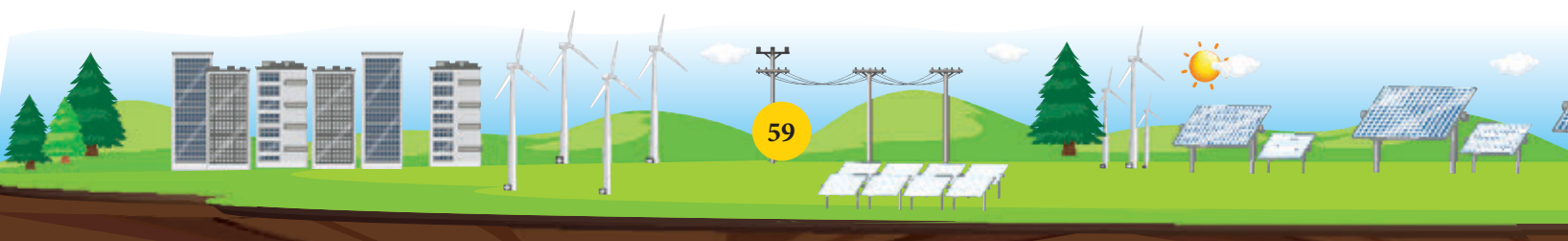
21.08.2023. The Guidelines also been further amended vide notifications dated 17.11.2023, 02.02.2024 and 12.02.2025. The objective is to promote renewable capacity additions and RCO fulfilment; facilitate a transparent and fair procurement of electricity through competitive means; provide for a standardized framework for an Intermediary Procurer as an Aggregator/Trader; and provide a risk-sharing framework between various stakeholders. Procurement shall be from hybrid power projects with a minimum bid capacity of 10 MW and 50 MW for projects connected to the intra-state transmission system and inter-state transmission system, respectively. The rated power capacity of one resource (wind or solar) shall be at least 33% of the total contracted capacity, and solar and wind components of the hybrid project can be located at the same or different locations. It has provisions for payment security mechanism, generator compensation for off-take constraints, adding storage to the hybrid power project, etc.

iii. The status of hybrid projects awarded under Wind-Solar Hybrid Policy are as given in Table 4.5.

Table 4.5: Details of REIA Tenders awarded under Solar-Wind Hybrid Policy

S. No.	Bidding Agency	Awarded Capacity	Capacity Commissioned (MW)	Minimum Tariff (Rs. / kWh)
1	SECI Hybrid-I	840	840	2.67
2	SECI Hybrid-II	600	600	2.69
3	SECI Hybrid-III	1110	546	2.41
4	SECI Hybrid-IV	1200	0	2.34
5	SECI Hybrid-V	1170	0	2.53
6	SECI Hybrid-VI	1200	0	4.64
7	SECI Hybrid-VII	900	0	3.15
8	SECI Hybrid-VIII	1200	0	3.43
9	SECI Hybrid-IX	600	0	3.25
10	NTPC Hybrid-I	1080	0	3.35
11	NTPC Hybrid-01/2024-25	1170	0	3.28
12	NTPC Hybrid-02/2024-25	1200	0	3.38
13	NTPC Hybrid-03/2024-25	1200	0	3.35
14	NTPC Hybrid-IV	1500	0	3.27
15	NTPC Hybrid-V	1000	0	3.41
16	NTPC Hybrid-VI	1000	0	3.43
17	NHPC Hybrid-I	960	0	3.48
18	NHPC Hybrid-II	2400	0	3.41
19	SJVN Hybrid-I	1500	0	3.43



20	SJVN Hybrid-II	1500	0	3.41
21	SJVN Hybrid-III	1200	0	3.19
	Total	**24530**	**1674**	

iii. In addition, the status of awarded hybrid projects through assured supply during peak hours, Firms & Dispatchable Renewable Energy (FDRE) and Round the Clock (RTC) bids are as given in Table 4.6.

Table 4.6: Details of REIA Tenders awarded under Assured Peak Power Supply, FDRE & RTC bids

S. No.	Bidding Agency	Awarded Capacity	Capacity Commissioned (MW)	Minimum Tariff (Rs. / kWh)
1	SECI Assured Peak Power-VII	1200	300	2.88
2	SECI RTC	400	0	2.9
3	SECI RTC-IV	420	0	5.06
4	SECI FDRE-IV	630	0	4.98
5	NTPC FDRE-I	1530	0	4.64
6	NTPC FDRE-01/2024-25	760	0	4.69
7	NHPC FDRE-I	1400	0	4.55
8	NHPC FDRE-II	2100	0	4.37
9	NHPC FDRE-III	1200	0	4.48
10	SJVN FDRE-I	2368	0	4.38
11	SJVN FDRE-II	2400	0	4.25
12	SJVN FDRE-III (RTC)	448	0	4.82
	Total	**14856**	**300**	

4.2.4. Concessional Custom Duty Exemption Certificates for manufacturing of Wind Turbines

Ministry is issuing concessional custom duty exemption certificates (CCDCs) to the manufacturers of wind operated electricity generators as per Ministry of Finance tariff notification no. 50/2017-customs dated 30.06.2017 as amended from time to time. To avail concessional custom duty benefits for essential imports of major components/sub-components/ part/ sub-parts of components of wind electric generators and raw materials for manufacturing in India, the eligible turbine and component manufacturers listed in ALMM (Approved list of Models & Manufacturers) are required to get the bill of material for turbine models approved and then apply in prescribed application formats to this Ministry for issue of CCDC (Concessional Custom Duty Certificates) for their import consignments. In order to make the entire process fast and transparent, an online portal was developed and is active since October, 2019. A total 278 nos. of CCDC have been issued in 2025.

National Green Hydrogen Mission (NGHM)

5.1 Introduction

The National Green Hydrogen Mission (NGHM), was launched in January 2023 with an outlay of ₹19,744 crore until 2029-30. This includes ₹17,490 crore for the Strategic Interventions for Green Hydrogen Transition (SIGHT) Programme, ₹1,466 crore for pilot projects, ₹400 crore for R&D, and ₹388 crore for outreach, skilling, and other initiatives. The objective of the Mission by 2030 is to produce at least 5 (MMTPA) Million Metric Tonnes per Annum of Green Hydrogen. The expected outcomes of the Mission include RE capacity addition of 125 GW, over Rs. 8 lakh crores in total investments, creation of over 6 lakh full time jobs and aversion of 50 MMT per annum of CO2 emissions. The key components of the Mission include incentives for Electrolyser manufacturing and Green Hydrogen production; pilot projects, R&D, regulatory frameworks, Green Hydrogen hubs, and skill development programs.

To implement the Mission, a flexible and result-oriented governance structure has been constituted. An Empowered Group (EG) chaired by the Cabinet Secretary, and an Advisory Group (AG) chaired by the Principal Scientific Adviser to the Government of India have been constituted. A Mission Secretariat headquartered at MNRE, headed by the Mission Director (serving as Secretary to the EG) and comprising of Programme Directors, and Subject Matter Experts have also been constituted to coordinate the program and facilitate the day-to-day activities of the Mission.

5.2 Strategic Interventions for Green Hydrogen Transition (SIGHT) programme

Under the Strategic Interventions for Green Hydrogen Transition (SIGHT) programme, a crucial component of the NGHM mission, with a total outlay of ₹17,490 crore, significant progress has been made. In 2025, following progress has been made.

5.2.1 4,50,000 MTPA of Green Hydrogen Production capacity awarded under Tranche II of the incentive scheme for GH2, taking the total awarded capacity to 8,62,000 MTPA.

5.2.2 Prices have been discovered by SECI for the production and supply of 7,24,000 MTPA of Green Ammonia (a derivative of Green Hydrogen) to various fertilizer units across the country. These are some of the lowest prices in the world with Weighted Average Price of Rs. 53.27 per kilogram.

5.2.3 Projects have been awarded for the production and supply of 20,000 MTPA of Green Hydrogen to IOCL, BPCL and HPCL Refineries. The prices discovered per kg of Green Hydrogen are ₹336/ kg for IOCL and ₹328/kg for HPCL and BPCL.

These initiatives aim to accelerate India's transition to a Hydrogen economy by scaling up domestic manufacturing and ensuring a steady supply of Green Hydrogen and its derivatives.

5.3 Pilot projects

Under the Mission, pilot projects are being implemented to replace fossil fuels and fossil fuel-based feedstocks with Green Hydrogen and its derivatives. These initiatives aim to demonstrate the feasibility and scalability of Green Hydrogen technologies, particularly in hard-to-abate sectors.

In 2025, The following projects have been implemented:

5.3.1 Four pilot projects were awarded for the use of hydrogen in steel sector. Funds sanctioned for these projects is about ₹106 Crore. The award of these four projects, took the tally of total awarded projects to five with total fund allocation of about ₹132 Crore.

5.3.2 A pilot project was awarded to deploy one hydrogen fueled truck and one hydrogen refueling station, taking the total projects count to five pilot projects awarded to deploy 37 hydrogen-fueled vehicles (comprising 10 buses and 27 trucks) along with 9 hydrogen refueling stations have been awarded across 10 different routes in the country. The total fund allocation for these projects is about ₹208 Crore.

5.3.3 A project has been awarded to develop bunkering and refueling facility at V. O. Chidambaranar Port Authority, that is at the Tuticorin Port in Tamil Nadu.

5.4 Green Hydrogen hubs & Hydrogen valley innovation cluster

The scheme guidelines for setting up Hydrogen Hubs has been revised to include setting up of Hydrogen Valley Innovation Clusters (HVIC) in India under National Green Hydrogen Mission (NGHM) that will provide learnings to scale up projects as Green hydrogen hubs. Accordingly, the scheme, now consists of two components:

5.4.1 **Component A: Hydrogen Valley Innovation Cluster –** Four projects have been awarded to be developed as Hydrogen Valley Innovation Clusters (HVICs), viz., JHV Innovation (Jodhpur), Odisha Hydrogen Valley (Bhubaneshwar), Pune Hydrogen Valley and Kerala HVIC. Funds sanctioned for these projects is about ₹170 Crore.

5.4.2 **Component B: Green Hydrogen Hubs -** This scheme supports the preparation of DPRs for Green Hydrogen Hubs in the state. Each DPR would be supported with a maximum funding of ₹3 Crore. To enable large scale export opportunities of Green Hydrogen derivatives Kandla, Paradip and Tuticorin ports have been identified to be developed as Green Hydrogen hubs.

5.5 Skill Development

For skill development in the Hydrogen value chain, as on December 2025, a total of 43 Qualification Packs (QPs) have been approved by the National Council for Vocational Education and Training (NCVET). 78 Master Trainers, 325 Trainers aligned. 6,541 trainees have been certified.

5.6 Green Hydrogen Certification Scheme of India

The Green Hydrogen Certification Scheme of India was launched in April, 2025 by the Hon'ble Minister of New and Renewable Energy, Shri Pralhad Venkatesh Joshi. This scheme, building upon the Green Hydrogen Standard launched in August 2023 ensures the integrity and global recognition of the Green Hydrogen produced in India. This will be a instrument to ensure the quality and sustainability of Green Hydrogen produced in India.

5.7 Testing Facilities

Five projects have been awarded for the funding of testing facilities, infrastructure, and institutional support for the development of Standards and Regulatory Framework. Funds sanctioned for these projects is about ₹114 Crore.

5.8 Research and Development

Under the Research and Development scheme, 23 projects have been awarded under different categories such as production, safety and integration, and applications. Funds sanctioned for these projects is about ₹115 Crore.

5.9 Regulations, Codes, and Standards (RCS)

For the development of Regulations, Codes, and Standards (RCS) in the sector in India, as on October 2025, 128 standards have been adopted / published by entities involved in developing standards for Green Hydrogen such as the Bureau of Indian Standards (BIS), Oil Industry Safety Directorate (OISD), Ministry of Road Transport and Highways (MoRTH), Petroleum and Explosives Safety Organization (PESO), Petroleum and Natural Gas Regulatory Board (PNGRB).

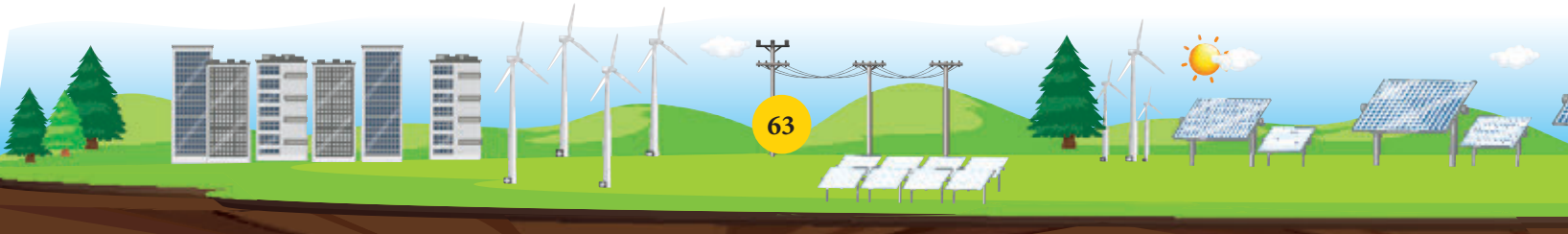
5.10 National Institute of Solar Energy (NISE)

National Institute of Solar Energy (NISE), Gurugram signed a MoU with Toyota Kirloskar Motors in December 2025 for a pilot project on the use of hydrogen in mobility sector.

5.11 Public Awareness and Outreach

In 2025, MNRE organized several events and actively participated in some key events, conferences, and workshops across the globe. All these were aimed at advancing the National Green Hydrogen Mission, and fostering international cooperation. Some of the major events include:

5.11.1 3rd International Conference on Green Hydrogen (ICGH 2025): The 3rd edition of the International Conference on Green Hydrogen was organized on 11th and 12th



November 2025 at the Bharat Mandapam, New Delhi. The event saw the participation of eminent speakers, and attendance by delegates, researchers, industrialists, associations, and students from both India and abroad.

5.11.2 **1st R&D Conference on Green Hydrogen (R&D Conference on Green Hydrogen 2025):** The inaugural R&D Conference on Green Hydrogen was organized on 11th and 12th September 2025 at the Dr. Ambedkar International Center, New Delhi. The event saw the participation of eminent speakers, and attendance by researchers, and students.

Fig. 5.1 *Shri Pralhad Joshi, Honourable Union Cabinet Minister, MNRE, inaugurating the Start-up Expo in the presence of Prof Ajay K Sood, Principal Scientific Adviser to the Govt of India, Mr Santosh Sarangi, Secretary, MNRE, Mr Abhay Bakre, Mission Director - National Green Hydrogen Mission, MNRE and Dr Mohammad Rihan, Director General, National Institute of Solar Energy.*

5.11.3 **Workshop on National Green Hydrogen Mission – Opportunities for MSMEs:** The Ministry of New and Renewable Energy (MNRE) organized the workshop on 29.04.2025 focusing on "Opportunities for MSMEs". The event brought together policymakers, industry experts, R&D institutions, financial institutions, and MSME stakeholders to deliberate on enabling frameworks, investment pathways, and innovation partnerships to embed MSMEs within India's Green Hydrogen value chain. Major Green Hydrogen plant components were identified for MSMEs.

Fig. 5.2 *Fig Shri Pralhad Joshi, Honourable Union Cabinet Minister, MNRE launching the Green Hydrogen Certification Scheme of India at the Workshop on National Green Hydrogen Mission – Opportunities for MSMEs.*

5.11.4 MNRE participated in the 43rd Steering Committee Meeting of the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE) from June 9-13, 2025, at Santiago, Chile. The meeting brought together IPHE delegates from Austria, France, the European Commission, Japan, Germany, the Netherlands, the UAE, Saudi Arabia, the UK, the US, Singapore, Mauritania and South Korea, along with representatives from the host country, Chile. Discussions were held on a wide range of issues related to the deployment of Green Hydrogen and its derivatives.

Fig. 5.3 *IPHE 43rd Steering Committee Meeting, Santiago, Chile*

5.11.5 India set up its own pavilion, at the World Hydrogen Summit 2025, held in Rotterdam, Netherlands, during May 13 – 15, 2025. This pavilion was inaugurated by Secretary, Ministry of New and Renewable Energy, Shri Santosh Sarangi. The Indian delegation comprised nominees from Ministry of New & Renewable Energy, Department of Science and Technology, Ministry of Railways, Ministry of Petroleum and Natural Gas and representatives from private and public sector companies as well.

Fig. 5.4 *India Pavilion at World Hydrogen Summit 2025, Rotterdam*

5.11.6 World Hydrogen and Fuel Cell Day was celebrated on 08.10.2025 at MNRE Atal Akshay Urja Bhawan. This brought together Hydrogen experts from the industry, academia and government. A roundtable was organized as part of the event.

5.11.7 India participated in the European Hydrogen Week 2025 from 29.09.2025 to 03.10.2025 at Brussels, Belgium.

Fig. 5.5 *Shri Santosh Kumar Sarangi, Secretary, MNRE delivering his remarks at the High- Level Business Roundtable on 29.09.2025.*

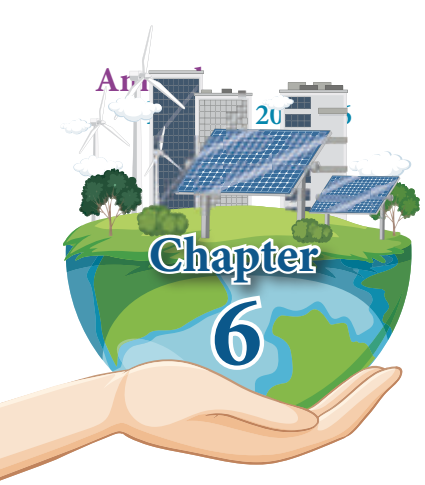
5.12 National Hydrogen Safety Panel (NHSP)

To ensure safe and robust quality and performance across hydrogen value chain, a National Hydrogen Safety Panel (NHSP) has been constituted in September 2025 consisting of experts from all domains of the hydrogen value chain. The safety panel will support the development and harmonization of hydrogen safety standards across value chain, suggest measures to promote awareness, training and knowledge sharing, identify gaps in safety practices, and recommend codes, standards, protocols and model guidelines for commissioning and operation of hydrogen projects.

Fig. 5.6 *Dignitaries on dais, Shri Pralhad Joshi, Hon'ble Minister, MNRE, Shri Ajay K Sood, Principal Scientific Adviser to the Government of India, Sri Santosh Kumar Sarangi, Secretary, MNRE, Shri Akash Tripathi, Managing Director, SECI, and Shri Jorgo Chatzimarkakis, CEO, Hydrogen Europe addressing the gathering at the event.*

NGHM
NATIONAL GREEN HYDROGEN MISSION

Fig. 5.7 *The logo for the National Green Hydrogen Mission was launched on 11th November 2025 by the Hon'ble Minister of New and Renewable Energy, Shri Pralhad Venkatesh Joshi during the International Conference on Green Hydrogen 2025.*



Bio-Energy and Small Hydro Power

6.1 Biogas Programme

6.1.1 The Ministry of New and Renewable Energy (MNRE) has been implementing Biogas Programme for the dissemination and deployment of biogas plants in remote, rural and semi-urban areas of the country since November 2022. The Biogas Programme continued under the umbrella National Bio-energy Programme (NBP) which was announced on 02.11.2022 for the period from 01.04.2021 to 31.03.2026.

The objectives of the Biogas Programme are to support setting up of biogas plants for clean cooking fuel, lighting, meeting thermal and decentralized power generation needs of users, which ultimately results in Green House Gas (GHG) emission reduction, improved sanitation, facilitating management and utilization of biogas plant produced slurry as an organically enriched Solid Biogas Fertilizer, Women Empowerment, and creation of Rural Employment etc.

The Biogas Programme is being implemented through the Agriculture Farmers Welfare and Rural Development Departments of the States, Dairy Co-operatives, State Nodal Agencies (SNAs), Biogas Development and Training Centers (BDTCs), Khadi and Village Industries Commission (KVIC), National Dairy Development Board (NDDB), Amul Dairy etc.

6.1.2 Achievements under the biogas programme

The State-wise installed number of biogas plants during Phase-I of National Bioenergy Programme is given as under:

Table 6.1: The State/UT-wise achievements for family type/small biogas plants, under the Biogas Programme.

Sl No	Name of the State	Number of small biogas plants
1.	Andhra Pradesh	88
2.	Arunachal Pradesh	200
3.	Assam	389
4.	Bihar	255
5.	Chhattisgarh	546
6.	Goa	11
7.	Gujarat	3668

8.	Haryana	439
9.	Jharkhand	11
10.	Karnataka	1398
11.	Kerala	637
12.	Madhya Pradesh	6260
13.	Maharashtra	14468
14.	Manipur	25
15.	Meghalaya	1
16.	Mizoram	1
17.	Nagaland	52
18.	Odisha	216
19.	Punjab	3220
20.	Rajasthan	567
21.	Tamil Nadu	124
22.	Telangana	23
23.	Tripura	161
24.	Uttar Pradesh	540
25.	Uttarakhand	1436
26.	West Bengal	159
27.	Dadra & Nagar Haveli	18
	Total	**34913**

Table 6.2: The details of medium sized the Biogas Programme sanctioned

Nos.	Installed Capacity (in MWeq)	CFA Sanctioned (in Rs. Crores)
38	4.02	16.06

6.1.3 Subsidy and other central financial assistance under biogas programme

6.1.3.1 The details of Central Financial Assistance (CFA) for different components under this programme are as follows:

A. For small biogas plants (1-25 cubic meter/day plant capacity): Rs. 9800/- to Rs.70,400/- per plant based on size of the plant in cubic meter; and

B. For Power generation and thermal application (capacity ranging from above 25 to 2500 cubic meter biogas generation per day), (3 to 250 kWe Power Generation capacity per day): Rs. 35,000/- to Rs. 45,000/- per kilowatt for power generation and Rs.17,500 /- to Rs. 22,500/- per kilowatt equivalent for thermal applications (25 - 2500 cubic meter/day plant capacity). The eligible CFA would be 20% higher than Standard CFA for Islands, NER States, SC/ST beneficiaries, and for biogas plant installed in registered Gaushalas, Govt registered Gothans.

C. The Ministry has also amended the guidelines for the 40% advance release of CFA against the annual allocated targets for small biogas plants to the designated state's PIA. Similarly, the provision has been made for advance release of 50% of the annual approved budget outlay for BDTCs activities under the Biogas Programme.

6.1.3.2 Benefits of MNRE's Biogas Programme on rural and environmental aspect:

MNRE's Biogas Programme plays a significant role in improving rural livelihoods while promoting numerous environmental benefits. In rural areas, household and community biogas plants provide a reliable source of clean cooking energy, reducing dependence on firewood, dung cakes, and fossil fuels. This lowers household energy costs, improves indoor air quality, and reduces health risks, particularly for women and children. The programme also supports local employment through plant construction, operation, and maintenance, while the use of digested slurry as organic manure enhances soil fertility and reduces reliance on chemical fertilizers, thereby supporting sustainable agriculture.

From an environmental perspective, the programme contributes to climate change mitigation and pollution control by capturing methane from animal dung and organic waste and using it as energy instead of allowing it to escape into the atmosphere. Reduced use of firewood helps curb deforestation and pressure on forest resources. Additionally, systematic management of organic waste through biogas plants improves sanitation and prevents land and water pollution. Overall, the biogas programme promotes a circular economy by converting rural waste into clean energy and bio-manure, aligning energy access with environmental protection and sustainable rural development.

6.1.4 PHOTOGRAPHS:


Fig. 6.1: Biogas Plant

6.2 Biomass Power

6.2.1 Ministry has been promoting Biomass Power with an aim to recover energy from biomass such as surplus agricultural residues, wood produced from energy plantation, wood waste from industrial operations, agro based industrial residue, forest residue, weeds, palm leaves, coconut shells and husk etc.

6.2.2 Biomass Potential available in the country

The potential for power generation from about 228 MMT (Million Metric Tonnes) surplus agricultural residue is estimated at about 28,446 MW. With progressive higher steam temperature and pressure and efficient project configuration in new sugar mills and modernization of existing ones, the potential of surplus power generation through bagasse cogeneration in sugar mills is estimated at around 13,866 MW. Thus, the total estimated potential for biomass power is about 42,312 MW.

6.2.3 Programme for promoting installation of Biomass based projects

The Ministry has notified Biomass Programme on 02.11.2022 with a budget outlay of Rs.158 crores under the umbrella of National Bioenergy Programme (Phase-I) for duration of FY 2021-22 to FY 2025-26 with an objective to harness the available biomass potential in the country. This programme has a provision of Central Financial Assistance (CFA) for setting up of Biomass Briquette/Pellet manufacturing plants and Biomass (non-bagasse) based cogeneration projects in the country. The details of CFA under this programme are as follows:

(a) For Briquette manufacturing plants: Rs. 9 Lakhs / MTPH (metric ton/hour) [Maximum CFA- Rs. 45 Lakh per project].

(b) For Non-Bagasse Cogeneration Projects: Rs. 40 Lakhs / MW (on installed capacity) (Maximum CFA- Rs. 5 Crore per project).

(c) For pellet plants whose applications have been received before 16.07.2024: Rs. 9 Lakhs/ MTPH (metric ton/hour) [Maximum CFA- Rs. 45 Lakh per project].

(d) For pellet plants whose applications have been received on or after 16.07.2024 :

i. For Non-Torrefied Pellet manufacturing plant: Rs. 21 lakhs/MTPH production capacity or 30% of the capital cost considered for plant and machinery of 1 MTPH plant, whichever is lower (Maximum Rs. 105 lakhs per project).

ii. For Torrefied Pellet manufacturing plant: Rs. 42 lakhs/MTPH production capacity or 30% of the capital cost considered for plant and machinery of 1 MTPH plant, whichever is lower (Maximum Rs. 210 lakhs per project).

To facilitate ease of doing business for the stakeholders and to expedite timely disbursal of CFA, the guidelines of the Biomass Programme have been revised on 27.06.2025.

6.2.4 Achievements

More than 800 Nos. of Biomass IPP and Bagasse/non bagasse cogeneration-based power plants with aggregate capacity of 10757.307 MW have been installed in the country mainly in the states of Maharashtra, Uttar Pradesh, Karnataka, Tamil Nadu, Andhra Pradesh, Chhattisgarh, West Bengal and Punjab up to December 2025. This includes 7935.31 MW from Bagasse Cogeneration Sector, 1886.01 MW from Biomass IPP Sector and 935.987 MW from biomass (non-bagasse) cogeneration sector.

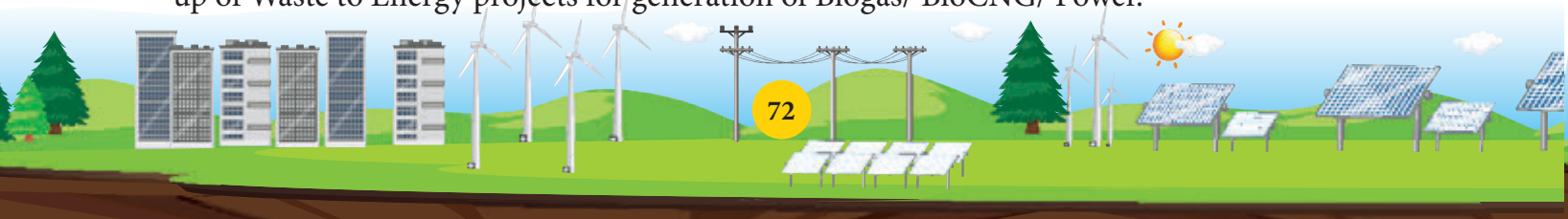
6.3 Waste To Energy

6.3.1 Programme on Energy from Urban, Industrial, Agricultural Wastes and Residues

The Ministry has been implementing the scheme "Programme on Energy from Urban, Industrial and Agricultural Waste/Residues" (Waste to Energy Programme) aimed at generation of biogas, BioCNG and Power from different wastes, such as vegetable and other market wastes, slaughterhouse waste, agricultural residues and industrial wastes & effluents. In addition to Bio-CNG/Biogas, biogas plants generate organic fertilizer as a by-product which is valuable for agricultural fields.

Such projects are being set up in a number of industry sectors namely distillery, paper and pulp solvent extraction, dairy, starch industries, sugar mills, pharmaceutical industries etc. and sewage treatment plants.

For the continuation of the above scheme for the period FY 2021-22 upto FY 2025-26, the Ministry has issued guidelines under the Phase-I of the umbrella of National Bioenergy Energy Programme on 02.11.2022 with an initial allotment of Rs 600 crores, which was later enhanced to Rs 637.5 crores. The Waste to Energy Programme provides Central Financial Assistance (CFA) for setting up of Waste to Energy projects for generation of Biogas/ BioCNG/ Power.



Moreover, the Ministry has revised the guidelines for Waste to Energy programme vide OM. NO. 300/1/2024-Waste to Energy dated 27.06.2025 for improving transparency, efficiency, and accountability in programme implementation. Moreover, the updated guidelines aims to address operational gaps, enhance compliance, and enable more effective utilization of resources under the programme.

6.3.2 Objectives of the Scheme:

- To promote setting up of projects for recovery of energy in the form of Biogas/ Bio-CNG/ Power from Urban, Industrial and Agricultural Waste and Captive Power and Thermal use through Gasification in Industries.
- To promote Biomass Gasifier for feeding power into the grid or meeting captive power and thermal needs of rice mills/other industries and villages.
- To create conducive conditions and environment, with fiscal and financial regime, to develop, demonstrate and disseminate utilization of wastes and residues for recovery of energy.

6.3.3 Subsidy/Grant/Incentive provided under the Scheme

The CFA pattern for Waste to Energy projects are as follows:

a. Biogas generation: Rs 0.25 crore per 12000 cum/day (Maximum CFA- Rs.5.00 crore/project).

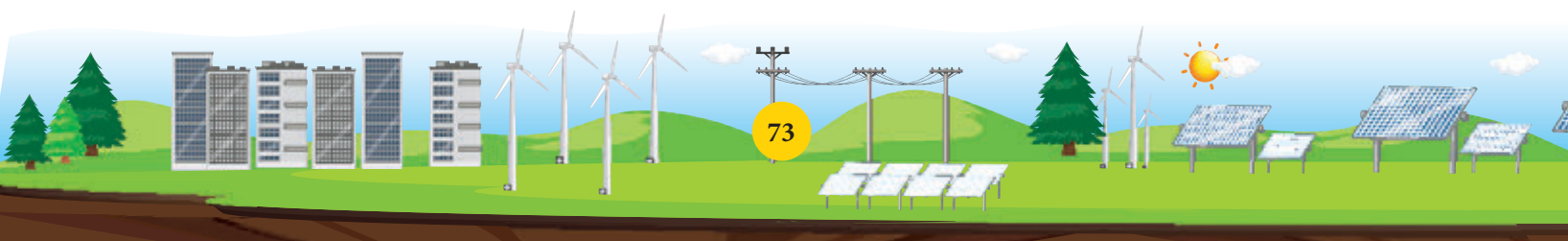
b. BioCNG/Enriched Biogas/Compressed Biogas generation: (Maximum CFA- Rs.10 crore/ project)
   i. BioCNG generation from new Biogas plant- Rs 4.0 Crore per 4800 Kg/day;
   ii. BioCNG generation from existing Biogas plant- Rs 3.0 Crore per 4800 Kg/day;

c. Power generation based on Biogas: (Maximum CFA- Rs. 5.00 crore/project)
   i. Power generation from new biogas plant: Rs 0.75 Crore per MW
   ii. Power generation from existing biogas plant: Rs 0.5 crore / MW

d. Power generation based on bio & agro-industrial waste (other than MSW through incineration process): Rs. 0.40 crore/MW (Maximum CFA - Rs.5.00 Crore/Project).

e. Biomass Gasifier for electricity/ thermal applications:
   i. Rs. 2,500 per kWe with duel fuel engines for electrical application.
   ii. Rs. 15,000 per kWe with 100% gas engines for electrical application.
   iii. Rs. 2 lakh per 300 kWth for thermal applications.

Note: 20% higher CFA for special category states (NE Region, Sikkim, Himachal Pradesh and Uttarakhand, Jammu & Kashmir, Ladakh, Lakshadweep, Andaman & Nicobar Islands) and Gaushalas/Shelters.



6.3.4 Progress during the Financial year 2025-26

i. **Physical Achievement:** As on 31.12.2025, during the FY 2025-26, the capacities added in respect of various output products are given as under:

Progress of Installed Capacity Addition during FY 2025-26 (till 31.12.2025)				
Sl. No.	**Output Product**	**No. of plants**	**Capacity Addition in FY 2025-26 (MWeq)**	**States**
1.	Bio-CNG/CBG	6	7.81	Uttar Pradesh, Gujarat Rajasthan, Karnataka, Delhi, Uttarakhand
2.	Power	2	8.6	Maharashtra, Uttar Pradesh
	Total	**8**	**16.41**	

ii. **Biourja Application Portal:** The Ministry of New and Renewable Energy has revamped the Biourja Application Portal (www.biourja.mnre.gov.in) to facilitate submission and processing of applications for grant of CFA for Bioenergy projects. All communication with developers in respect of their applications is envisaged through this portal.

6.3.5 Cumulative Physical Achievement

As on 31.12.2025, the total installed capacity is 856.62 MWeq, including 309.34 MW capacity of Grid-interactive Waste to Power projects, and 547.28 MWeq capacity Off-grid Waste-to-Energy projects. The installed capacity details under the programme till 31.12.2025 is given as under:

The Cumulative Installed Capacity of Waste-to-Energy Projects		
Sl. No.	**Output product**	**Cumulative Installed capacity**
1	Biogas	8,80,698 m3 per day
2	Bio-CNG/CBG	12,48,602 kg per day
3	Power (Grid & Offgrid)	523.08 MW

6.3.6 Photographs:

Fig. 6.2: 10,000 kg/day BioCNG plant set up by M/s IOT Biogas Private Limited at Namakkal, Tamil Nadu

6.4 Small Hydro Power

6.4.1 The Ministry of New and Renewable Energy (MNRE) is vested with the responsibility of developing hydro power projects of capacity up to 25 MW, categorized as Small Hydro Power (SHP) Projects. These projects have the potential to meet power requirements of remote and isolated areas in a decentralized manner besides providing employment opportunity to local people. Small Hydro Power projects are further categorized into small, mini and micro hydel projects based on their capacity as follows:

Micro Hydel ≤ 0.1 MW

Mini Hydel> 0.10 MW to ≤ 2.00 MW / Small Hydel> 2.00 MW to ≤ 25.00 MW

6.4.2 The estimated potential of small / mini / micro Hydel projects in the country is 21133.61 MW from 7133 sites located in different States of India. The SHP projects in the country are being set-up both in public and private sectors. Setting up of SHP projects normally require about 3-4 years depending upon its size and location. An aggregate capacity of 5158.61 MW been achieved as on 31.12.2025 through 1196 Small Hydro Power projects. In addition, 96 projects of 437.49 MW are at various stages of implementation. Table 6.3 provides state-wise details of identified potential, projects completed and those under execution.

Table 6.3: State wise list of potential sites, installed projects and on-going projects in SHP sector (as on 31.12.2025)

(A fresh table provided below)

State wise list of potential sites, installed projects and on-going projects in SHP sector (as on 31.12.2025)											
S. No.	State	Total Potential		Projects Installed						Projects under Implementation	
		Nos.	Total Capacity (MW)	Upto 2024-25		2025-26		Total			
				Nos.	Capacity (MW)	Nos.	Capacity (MW)	Nos.	Capacity (MW)	Nos.	Capacity (MW)
1	Andhra Pradesh	359	409.32	46	164.51	0	0	46	164.51	1	1.20
2	Arunachal Pradesh	800	2064.92	158	140.61	0	0	158	140.61	5	6.05
3	Assam	106	201.99	6	34.11	0	0	6	34.11	0	0
4	Bihar	139	526.98	29	70.70	0	0	29	70.70	0	0
5	Chhattisgarh	199	1098.2	10	76	1	24.90	11	100.90	0	0
6	Goa	7	4.7	1	0.05	0	0	1	0.05	0	0
7	Gujarat	292	201.97	23	106.64	1	6.66	24	113.30	2	10.50

8	Haryana	33	107.4	9	73.5	0	0	9	73.5	0	0
9	Himachal Pradesh	1049	3460.34	204	1000.71	0	0	204	1000.71	50	241.19
10	UT of Jammu & Kashmir	103	1311.79	26	189.93	0	0	26	189.93	4	24.65
11	UT of Laddakh	199	395.65	34	45.79	0	0	34	45.79	2	3.30
12	Jharkhand	121	227.96	6	4.05	0	0	6	4.05	0	0
13	Karnataka	618	3726.49	171	1284.73	0	0	171	1284.73	5	12.45
14	Kerala	238	647.15	41	276.52	0	0	41	276.52	4	32.85
15	Madhya Pradesh	299	820.44	14	123.71	0	0	14	123.71	3	7.7
16	Maharashtra	270	786.46	74	384.28	0	0	74	384.28	6	6.10
17	Manipur	110	99.95	8	5.45	0	0	8	5.45	0	0
18	Meghalaya	97	230.05	6	55.03	0	0	6	55.03	1	3.0
19	Mizoram	72	168.9	20	45.47	0	0	20	45.47	0	0
20	Nagaland	98	182.18	14	32.67	0	0	14	32.67	1	2.4
21	Odisha	220	286.22	13	115.63	1	25.00	14	140.63	2	31.5
22	Punjab	375	578.28	59	176.10	0	0	59	176.10	5	4.05
23	Rajasthan	64	51.67	10	23.85	0	0	10	23.85	0	0
24	Sikkim	88	266.64	18	55.11	0	0	18	55.11	0	0
25	Tamil Nadu	191	604.46	21	123.05	0	0	21	123.05	0	0
26	Telangana	94	102.25	29	89.67	0	0	29	89.67	0	0
27	Tripura	13	46.86	3	16.01	0	0	3	16.01	0	0
28	A&N Islands	7	7.27	1	5.25	0	0	1	5.25	0	0
29	Uttar Pradesh	251	460.75	10	49.1	1	1.50	11	50.6	0	0
30	Uttarakhand	442	1664.31	104	233.82	0	0	104	233.82	5	50.55
31	West Bengal	179	392.06	24	98.5	0	0	24	98.5	0	0
	Total	**7133**	**21133.61**	**1192**	**5100.55**	**4**	**58.06**	**1196**	**5158.61**	**96**	**437.49**

6.4.3 For the year 2025-26, a target of commissioning of 100 MW small hydro projects was set. Further, during the period of 01.04.2025 to 31.12.2025, 04 projects of aggregate capacity of 58.06 MW have been synchronized to the grid (Table 6.4).

6.4.4 Under the 'Ladakh Renewable Energy Initiative (LREI)', Kargil Renewable Energy Development Agency (KREDA) and Ladakh Renewable Energy Development Agency (LREDA) are implementing Small/ Mini hydro projects in their respective regions. A total of 7 Hydro projects with aggregate capacity of 10.55 MW are being implemented

by KREDA, out of which 6 projects with aggregate capacity of 8.05 MW has been commissioned by KREDA till date. LREDA is implementing 6 nos. of projects with aggregate capacity of 3.65 MW, out of which 5 projects with aggregate capacity of 2.85 MW has been commissioned by LREDA till date.

Table 6.4: List of SHP projects commissioned during the period of 01.04.2025 to 31.12.2025

(A fresh table provided below)

S. No.	Name of Project	Capacity (MW)	Agency/State	Date of Commissioning
1	Khara SHP, Uttar Pradesh	1.50	Uttar Pradesh Jal Vidyut Nigam Ltd., Uttar Pradesh	April-25
2	Kachchh Branch Canal SHP-III, Gujarat	6.66	Sardar Sarovar Narmada Nigam Ltd., Gujarat	July-25
3	Rehar-I SHP, Chhattisgarh	24.90	M/s Chhattisgarh Hydro Power LLP, Raipur	July-25
4	Shaheed Lakhan Nayak SHP, Koraput, Odisha	25.00	M/s Meenakshi Odisha Power Pvt. Ltd.	August-25
	Total	**58.06**		

Accelerating the Clean Energy Ecosystem

7.1 Renewable Energy Research and Technology Development (RE-RTD) Programme

7.1.1 Introduction

Under the Renewable Energy Research and Technology Development (RE-RTD) Programme, the Ministry supports R&D projects on renewables by providing up to 100% financial support to Government/non-profit research organizations/ NGOs and up to 50% to 70% to industry. The Renewable Energy Research and Technology Development (RE-RTD) Programme has a budget allocation of Rs. 228 crores for the period FY 2021-22 to 2025-26.

7.1.2 Research Development and Demonstration (RD&D) Thrust Areas

The projects supported for Research, Development and Demonstration (RD&D) assistance are aligned with the R&D thrust areas of the Ministry, covering solar photovoltaic (SPV), solar thermal, bioenergy, wind, wind–hybrid systems, energy storage, small hydro power, hydrogen, fuel cells, geothermal energy, and allied sectors. Projects falling outside the identified thrust areas are also considered for financial support based on their technical merit, practical relevance, and potential for deployment. Participation of industry in RD&D projects is actively encouraged to facilitate technology validation, scale-up, and commercialization.

Within the solar energy domain, research and development efforts are directed toward the advancement of technologies for power generation and industrial process heat applications, encompassing thermal energy storage systems and hybrid configurations. Particular emphasis is being placed on next-generation perovskite solar technologies to achieve higher efficiencies and cost reduction.

Concurrently, focused R&D initiatives in geothermal energy generation aim to harness indigenous geothermal resources, enabling reliable, sustainable, and base-load renewable energy generation to strengthen national energy security.

A review of the Renewable Energy Research and Technology Development (RE-RTD) Programme was undertaken by a High-Level Committee chaired by Dr. Anil Kakodkar, Chancellor, Homi Bhabha National Institute, in its meeting held on 15.09.2025. After detailed deliberations on the

progress, outcomes, and overall evaluation of the Programme, the Committee offered its valuable recommendations and concluded that the RE-RTD Programme may be continued for the period 2026–27 to 2030–31 with an enhanced budgetary allocation, considering its strategic importance in strengthening indigenous research, innovation, and technology development in the renewable energy sector.

7.1.3 Institutional Mechanism

In order to accelerate the commercialization of indigenously developed technology, the Ministry supports the strengthening of R&D Programs of its 3 institutions, namely, the National Institute of Solar Energy (NISE), Gurugram, Sardar Swarn Singh National Institute of Bioenergy (SSS-NIBE), Kapurthala and National Institute of Wind Energy (NIWE), Chennai in various areas like resource assessment, testing, standardization, and certification in solar, bioenergy, and wind energy systems, etc.

7.1.4 R&D in Solar Energy

Solar Photovoltaics

Highlights of the progress achieved under the Solar Photovoltaic (SPV) R&D projects funded by the MNRE are listed below:

A. National Centre for Photovoltaic Research and Education (NCPRE)- Phase III.

This flagship project of the Ministry continued to function as a National Centre of Excellence, undertaking advanced R&D, testing, standardization, and capacity building in solar photovoltaics. The project has several work streams, and the main highlights of progress are briefly described below:

- **Research and Development Activities PV Deployment, Reliability and Standards:** NCPRE carried out focused studies on the field performance and reliability of PV modules and systems operating under Indian climatic conditions. A new characterization test was developed to detect latent insulation defects in field-deployed PV modules, which are not reliably captured through conventional dry or wet insulation resistance tests. The test demonstrated significantly improved detection capability and has potential application for plant safety assessment and module reuse decisions. NCPRE continued its leadership in international standardisation. During the year, the Centre led progress on a new IEC technical specification on bypass diode failures under high-temperature reverse bias conditions, representing a significant contribution from India to global PV safety and reliability standards.
- **Technology Development and Testing Infrastructure:** Construction of the joint NCPRE–IISc photovoltaic field test site at Challakere, Karnataka, was completed during

2025. The facility is designed for controlled assessment of fixed-tilt and tracking-based PV systems and is expected to support benchmarking of emerging PV technologies under field conditions. Advanced indoor accelerated testing facilities for durability evaluation of anti-soiling and anti-reflective coatings were operational during the year. These IEC-compliant facilities enable multi-stressor testing involving abrasion, thermal cycling, rainfall simulation, and UV exposure, and have been utilised for evaluation of coatings from PV manufacturers and developers.

- **Power Electronics for Grid Integration:** R&D activities during 2025 focused on reliable and efficient power electronic systems for grid integration of large-scale solar power. Work progressed (shown in Fig. 7.1.c) on SiC-based medium-voltage inverter architectures, addressing topology selection, insulation design, harmonic mitigation, and thermal stress management, in compliance with IEEE 519 and other applicable grid standards. A generalized harmonic model for an integrated three-phase dual active bridge (I3DAB) converter was developed to reduce component count and improve efficiency in cascaded H-bridge based medium-voltage PV systems, supporting future deployment of compact and reliable grid-connected inverters.
- **Solar Cells and Advanced Materials:** Significant progress was achieved during 2025 in next-generation solar cell technologies. NCPRE demonstrated four-terminal perovskite–silicon tandem solar cells with efficiencies exceeding 30 per cent, and four-terminal CdTe–perovskite tandem solar cells with efficiencies above 24 per cent, along with enhanced operational stability. Climate-specific modelling of perovskite–silicon tandem solar cells was undertaken to assess energy yield and levelized cost of electricity (LCOE) under Indian climatic conditions. The studies identified optimal perovskite bandgaps for minimising LCOE and provided inputs relevant for technology design and deployment. Research on durability of hydrophobic anti-soiling coatings under realistic cleaning loads generated guidance for operation and maintenance practices in utility-scale PV plants.
- **Education, Training and Capacity Building :** NCPRE organised multiple capacity-building initiatives. A three-day training programme on "Advanced Power Electronics for Solar PV Integration" was conducted in July 2025, covering inverter architectures, wide-bandgap devices, control strategies, and hands-on hardware demonstrations. The programme benefitted 41 participants from industry, academia, government organisations, and research institutions.

Fig. 7.1 (a) to (c) clockwise; (a) Shri Santosh Kumar Sarangi, Secretary, MNRE (second from Right) inaugurated the ART-PV India and Module Simulator Facility at NCPRE, Dr. Sangita M. Kasture, Advisor, MNRE (Right); (b) Hon'ble Minister Shri Prahlad Joshi (Second from Left), Shri Sudeep Jain, Add'l Secretary (Right), MNRE, and Dinesh Kabra (L) showing the in-house tool; (c) Prof. B. G. Fernandes, PI of NCPRE (Left) showing the prototypes in Power Electronics Lab.

- **Industry Interaction and Public–Private Collaboration:** NCPRE maintained active engagement with industry through collaborative research and testing support. The NCPRE-incubated start-up ART-PV India entered into a grant agreement with Waaree Energies Limited to enhance laboratory capabilities for characterisation and development of perovskite–silicon tandem solar cells, supporting translation of research towards commercial readiness.
- **National and International Engagement :** The Hon'ble Union Minister for New and Renewable Energy, Shri Pralhad Joshi, visited IIT Bombay in July 2025 to review NCPRE activities and perovskite–silicon tandem research, reaffirming MNRE's support for scaling up next-generation PV technologies. NCPRE also represented India in IEC TC82 / WG2 meetings during 2025. In addition, the Industrial Research and Consultancy Centre (IRCC), IIT Bombay, in collaboration with NCPRE, organised an Industry Day on "Empowering India's Solar Future (EISF): Innovation, Indigenisation, and Collaboration" on 08.11.2025. Shri Santosh Kumar Sarangi, Secretary, MNRE, graced the event as Chief Guest and inaugurated the ART-PV India facility (shown in Fig. 7.1.a) and the Module Simulator Facility at NCPRE. The event brought together academia, industry, and policymakers and included technical sessions, panel discussions, and laboratory visits, strengthening industry–academia collaboration.

B. National Primary Standard Facility for Solar Cell Calibration (CSIR-NPL) : National Primary Standard Facility for Solar Cell Calibration has been established at the CSIR–National Physical Laboratory (CSIR-NPL), the National Metrology Institute of India, with support from the Ministry of New and Renewable Energy (MNRE). The facility (shown in Fig. 7.2) is based on a Laser-based Differential Spectral Responsivity (L-DSR) Measurement System and enables rollout of primary reference solar cell calibration services in the country.

Figure 7.2 Dr. Jitendra Singh (Hon'ble Minister of State for Ministry of Science and Technology, and Vice President, CSIR) (Third from Right) inaugurated the National Primary Standard Facility for Solar Cell Calibration; Shri Santosh Kumar Sarangi, Secretary, MNRE (Right); Dr. (Mrs.) N. Kalaiselvi, DG-CSIR and Secretary, DSIR (Left)

The establishment of this facility marks a significant milestone in strengthening India's Photovoltaic Quality Infrastructure (PV-QI) by providing traceable, high-accuracy calibration services for solar cells under Standard Test Conditions (STC). Earlier, India depended on a limited number of overseas World Photovoltaic Service (WPVS) laboratories for primary calibration services. With the commissioning of the L-DSR facility, CSIR-NPL has emerged as the fifth internationally recognised WPVS laboratory, achieving the lowest reported uncertainty in short-circuit current (ISTC) measurements among peer laboratories.

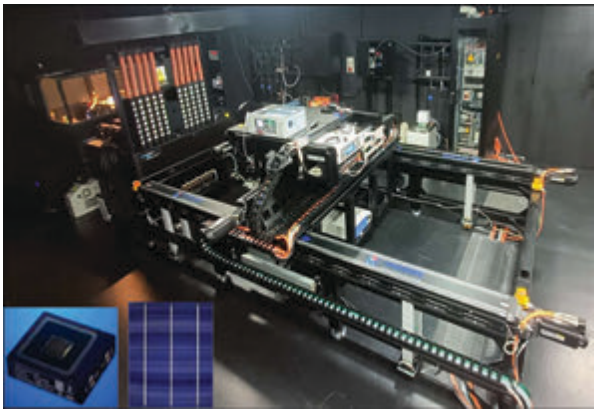


Figure 7.2 (b)

The facility is capable of measuring ISTC with an uncertainty of 0.35 % (k = 2) for WPVS reference solar cells and 0.6 % (k = 2) for industrial-scale (156 × 156 mm^2) solar cells. Such low measurement uncertainty is critical for accurate valuation of photovoltaic products and for avoiding large financial ambiguities across the solar value chain, particularly in large-scale solar deployment scenarios.

The L-DSR system operates over a wide wavelength range of 210 nm to 4000 nm, with substantially higher optical power compared to conventional lamp-based systems, ensuring improved spectral uniformity and measurement accuracy. The facility has been established in collaboration with PTB, Germany, in line with international best practices while ensuring national self-reliance.

The National Primary Standard Facility is expected to enhance transparency, investor confidence, and informed decision-making in the solar PV sector, while reducing dependence on overseas calibration services and may invite PV manufacturers, testing laboratories, and other stakeholders to avail these services and contribute to strengthening India's solar measurement and quality ecosystem.

C. **Scale-up of Perovskite Tandem Solar Cells (Phase-I):** The project is being implemented at the Indian Institute of Technology Bombay in collaboration with ART-PV India Pvt. Ltd (Start-up of NCPRE, IIT Bombay)., Waaree Energies Ltd., First Solar India, and Excel Instruments Pvt. Ltd. The objective is to develop commercial wafer-size (M10) perovskite tandem solar cell technologies for non-exclusive transfer to Indian manufacturers. IIT Bombay has earmarked about 4,800 sq. ft. for setting up a dedicated tandem solar cell laboratory, including an ISO Class-7 cleanroom, which is currently under construction.

Good technical progress has been achieved in the development of monolithic perovskite–silicon tandem solar cells. Heterojunction (HJT) silicon has been identified as the preferred bottom cell. Use of a thin tin oxide (SnO_x) interlayer deposited through Atomic Layer Deposition has helped reduce damage during electrode coating and maintain good electrical performance. Small-area tandem devices have achieved an efficiency of 13.25%. Larger-area perovskite solar cells have demonstrated efficiencies up to 19.8%, while bifacial near-infrared transparent cells have shown encouraging performance suitable for tandem applications. In addition, silver screen printing has been successfully demonstrated as a scalable and industry-compatible metallisation process, supporting future manufacturing readiness at M10 wafer scale.

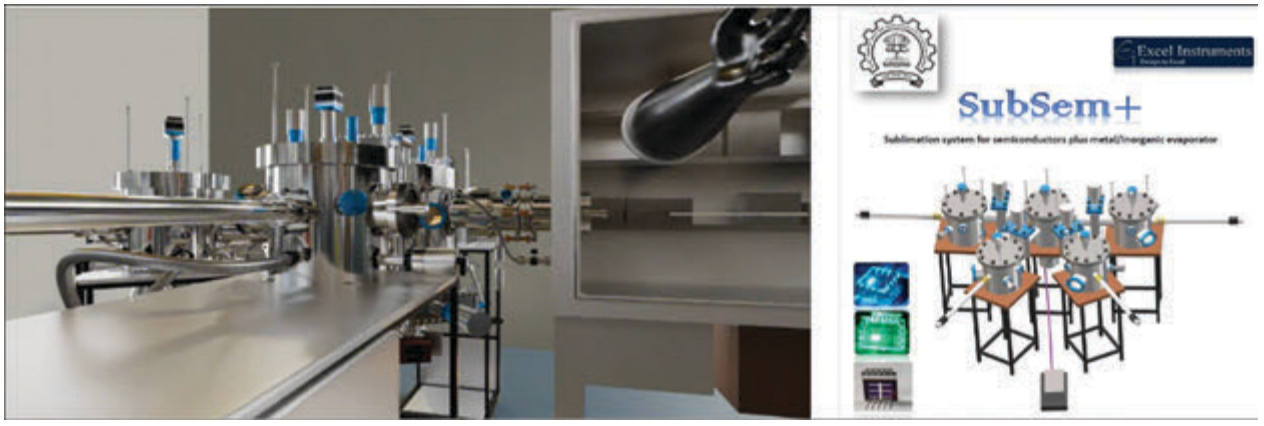


Figure 7.3 SUBSem+, a proprietary equipment for automated manufacturing of Perovskite, Perovskite-Silicon 2T Tandem Solar Cells

D. **Perovskite Solar Modules**

The project at IIT Bombay, focuses on improving the stability and scalability of perovskite solar technologies. The work addresses degradation mechanisms under ISOS and SETO

protocols through compositional engineering and aims to develop ~100 cm² perovskite solar modules using an AI-assisted robotic fabrication system. An indigenously designed automated platform integrating coating, annealing, inspection, and in-situ characterisation is under development, supporting scalable and manufacturing-ready perovskite module fabrication.

E. **Flexible Perovskite Solar Cells and Intermediate Modules:** The project implemented at IIT Bombay achieved significant performance milestones in flexible and scalable perovskite photovoltaics. Small-area devices (0.1 cm²) demonstrated efficiencies up to 26%, exceeding the target of 20%, with stable devices maintaining 25–25.5% efficiency. Large-area devices of 16 cm² achieved ~21% efficiency, while 100 cm² modules reached ~14% efficiency with a 94% geometrical fill factor. Flexible PET-based devices recorded 25.1% efficiency using low-temperature oxide processing. Roll-to-roll slot-die coated devices achieved ~23% efficiency, retaining >70% performance after 8,000 bending cycles and demonstrating stability of ~9,000 hours.

7.1.5 R&D in Small Hydro

Highlights of the progress achieved under the Small Hydro R&D projects funded by the MNRE are listed below:

A. **Research and development of ultra-low head and Hydrokinetic Turbines and performance prediction of small hydro turbine models**

The Ministry of New and Renewable Energy is supporting a **Centre of Excellence** for research, development, and performance assessment of ultra-low head and hydrokinetic turbine technologies relevant to small hydro applications in India. During the year, substantial progress has been achieved across all three approved components of the Centre, namely development of ultra-low head (ULH) turbines, development of hydrokinetic turbines (HKT), and formulation of computer-based guidelines for performance prediction of small hydro turbines and reversible pump storage systems.

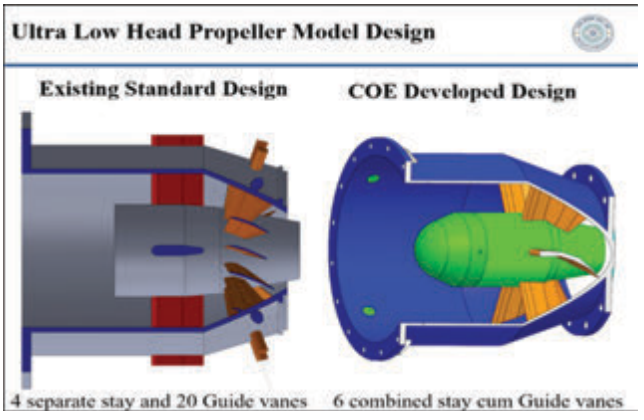


Figure 7.4 Ultra Low Head Propeller Model Design

Under the ULH turbine component, suitable vertical and horizontal propeller-type turbine technologies have been finalized. Hydraulic and mechanical designs have been completed using simplified configurations to reduce mechanical complexity and manufacturing costs. Major turbine components have been manufactured, and

development of laboratory infrastructure, including installation of overhead tanks and pipeline systems, is nearing completion. Performance analysis using computational tools has been initiated. In addition, design and analysis of a screw-type ULH turbine are also in progress.

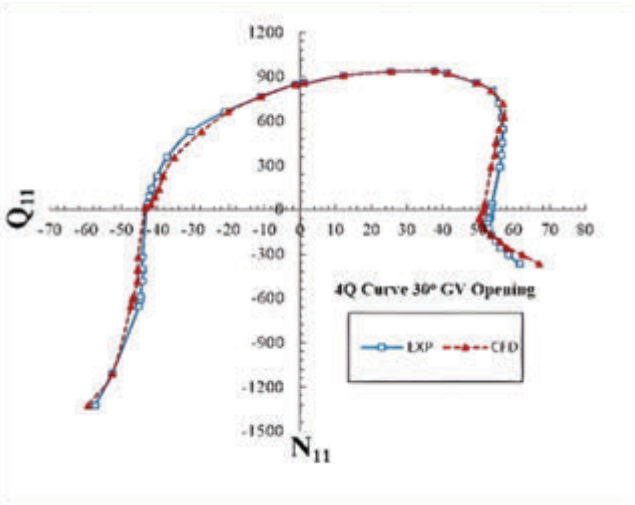


Figure 7.5 PSP Design Validation 4Q Curve_30 degree GVO

In the area of hydrokinetic turbines, performance simulations for multiple turbine configurations have been completed, and a dedicated testing facility has been fabricated, with installation and commissioning planned. Advanced flow measurement systems have been commissioned to support detailed performance evaluation.

For performance prediction guidelines, field data from operating turbines have been collected and validated through simulations and inter-laboratory studies. Grid convergence and validation exercises are underway to support development of standardized guidelines for small hydro and pump storage projects.

Figure 7.6 HPC Server for CFD at IIT Roorkee

7.1.6 R&D in Bioenergy: Highlights of the progress achieved under the Bioenergy R&D projects funded by the MNRE are listed below:

A. Biomass Gasification through Plasma Pyrolysis Technology for its application in gasifier

Under the MNRE-supported project, a laboratory-scale plasma pyrolysis and gasification system has been successfully fabricated and commissioned at IIT Roorkee. The system comprises a biomass feeding mechanism, plasma reactor equipped with plasma torches, gas cooling and wet scrubbing units, gas recovery arrangement, and an integrated control panel. The facility enables controlled experimental investigation of biomass gasification and plasma-assisted pyrolysis processes.

- **Experimental Activities and Process Development :** Thermo-chemical characterization and experimental gasification studies were conducted using a variety of biomass feedstocks including sugarcane bagasse, rice and wheat husk, wood sawdust, and pine needles. Producer gas (syngas) generated through plasma gasification was subjected to

firing tests and gas composition analysis using online gas analyzers. Systematic process optimization was undertaken by varying operational parameters such as heating rate, biomass feed rate, inlet gas composition, and reactor geometry.

Figure 7.7 Plasma Pyrolysis Unit at IIT Roorkee

- **Key Outcomes and Technological Advancements :** The experimental investigations resulted in successful synthesis of producer gas and generation of high calorific value biochar through plasma-based pyrolysis, demonstrating its potential as an alternative solid fuel. Based on the optimized reactor configuration and process parameters, the design patent process has been initiated. The outcomes of the study also provide a strong foundation for future scale-up and application of plasma gasification technology.
- **Future Scope and Relevance to MNRE Programs :** The developed system and experimental findings offer significant potential for future applications including plasma-assisted conversion of biomass for sustainable aviation fuel synthesis, mixed waste processing, utilization of pine needles to mitigate forest fire risks in the Himalayan region, and production of green hydrogen and biochar from agricultural and biomass residues.

B. Densification of Agro-Waste and Assessment for Its Application in the Gasifier : The project at NIBE, supported by Ministry of New and Renewable Energy (MNRE) was undertaken to enhance utilization of surplus agricultural residues for decentralized bioenergy applications. The project addresses critical challenges related to low bulk density, handling inefficiencies, and inconsistent gasifier performance of loose agro-residues by adopting pelletization and systematic fuel characterization.

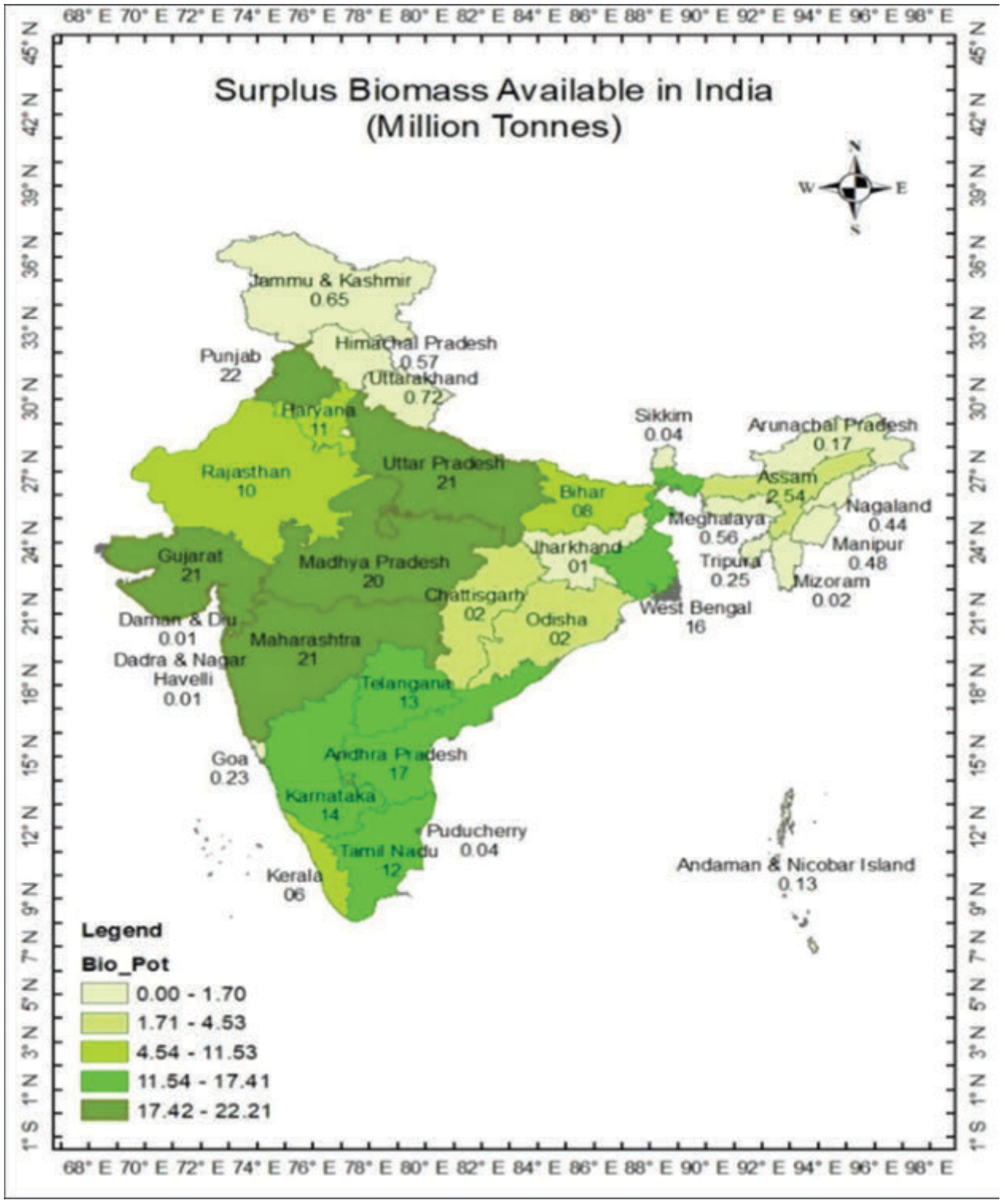


Figure 7.8 Surplus Biomass Available in India State-wise

Technical Progress and Findings: Six agro-residues—paddy straw, corn stover, sweet sorghum, pearl millet, cotton stick, and mustard residue were collected from Punjab and

characterized. Proximate analysis showed volatile matter ranging from 73.3–82.5%, while ash content varied significantly, with paddy straw recording the highest ash (18.1%) and cotton stick the lowest (5.4%). Ultimate analysis indicated carbon content between 36.8–42.5%. Gross calorific value ranged from 12.4 MJ/kg (paddy straw) to 17.6 MJ/kg (cotton stick), establishing cotton stick and sweet sorghum as high-energy feedstocks. These results are supported by characterization data and statistical ANOVA analysis.

Gasifier Performance Evaluation: Pelletized paddy straw was successfully tested in a 10 kVA downdraft gasifier (Figure 7.9). Stable producer gas combustion with a blue-yellow flame was observed. Gas composition analysis indicated CO + CH_4 > 44%, and electrical output of 6.5 kW, corresponding to ~65% generator capacity utilization, demonstrating technical feasibility for decentralized power generation.

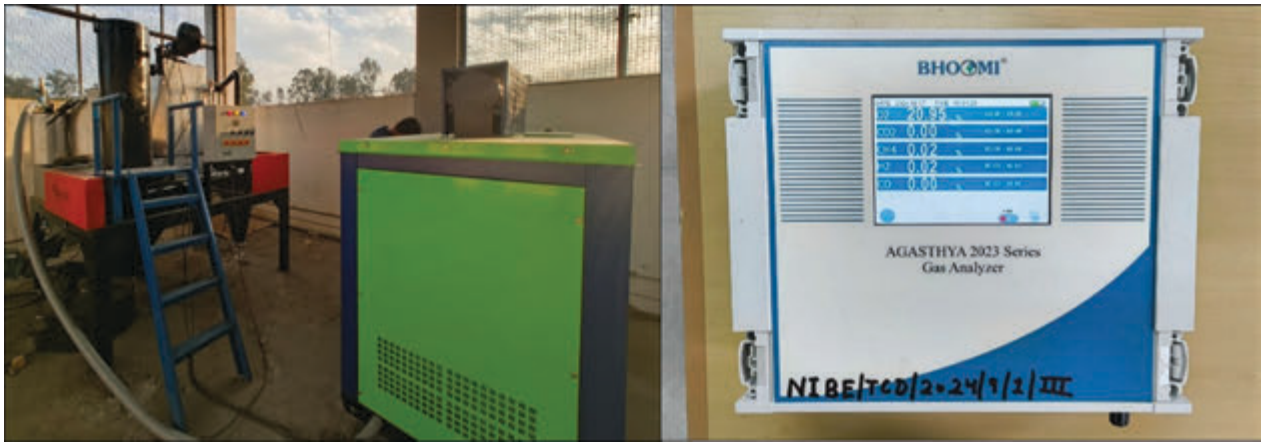


Figure 7.9 (Left) Biomass Downdraft gasifier with Gen set (10KVA); Producer gas analyser (Right)

7.1.7 R&D in Green Hydrogen

Highlights of the progress achieved under the Green Hydrogen R&D projects funded by the MNRE are listed below:

A. Green Hydrogen Mobility Project, Leh (Ladakh) : The Green Hydrogen Mobility Project at Leh, Ladakh, implemented by NTPC under MNRE support, demonstrates integrated production, storage, dispensing, and utilization of green hydrogen for public transport in extreme climatic conditions.

Figure 7.10 Takeover agreement signed between NTPC and SIDCO (UT owned) on 18.06.2025

Technical Configuration and Capacity: The project comprises a 1.70 MW solar plant spread over 7 acres, hydrogen generation capacity of 80 kg/day with 11 hours of operation, hydrogen storage at 450 bar (100 kg capacity), and dispensing at 350 bar with a flow rate of 1.7 kg/min. The

hydrogen is utilized in a fleet of five fuel cell electric buses (9 m length), each having a range of ~200 km, enabling operation of approximately 1,000 km/day under high-altitude and sub-zero temperature conditions.

NTPC H2 Leh Performance report	
H2 Generation data from 01/04/2025-31/08/2025	
Total H2 Generated (kg)	2419
Total H2 Dispensed(kg)	1311.4
Bus data from 26/06/2025-31/08/2025	
Total distance travelled(km)	14139
Total Hydrogen filled (kg)	939
Mileage(km/kg)	15.06
Solar Gen data from 06/06/2024-31/08/2025	
Total Gen (MWh)	2275

Figure 7.11 (a) Operational Data

Operational Performance: As per operational data from 01.04.2025 to 31.08.2025, total hydrogen generation was 2,419 kg, of which 1,311.4 kg was dispensed. Bus operations (26.06.2025–31.08.2025) covered 14,139 km using 939 kg of hydrogen, achieving an average mileage of 15.06 km/kg. Solar generation during the same period amounted to 2,275 MWh, confirming reliable renewable energy support for hydrogen production.

Figure 7.11 (b) Hydrogen Fuelling Station (altitude- 3650m MSL) & Hydrogen Fuel Cell Bus

B. Design and Development of 20 kW Low Temperature Polymer Electrolyte Membrane (LT-PEM) Fuel Cell with High Indigenous Content

The MNRE-supported project on development of a 20 kW Low Temperature PEM fuel cell system is being implemented at the ARCI – Centre for Fuel Cell Technology, Chennai. The project aims to establish indigenous capability for PEM fuel cell stack design, manufacturing, and testing.

Figure 7.12 Automated PEM fuel cell Assembly at ARCI-CFCT, Chennai

A 20 kW PEM fuel cell stack has been successfully developed as part of a modular 100 kW (5 × 20 kW) system. An automated PEM fuel cell assembly pilot line with a production capacity of 100 kW per year has been established. Indigenous manufacturing of key components has been demonstrated, including fabrication of ~700 bipolar plates and ~300 MEA/CCM units covering an electrode area of ~30 m^2. Imported component usage has been reduced to ~5% by value, excluding the membrane.

Performance evaluation indicates a specific power of 95–103 W/kg and geometric power density of ~133 mW/cm^2 at stack level. Long-duration durability testing of the stack was completed for 5,000 hours, with an observed voltage degradation rate of 25.2 mV per 1,000 hours, meeting project targets. Stack cost has been reduced to ₹2.31 lakh/kW using Nafion membranes and ₹1.98 lakh/kW using alternative membranes. The project has resulted in two patents granted, three under filing, and establishment of India's first automated PEMFC pilot manufacturing line.

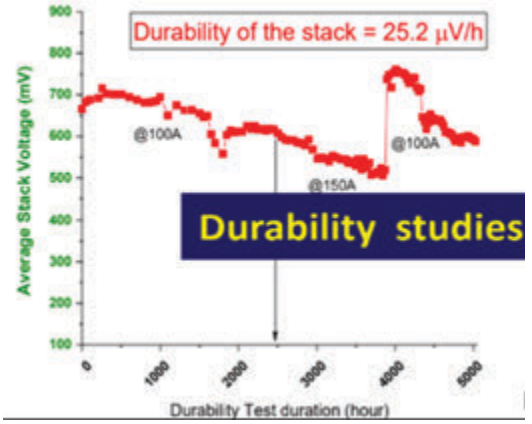


Figure 7.13 Durability Study on the stack

C. Setting up of a Centre of Excellence on Hydrogen Energy at NISE, Gwal Pahari, Haryana

The project aims to establish a Centre of Excellence (CoE) on Hydrogen Energy at the National Institute of Solar Energy (NISE) to strengthen indigenous capability in green hydrogen production, storage, dispensing, and mobility demonstrations. NISE hosts India's first Solar PV–based Green Hydrogen generating and dispensing station, serving as a national demonstration and training facility.

The facility comprises a 120 kWp solar PV plant powering two KOH-based alkaline electrolysers with a combined hydrogen production capacity of 15 Nm^3/hr (~1.35 kg/hr). Hydrogen is purified to 99.999% fuel-cell grade and stored at 500 bar in high-pressure tanks with a total storage capacity of ~60 kg. A dedicated H35 dispenser (350 bar) enables real-time refuelling and demonstration of hydrogen-fuelled vehicles.

Figure 7.14 Hands on training on Green Hydrogen Plant operation, instrumentation and controls of the new Electrolyser

Under the MNRE-funded CoE project, revival of the existing hydrogen station has been undertaken, including troubleshooting, repair, and replacement of critical components. A new 10 Nm^3/hr alkaline electrolyser was commissioned in February 2025, augmenting hydrogen generation capacity. NISE has also conducted hands-on training programmes on hydrogen production, storage, instrumentation, and safety during August 2024 and February 2025, contributing to national capacity building.

To advance hydrogen mobility, NISE has entered a MoU with Toyota Kirloskar Motor for evaluation and demonstration of the Toyota Mirai fuel-cell vehicle under Indian operating conditions, further strengthening applied research and demonstration objectives of the CoE.

7.1.8 R&D in Geothermal Energy

The Ministry of New and Renewable Energy (MNRE) notified the National Policy on Geothermal Energy on 15.09.2025, with the objective of establishing geothermal energy as an integral component of India's renewable energy portfolio in support of energy security and the national commitment to achieve net-zero emissions by 2070. The Policy provides a structured framework for research, exploration, resource assessment, and deployment of geothermal technologies, encompassing power generation, direct-use applications, and ground source heat pumps, while promoting indigenous R&D, risk mitigation, private sector participation, and international collaboration.

In furtherance of R&D-led implementation of the Policy, a stakeholder consultation meeting was held on 12.11.2025 under the chairmanship of Secretary, MNRE. The deliberations emphasized strengthening research and development through enthalpy-based resource classification, adoption of UNFC-aligned assessment standards, focused exploration in high-potential regions, creation of a centralized geothermal data repository, and enhanced inter-agency coordination. Stakeholders also highlighted the need for suitable tariff and viability gap funding mechanisms, collaboration with international leaders in geothermal technology, and differentiated R&D approaches for geothermal power generation and low-enthalpy direct-use applications.

Highlights of the progress achieved under the Geothermal Energy R&D projects funded by the MNRE are listed below:

A. Pilot Integrated Commercial Geothermal Energy of 450 kW by retrofitting unproductive oil and gas wells:

MNRE has recently sanctioned a pilot R&D project implemented by the Indian Institute of Technology Madras, aimed at commercializing geothermal power generation through repurposing of unused oil and gas reservoirs. The project focuses on reservoir classification, assessment of geothermal gradients and temperatures, and techno-economic evaluation of electricity generation using retrofitted wells. Key objectives include converting existing hydrocarbon wells into geothermal producers, estimating outlet temperatures and revenue potential, and establishing a 450 kW Organic Rankine Cycle (ORC) power plant with grid connectivity. Planned deliverables encompass well integrity assessment, reservoir data compilation, well retrofitting, system design, installation, commissioning, performance testing, environmental assessment, and initiation of commercial operation, supporting scalable geothermal deployment in India.

B. Harnessing of geothermal energy from Arunachal Himalaya

MNRE has sanctioned a project implemented by the Centre for Earth Sciences and Himalayan Studies (CESHS), Government of Arunachal Pradesh, to systematically assess and utilize geothermal resources in the Himalayan region. The project involves integrated geological, geochemical, geophysical, and geothermal investigations, including detailed

structural mapping and development of a 3-D geological model to estimate exploitable geothermal potential. It also evaluates the feasibility of geothermal energy for industrial use, electricity generation, and geothermal heating for Army base camps. Key deliverables include detection and delineation of geothermal sites, identification of geochemical thresholds, generation of deep heat-flow and geo-electrical data, and demonstration of geothermal heating applications, supporting strategic and energy security objectives.

C. Demonstration of power generation using integrated Solar-Geothermal energies

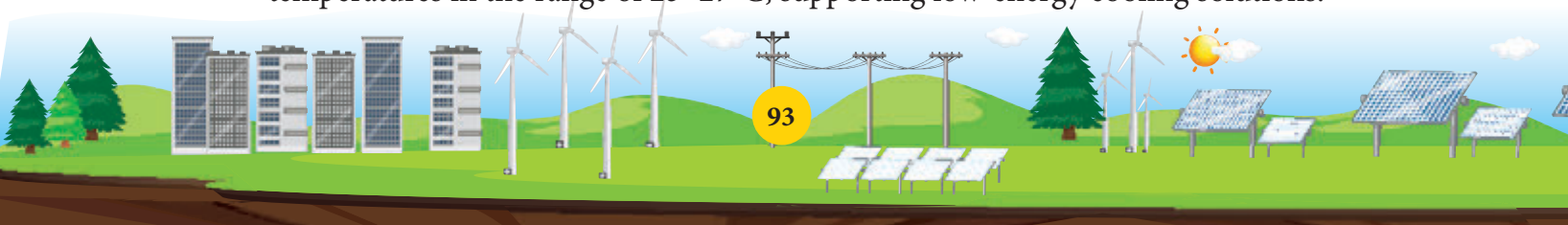
MNRE has sanctioned a R&D project implemented by the Pandit Deendayal Energy University, Gujarat, to demonstrate integrated solar–geothermal energy utilization. The project involves exploratory surveys to identify geothermal hotspots and detailed analysis of geothermal water quality for compatibility with power plant equipment. A small-scale Organic Rankine Cycle–based hybrid solar thermal and geothermal power plant is being set up to assess power generation potential. The project also focuses on designing and demonstrating direct-use applications of residual geothermal energy. Key deliverables include subsurface characterization of aquifer continuity, comprehensive water quality assessment, evaluation of hybrid power output, and implementation of direct geothermal applications.

D. A Pilot Project on Study and Testing of Shallow Geothermal Energy Potential in India

MNRE has sanctioned a R&D project implemented by the Indian Institute of Technology Delhi to assess the potential of shallow geothermal energy in India. The project focuses on preliminary national-level potential estimation, analytical and numerical evaluation of geothermal borehole designs, and field testing to validate model predictions. It also aims to develop standardized procedures for testing, installation, and design of ground source heat pump (GSHP) systems, including comparative cost–benefit analysis with other green technologies. Key deliverables include development of a national shallow geothermal potential map, comprehensive design and testing guidelines with economic analysis, and exploration of technology indigenization through patent filings.

E. Design and Development of Geothermal Cooling for Air Conditioning System in 20x20x10 ft Room

MNRE has sanctioned a R&D project implemented by the Osmania Technology Business Incubator, Osmania University, focusing on geothermal-based natural cooling for space conditioning. The project aims to utilize the low subsurface temperatures at shallow depths (1–3 m) to develop an energy-efficient geothermal cooling system for air-conditioning applications. Key objectives include reducing indoor temperatures to around 26°C with minimal electricity consumption and optimizing system parameters for different room sizes. Major deliverables include validation of the geothermal cooling concept, emulation of optimal design parameters, and demonstration of water circulation to achieve indoor temperatures in the range of 25–27°C, supporting low-energy cooling solutions.



7.1.9 R&D in Wind Energy

A. Met Ocean Measurement Project in Gulf of Khambhat and Gulf of Mannar

The Ministry supported a Met-ocean measurement project in the Gulf of Mannar to generate high-quality wind and oceanographic data for facilitating offshore wind energy development in India. The project aimed at establishing a robust, site-specific database covering wind, wave, tide, current, and water level parameters to support offshore wind resource assessment, zoning, and project planning.

Under the project, offshore LiDAR systems were installed at strategic locations, including VOC Port and Udangudi, and a comprehensive wind measurement campaign was completed. Real-time offshore wind data were generated at multiple heights up to 200 m, indicating favourable wind regimes with mean wind speeds exceeding 7 m/s at 150 m hub heights. Complementary oceanographic measurements were undertaken through a separate initiative. The project was completed in March 2025.

The project has resulted in the creation of a valuable offshore wind and met-ocean dataset, providing reliable validation of mesoscale offshore wind models through site-specific measurements, including floating LiDAR observations. The generated data enables accurate demarcation of offshore wind zones in the Gulf of Mannar, supports seabed leasing and bidding processes, and strengthens India's offshore wind programme by serving as a credible technical reference for offshore wind developers in feasibility assessments and project planning.

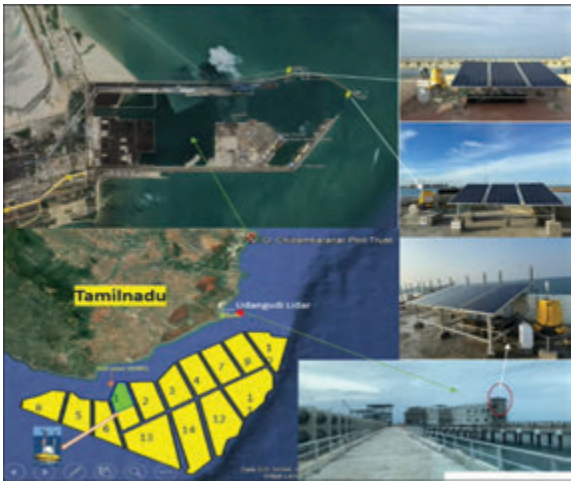


Figure 7.15 LiDAR installed at VOC port and Udangudi, Gulf of Mannar, Tamil Nadu

7.1.10 R&D to commercialization

MNRE's brainstorming consultation held on 08.08.2025 under the Chairmanship of Prof. Ashok Jhunjhunwala (IIT Madras) identified priority R&D actions for accelerating renewable energy commercialisation, with immediate focus on five domains in partnership with industry and R&D institutions. It was proposed that funding support be extended to start-ups along with loan provisions to scale up technologies. While silicon PV offers limited strategic advantage, Perovskite single-junction and tandem cells present strong TRL-5 opportunities requiring consortium-driven directed research. A national thrust on indigenous power-electronics and HVDC technologies can deliver TRL-7 products within two years. Grid-storage requires urgent pack-level indigenisation, with all grid-scale deployments mandated to use Indian battery-pack technology. Rooftop solar adoption can be unlocked through ToD-linked tariff reforms and domestically developed solar-

hybrid-UPS systems. A dual start-up support scheme—seed grants and subsidised venture debt—will help strengthen India's RE innovation pipeline. NITI Aayog has emphasized the development of pilot-scale plants and indigenous manufacturing for Long-Duration Energy Storage (LDES) technologies.

7.1.11 R&D Projects under Implementation

Given below is the list of R&D Projects under implementation during FY 2025-26:

Solar PV

S. no.	Title of the Project	Institution
1.	National Centre for Photovoltaic Research and Education (NCPRE) - Phase III	IIT Bombay
2.	National Primary Standard Facility for Solar Cell Calibration	CSIR-NPL, New Delhi
3.	Scale-up of Perovskite Tandem Solar Cells (Phase I)	IIT Bombay
4.	Perovskite Solar Modules	IIT Bombay
5.	Flexible Perovskite Solar Cells and Intermediate Module	IIT Bombay

Small Hydro

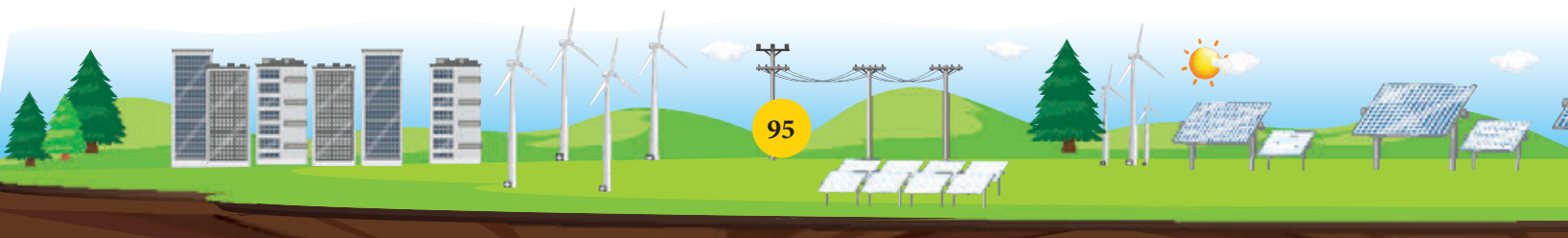
S. no.	Title of the Project	Institution
1.	Research and development of Ultra Low head and Hydrokinetic Turbines and performance prediction of small hydro turbine models	IIT Roorkee

Waste to Energy

S. no.	Title of the Project	Institution
1.	Biomass Gasification through Plasma Pyrolysis Technology for Chemical Production	IIT Roorkee
2.	Densification of agro-waste and assessment for its application in the gasifier	SSS-NIBE, Kapurthala

Green Hydrogen

S. no.	Title of the Project	Institution
1.	Green Hydrogen Mobility Project at Leh	NTPC
2.	Design and development of 20kW Low Temperature Polymer Electrolyte Membrane (LT-PEM) fuel cell with high indigenous content.	ARCI-CFCT, Chennai
3.	Setting Up of a Centre of Excellence on Hydrogen Energy at National Institute of Solar Energy	NISE, Gurugram



Geothermal Energy

S. no.	Title of the Project	Institution
1.	Pilot Integrated Commercial Geothermal Energy of 450 kW by retrofitting unproductive oil and gas well	IIT Madras
2.	Harnessing of geothermal energy from Arunachal Himalaya	CESHS, Govt. of Arunachal Pradesh
3.	Demonstration of power generation using integrated Solar-Geothermal energies	PDEU, Gujarat
4.	A Pilot Project on Study and Testing of Shallow Geothermal Energy Potential in India	IIT Delhi
5.	Design and Development of Geothermal Cooling for Air Conditioning System in 20x20x10 ft Room	Osmania University, Hyderabad

Wind Energy

S. no.	Title of the Project	Institution
1.	Met Ocean Measurement Project in Gulf of Khambhat and Gulf of Mannar	NIWE, Chennai

7.1.12 Recommendations by High Level Committee

A review of the Renewable Energy Research, Technology Development and Demonstration (RE-RTD) Programme was undertaken by a High-Level Committee chaired by **Dr. Anil Kakodkar**, Chancellor, Homi Bhabha National Institute, in its meeting held on 15.09.2025. After detailed deliberations on the progress, outcomes, and overall evaluation of the Programme, the Committee offered its valuable recommendations and concluded that the RE-RTD Programme may be continued for the period 2026–27 to 2030–31. Recommendations of Committee are mentioned below: -

- Strengthen industry–academia partnerships for TRL-based collaborative R&D.
- Establish dedicated national testing and validation facilities for wind, inverter, and storage technologies.
- Create a national R&D database for knowledge sharing and policy support.
- Enhance budgetary support and consider earmarking a fixed percentage of sectoral investment for R&D.
- Promote indigenization and supply-chain security through focused manufacturing R&D.
- Remodel the R&D scheme on ARPA-E/DARPA lines to drive innovation through competitive, goal-oriented projects.
- A detailed strategy and action plan which is aligned to national goals and strategy needs to be developed. There is a need to further scale the deployment of silicon-based solar cells, with active industry involvement in expanding domestic manufacturing capacity for solar as well as Inverters, Energy Storage &Power Electronics.

- The Ministry should provide support to start-ups in renewable energy to fast-track innovation, technology commercialization, and large-scale deployment of sustainable solutions and R&D budget should be increased by at least 3-4 times of existing budget.
- The Committee suggested that MNRE should identify thrust areas for R&D, adopt a staged TRL based pathway, allocate at least 5% of the renewable energy sector budget to R&D, and build a national database for policy support.
- To promote pan-India participation of industrial and academic research entities under the RE-RTD Programme, it is proposed that a structured framework for support, validation, and recognition of indigenously developed technologies and components be instituted. This framework shall facilitate collaborative development, encourage technology adoption, and enable scaling up of business opportunities across the renewable energy sector.

7.2 Production Linked Incentive (PLI) Scheme for High Efficiency Solar PV Modules

7.2.1 Introduction

Ministry of New and Renewable Energy, Government of India is implementing the Production Linked Incentive (PLI) Scheme for National Programme on High Efficiency Solar PV Modules, for achieving manufacturing capacity of Giga Watt (GW) scale in High Efficiency Solar PV modules with an outlay of Rs. 24,000 crores. This Scheme has provision for Production Linked Incentive (PLI) to the selected solar PV module manufacturers for five years post commissioning, on manufacture and sale of High Efficiency Solar PV modules.

7.2.2 Aims and Objectives

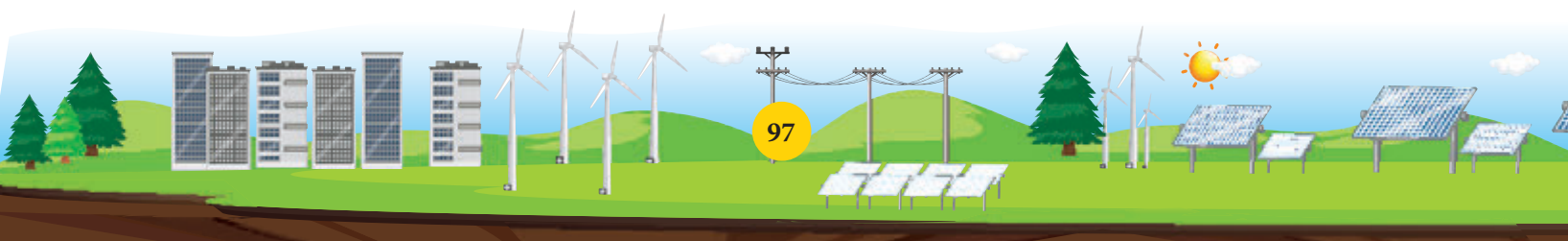
The scheme aims to build an ecosystem for manufacturing of high efficiency solar PV modules in India and thus reduce import dependence in the area of Renewable Energy. The objectives of the scheme include the following:

i. To build up solar PV manufacturing capacity of high efficiency modules.
ii. To bring cutting-edge technology to India for manufacturing high efficiency modules. The scheme will be technology agnostic in that it will allow all technologies. However, technologies which yield better module performance will be incentivized.
iii. To promote setting up of integrated plants for better quality control and competitiveness.
iv. To develop an ecosystem for sourcing of local material in solar manufacturing.
v. Employment generation and technological self-sufficiency.

7.2.3 The PLI Scheme is being implemented in two tranches as follows:

7.2.3.1 Tranche-I:

i. The Union Cabinet approved the Production Linked Incentive (PLI) Scheme for National Programme on High Efficiency Solar PV Modules, for achieving manufacturing capacity of



Giga Watt (GW) scale in High Efficiency Solar PV Modules on 07.04.2021. Ministry of New & Renewable Energy (MNRE) issued the Scheme Guidelines for Production Linked Incentive Scheme on 'National Programme on High Efficiency Solar PV Modules' on 28.04.2021, with an outlay of Rs. 4,500 crores.

ii. Under this tranche, Indian Renewable Energy Development Agency Limited (IREDA), the implementing agency on behalf of MNRE for the PLI Scheme (Tranche-I), issued the Bid Documents for selection of manufacturers for setting up manufacturing capacities for High Efficiency Solar PV Modules. Letters of Award were issued by IREDA in November and December, 2021 to three successful bidders for setting up of 8,737 MW capacity of fully integrated Solar PV Module manufacturing units within PLI scheme outlay of Rs. 4,500 crores. The aforesaid 8,737 MW solar PV manufacturing capacity is under implementation.

7.2.3.2 Tranche-II:

i. Subsequent to the Union Cabinet approval dated 21.09.2022, Ministry of New & Renewable Energy, on 30.09.2022, has issued Scheme Guidelines for implementation of Tranche-II of the PLI Scheme for High Efficiency Solar PV Modules, with an outlay of Rs. 19,500 crores.

ii. Under this tranche, Solar Energy Corporation of India (SECI), the implementing agency on behalf of MNRE for the PLI Scheme (Tranche-II), issued the tender document for selection of Solar PV manufacturers under Tranche-II of PLI Scheme for High Efficiency Solar PV Modules. Letters of Award (LoAs) have been issued by SECI to 11 bidders in April 2023 for setting up 39,600 MW of fully/partially integrated solar PV module manufacturing. Out of the awarded capacity, 4 GW of integrated capacity for solar cells and modules, has been declared commissioned in October 2025, and remaining capacity is under implementation.

7.2.3.3 In October 2025, the Government has allowed the successful bidders under tranche-I and tranche-II of PLI Scheme for high efficiency solar PV modules to avail the time extension in the scheduled commissioning date, up to a maximum of 2 years, subject to specified terms and conditions.

7.2.4 Expected Outcome/Benefits

The outcomes/benefits expected from the scheme are as follows:

i. It is estimated that about 48,337 MW per annum manufacturing capacity of fully and partially integrated, solar PV modules would be installed.

ii. The scheme will bring direct investment of around Rs.1,14,000 crore.

iii. Creation of manufacturing capacity for Balance of Materials like EVA, Solar Glass, Aluminium Frames, etc.

iv. Direct employment of about 35,000 persons.

v. Impetus to Research and Development to achieve higher efficiencies in Solar PV Modules.

7.3 Energy Storage

7.3.1 Renewable Energy sources are inherently variable and intermittent. Integrating a large share of such generation into the grid poses significant challenges to grid security, stability, and safety. Grid-scale Energy Storage Systems (ESS) play a crucial role in smoothing renewable generation output, enhancing power quality, and strengthening grid stability. Additionally, ESS helps reduce transmission network congestion and enables more efficient utilization of existing grid infrastructure.

7.3.2 Energy Storage Requirement

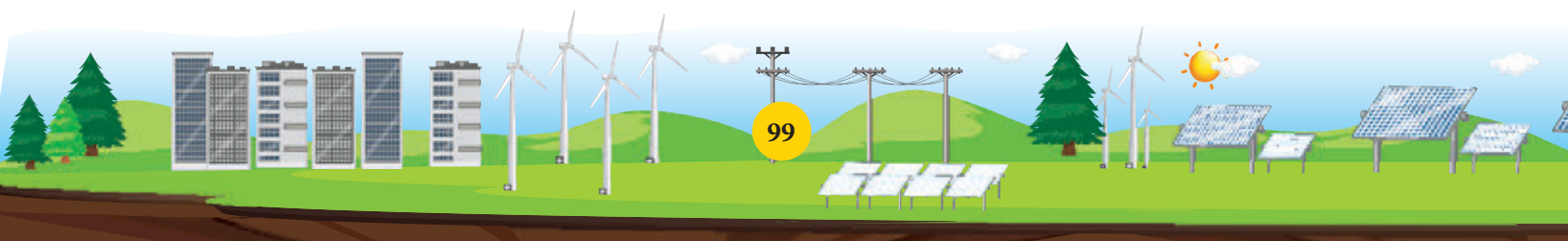
The Energy Storage requirements as per National Electricity Plan Vol.-1 and Optimal Generation Mix 2030 reports of CEA is as under:

Year/ Technology	2026-27	2029-30	2031-32	2047
BESS	8.68 GW / 34.72 GWh	41.65 GW / 208.25 GWh	47.24 GW/ 236.22 GWh	230 GW/ 1,840 GWh
PSP	7.45 GW / 47.65 GWh	18.98 GW / 128.15 GWh	26.69 GW/ 175.18 GWh	90GW/ 540 GWh
Total	**16.13 GW / 82.37 GWh**	**60.63 GW / 336.4 GWh**	**73.93 GW / 411.4 GWh**	**320 GW/ 2,380 GWh**

7.3.3 Installed/under tendering capacity

At present, around 505 MWh of BESS projects (≥1 MWh) have been installed in the country and about 75 GWh capacity is at various stages of tendering and construction.

Solar Energy Corporation of India Ltd (SECI), a CPSU under the Ministry of New and Renewable Energy (MNRE), is advancing innovative RE models by integrating solar, wind, and storage to enhance grid reliability and Capacity Utilization Factors (CUFs) through tender frameworks such as Round-the-Clock (RTC) RE, Assured Peak Supply, Standalone ESS, and Firm and Dispatchable RE (FDRE). The RE capacity awarded under such initiatives as on 30.09.2025 are as provided below:



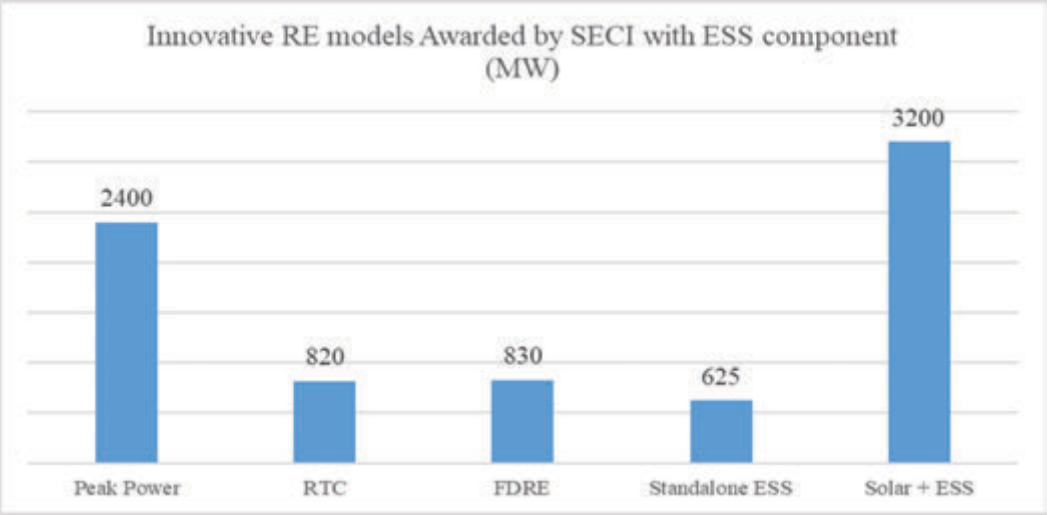


Fig. 7.16: *Further, the details of various projects operationalized and / or being implemented by SECI are as given below:*

7.3.4 In CAPEX Mode (Operational)

1. 100 MW (AC) Solar PV Power Plant (160 MWp DC capacity) along with 40 MW/120 MWh BESS at Rajanandgaon, Chhattisgarh. The project is India's largest Battery Energy Storage System (BESS) and the energy would be purchased by the state of Chhattisgarh, thus contributing to meeting the peak energy demand of the State.

Fig. 7.17: BEES Plant

Fig. 7.18: BEES Plant

2. 1.7 MWp Solar PV Power Plant with 1.4 MWh BESS in Kavaratti &Agatti Islands, Lakshadweep. The project is operational.

Fig. 7.19: BEES Plant

7.3.4.1 Under Implementation Projects

1. 25 MW Solar + BESS project in Leh, Ladakh. The project is under implementation.

7.3.5 Standalone BESS

- In March 2025, SECI issued a LoA for a standalone BESS project of 125 MW/500 MWh, with corresponding BESS. This takes SECI's cumulative awarded ESS capacity to 625 MW/1,500 MWh.

7.3.6 Key Battery Technologies

- The dominant battery technology currently being used for grid-scale storage application is based on Lithium-ion batteries technology, which have seen a significant scale-up in capacity.
- However, newer technologies such as sodium-ion batteries (SIBs) and flow batteries are garnering significant interest due to their suitability for grid scale applications. However, these technologies are under commercialization phase.

7.3.7 Trend in tariff discovered

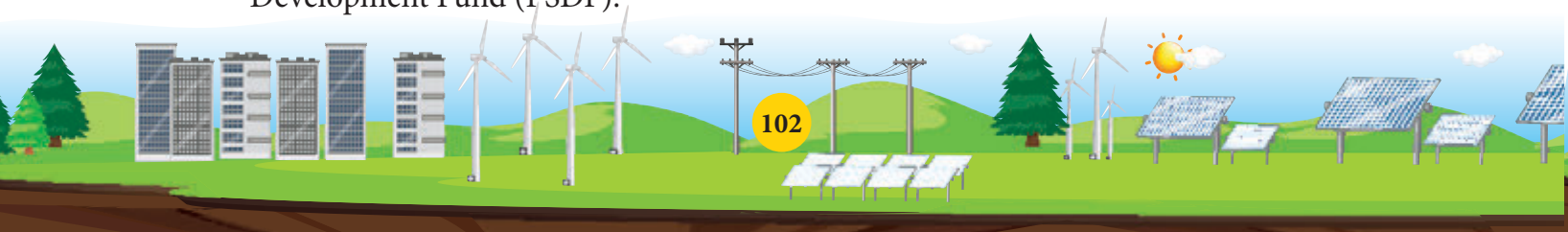
- The tariff for Solar + BESS projects has seen a gradual decline even with increasing penetration of BESS component in each project and storage duration. The tariff has come down from Rs. 6.99 / kWh in 2018 to Rs. 2.7 / kWh in 2025.
- The Standalone BESS tariffs have dropped by more than 75% in 2 years timeframe from Rs. 11.25 / kWh in 2022 to Rs. 2.54 / kWh in 2025.

7.3.8 Pump Storage Projects (PSP)

As on date, PSPs (above 25 MW) of cumulative capacity of approx. 6.7 GW has been installed in the country out of which around 5.2 GW is in operational. Further, around 12.1 GW capacity is under implementation.

7.3.9 Policies and incentives for promotion of Energy Storage Systems (ESS)

- The Government of India (GoI) is actively promoting the adoption of Battery Energy Storage Systems (BESS) across both the supply and demand sides of the power sector. Several policy measures and initiatives have been introduced to support large-scale deployment, encourage private participation, and create an enabling regulatory framework. The key policy interventions undertaken by the Government are as follows:
- Ministry of Power is having a Viability Gap Funding (VGF) scheme for development of 4000 MWh capacity of Battery Energy Storage Systems (BESS) in the country. The total outlay for this scheme is ₹9,400 crore including a budgetary support of ₹3,760 crore. Due to decline in BESS prices, the VGF support has been extended up-to 13,200 MWh BESS capacity, within the same sanctioned financial outlay.
- Ministry of Power further extended this scheme for development of an additional BESS capacity of 30,000 MWh with a total financial support of ₹5,400 crore through Power System Development Fund (PSDF).



- Ministry of Heavy Industries (MHI), in June, 2021 had come out with a Production Linked Incentive (PLI) scheme, 'National Programme on Advanced Chemistry Cell (ACC) Battery Storage' for implementation of giga-scale ACC manufacturing facilities in India, with an aim to establish a competitive domestic manufacturing ecosystem for 50 GWh with a total budgetary outlay of ₹18,100 crore. 40 GWh capacity has been allocated to bidders through Quality and Cost Based Selection (QCBS) process and remaining 10 GWh has been earmarked to Ministry of New & Renewable Energy for grid scale stationary storage applications .
- A 100% waiver on the inter-state transmission system (ISTS) charges for BESS and pumped hydro storage commissioned before 30.06.2028 (extended from original June 2025 deadline).
- Ministry of Power has also released the National Framework for Promoting Energy Storage Systems in 2023 for the development and deployment of ESS in India.
- Guidelines for Tariff Based Competitive Bidding Process for Procurement of Firm and Dispatchable Power from Grid Connected Renewable Energy Power Projects with Energy Storage System.
- Energy Storage Obligations (ESO) Target set to 4% of energy requirement by 2030, 10 states include the same in state RE policies.
- Ministry of Power in April, 2023 issued guidelines to promote development of Pump Storage Projects.
- Central Electricity Authority (CEA) has issued an Advisory on co-locating Energy Storage Systems with Solar Power Projects to enhance grid stability and cost efficiency. As per the Advisory, all Renewable Energy Implementing Agencies (REIAs) and State utilities are advised to incorporate a minimum of 2-hour co- located Energy Storage Systems (ESS), equivalent to 10% of the installed solar project capacity, in future solar tenders.
- Budgetary Support scheme for funding Enabling Infrastructure in Hydro Electric Projects, with an allocation of ₹12,461 crore to be implemented during FY 2024-25 to FY 2031-32, scheme will also be applicable to all Pumped Storage Projects (PSPs).

7.3.10 Event: World Energy Storage Day, 2025

To celebrate the World Energy Storage Day on 22.09.2025, the Ministry in association with NetZero Energy Transition Association (NETRA) as Knowledge Partner, hosted the Conference on Energy Storage – Driving the Clean Energy Transition at the Ministry premises. The high-level conference was graced by the presence of Hon'ble Minister for NRE and Hon'ble MoS for NRE and other senior officials from the Ministry. The event was attended by more than 200+ industry participants, researchers, and investors to deliberate on the role of energy storage in enabling India's clean energy transition.

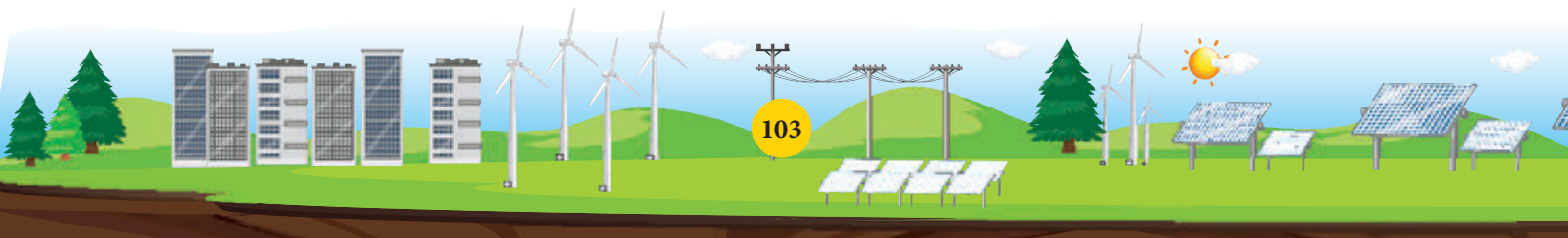


Fig. 7.20: World Energy Storage Day on 22nd September, 2025

7.4 Standards & Quality Control In Renewable Energy Sector

7.4.1 In continuation of MNRE's efforts to strengthen quality standards in the solar sector, the Ministry has notified the modified "Solar Systems, Devices, and Components Goods Order, 2025" (QCO 2025) vide Gazette Notification dated 27.01.2025 and this modified QCO become effective from 27.07.2025. This revised order supersedes erstwhile QCO, 2017 and incorporates the latest versions of Indian Standards for Solar PV Modules, Storage Batteries, and SPV Inverters. Additionally, QCO 2025 introduces further standards for the determination of efficiency of SPV Inverters. The respective Indian Standards for Solar PV Products are mentioned in table no. 7.1.

Table 7.1: Standards mentioned in QCO for SPV products

S. No.	Goods or articles	Indian Standard	Title of Indian Standard
1.	Crystalline Silicon Terrestrial Photovoltaic (PV) modules (Si wafer based)	IS 14286 (Part 1) : 2023/ IEC 61215-1 : 2021	Terrestrial Photovoltaic (PV) Modules - Design Qualification and Type Approval Part 1 Test Requirements
		IS 14286 (Part 1/Sec 1) : 2023/ IEC 61215-1-1: 2021	Terrestrial Photovoltaic (PV) Modules - Design Qualification and Type Approval: Part 1 Test Requirements: Sec 1 Special requirements for testing of crystalline silicon photovoltaic (PV) modules.
			Photovoltaic (PV) Module Safety Qualification Part 1 Requirements for Construction

		IS/IEC 61730-1 : 2016	Photovoltaic (PV) Module Safety Qualification Part 2 Requirements for Testing
		IS/IEC 61730-2 : 2016	Terrestrial Photovoltaic (PV) modules - Design qualification and type approval: Part 1 test requirements.
2.	Thin-Film Terrestrial Photovoltaic (PV) Modules [CdTe, a-Si, Cu(In,Ga)(S,Se)2]	IS 14286 (Part 1) : 2023/ IEC 61215-1 : 2021	Terrestrial Photovoltaic (PV) Modules - Design Qualification and Type Approval
		IS 14286 (Part 1/Sec 2): 2023/ IEC 61215-1-2: 2021 + Amd-1:2022	Part 1 Test Requirements Section 2 Special requirements for testing of thin-film cadmium telluride (CdTe) based photovoltaic (PV) modules
			Terrestrial Photovoltaic (PV) Modules - Design Qualification and Type Approval
		IS 14286 (Part 1/Sec 3) : 2023/ IEC 61215-1-3 : 2021 + Amd-1:2022	Part 1 Test Requirements Section 3 Special requirements for testing of thin-film amorphous silicon based photovoltaic (PV) modules
		IS 14286 (Part 1/Sec 4): 2023/ IEC 61215-1-4: 2021 + Amd-1:2022	Terrestrial Photovoltaic (PV) Modules - Design Qualification and Type Approval Part 1 Test Requirements Section 4 Special requirements for testing of thin-film Cu (In,Ga)(S,Se)2 based photovoltaic (PV) modules
		IS/IEC 61730-1: 2016	Photovoltaic (PV) Module Safety Qualification Part 1 Requirements for Construction
		IS/IEC 61730-2: 2016	Photovoltaic (PV) Module Safety Qualification Part 2 Requirements for Testing
3.	Storage Battery	IS 16270: 2023	Secondary Cells and Batteries for Solar Photovoltaic Application — General Requirements and Methods of Test
4.	Power inverters for use in photovoltaic power system	IS 16221 (Part 2): 2015/ IEC 62109-2: 2011	Safety of Power Converters for Use in Photovoltaic Power Systems Part 2 Particular Requirements for Inverters
		IS/IEC 61683: 1999	Photovoltaic systems - Power conditioners - Procedure for measuring efficiency
5.	Utility-Interconnected Photovoltaic Inverters	IS 16221 (Part 2): 2015/ IEC 62109-2: 2011	Safety of Power Converters for Use in Photovoltaic Power Systems Part 2 Particular Requirements for Inverters
		IS 16169: 2019/ IEC 62116: 2014	Test Procedure of Islanding Prevention Measures for Utility-Interconnected Photovoltaic Inverters.
		IS 17980: 2022/IEC 62891:2020	Maximum Power Point Tracking Efficiency of Grid Connected Photovoltaic Inverters

** In view of the availability of limited test facilities and providing more time for compliance, the implementation of "Solar Systems, Devices and Components Goods Order, 2025" for SPV inverters of the capacity more than 200 kW (i.e., >200kW) stands extended till 30.06.2026 or till further orders, whichever is earlier, based on self-certification,*

subject to the condition that such manufacturers have valid IEC certificates corresponding to Indian standards (IS 16221 (Part 2): 2015/ IEC 62109-2: 2011 & IS/IEC 61683: 1999 for item No. 4 and IS 16221 (Part 2): 2015/ IEC 62109-2: 2011, IS 16169: 2019/ IEC 62116: 2014 & IS 17980: 2022/IEC 62891:2020 for item No. 5), specified in the said order for these items and test reports from accredited test labs, for smooth implementation of the order.

7.4.2 BIS Registration of Products

The nos. of registration granted by Bureau of Indian Standards (BIS) for SPV Modules, SPV inverters and Storage Battery as per standards specified in MNRE Quality Control Order till 31.12.2025 is given in Table 7.2. Out of 772 nos. manufacturers who were granted registration for SPV Products, 492 Nos. are domestic manufacturers (63.73%). The MNRE has decided that only SPV Products with BIS Mark will be used in SPV Power Projects in the country. Thus, the Quality Control Order has given boost to not only quality control of SPV Products but also domestic manufacture of SPV Products with quality at international level, hence fulfilling the objective of Atmanirbhar Bharat.

Table 7.2: Registration nos. granted by BIS under MNRE Quality Control Order till 31.12.2025

S. no.	Product Name	No. of Registrations		
		Domestic	Foreign	Total
1	SPV Modules	316	156	472
2	SPV Inverters	162	124	286
3	Storage Batteries	14	0	14
	Total	**492**	**280**	**772**

7.4.3 Quality Control Order on Solar Thermal Systems, Devices and Components (Quality Control) Order, 2024

The Ministry of New and Renewable Energy also notified a Quality Control Order Solar Thermal Systems, Devices and Components (Quality Control) Order, 2024 vide gazette notification dated 8th October 2024. It came into force on the expiry of one hundred and eighty days from the date of its publication in the Official Gazette (i.e., 06.04.2025). The respective Indian Standards for Solar Water Heaters are mentioned in table no. 7.3:

Table 7.3: Standards mentioned in QCO for Solar Thermal Systems, Devices and Components (Quality Control) Order, 2024

S. No.	Goods or articles	Indian Standard	Title of Indian Standard
(1)	(2)	(3)	(4)
1.	Solar Flat Plate Collector for Solar Water Heating Systems	IS 12933 (Part 1): 2003	Solar Flat Plate Collector - Specification Part 1 Requirements
		IS 12933 (Part 2): 2003	Solar Flat Plate Collector- Specification Part 2 Components

2.	All Glass Evacuated Tubes Solar Water Heating System	IS 16544: 2016	All Glass Evacuated Tubes Solar Water Heating System
3.	Storage Water Tank for All Glass Evacuated Tubes Solar Water Heating Systems	IS 16542: 2016	Direct Insertion Type Storage Water Tank for All Glass Evacuated Tubes Solar Collector-Specification

7.5 Circular Economy

7.5.1 India has emerged as a global leader in promoting the circular economy and sustainable development. Initiatives like Mission LiFE, launched at COP26, encourage mindful resource use and environmental preservation. In 2021, NITI Aayog formed 11 inter-ministerial committees to drive the transition from a linear to a circular economy—focusing notably on the solar industry and lithium-ion batteries. Their action plans prioritise research, development, and demonstration (RD&D) of strategies such as designing, manufacturing, reuse, refurbishing, and recycling to enhance resource efficiency. Under India's G20 Presidency, the Resource Efficiency Circular Economy Industry Coalition (RECEIC) was launched, reaffirming commitments to reduce waste generation and promote zero-waste initiatives. Achieving these goals, however, depends on advancing technological and process innovations across the value chain.

7.5.2 To encourage research, development, and demonstration (RD&D) in the circular economy, the Ministry launched a "Call for Proposals on Innovation Challenge for Circularity in Renewable Energy Technologies – Batteries and Solar Photovoltaic" on 23.06.2025. The announcement was published on the MNRE R&D portal, with the deadline for proposal submission set for 1st August 2025.

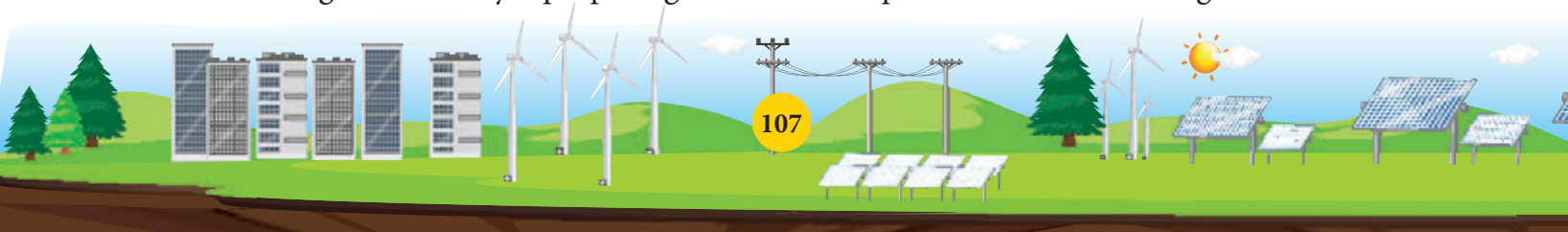
7.5.3 Participation:

7.5.3.1 A total of 202 proposals were received under the following three themes as envisaged in the "Call for Proposals":

i. **Theme 1:** Design and manufacturing innovations.
ii. **Theme 2:** Second-life use and recycling innovations.
iii. **Theme 3:** Operational management innovations.

7.5.3.2 Proposals were received from several academic, research institutions and start-ups across the country. Leading institutes such as IIT Bombay, IIT Delhi, IIT Hyderabad, IIT Roorkee, IIT Patna, IIT Kharagpur, and various NITs submitted innovative project proposals on circularity aligned with the specified themes in the areas of batteries and solar photovoltaics.

7.5.3.3 Several start-ups and private companies working in solar and battery technologies participated with scalable and commercially viable innovations submitted proposals focused on reverse logistics, battery repurposing, and AI-based performance monitoring.



7.6 PM Gati Shakti - National Master Plan (PMGS-NMP)

7.6.1 The PM Gati Shakti National Master Plan (PMGS-NMP) was launched by the Hon'ble Prime Minister in Oct 2021. This Ministry has been identified as one of the Ministries whose projects are to be uploaded on the NMP portal. This is a digital platform for integrated and coordinated infrastructure planning across ministries. It aims to provide seamless multi-modal connectivity for the movement of people, goods, and services, making Indian businesses more competitive.

7.6.2 Progress / Status:

- A Gati shakti cell has been created in the Ministry for all the works related PM Gati Shakti.
- Standard Operating Procedure (SOP) of MNRE finalized & Shared with DPIIT and Bhaskaracharya Institute for Space Applications and Geoinformatics (BISAG-N) for mapping of projects in PM Gati Shakti (National Master Plan) NMP.
- RE-Projects of capacity 50 MW or more being mapped on Gati shakti Portal.
- The Solar and Wind potential already mapped into the PM Gati Shakti portal. Data of projects from REIAs and NIWE of around 84 GW also obtained. 64 GW data mapped on PM Gati shakti Portal and balance data mapping activity is in progress
- A portal for Solar, Wind and Hybrid Projects developed by MNRE, to send data from developers to the NMP portal through an Application Programing Interface (API) integration.
- MNRE Portal has been updated and live. Portal can be accessed through the link: https://gatishakti.mnre.gov.in/home.
- Login credential and User manual have been shared with REIA's for mapping activity on MNRE Portal, a meeting with REIA has been scheduled for training on portal.
- The 13 GW Transmission Project from Ladakh under GEC has been approved by Network Planning Group (NPG) & subsequently by the Union Cabinet, which is also mapped in the portal.

7.6.3 State Resource Adequacy Planning

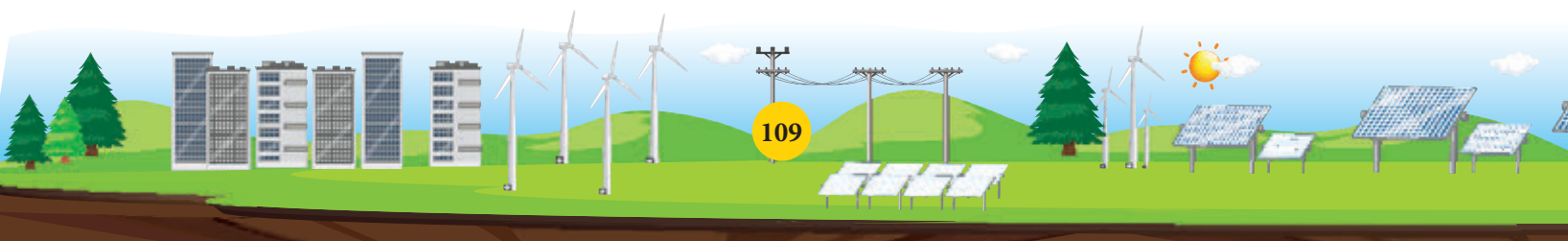
7.6.3.1 In exercise of the powers conferred under Rule 16 of the Electricity (Amendment) Rules, 2022, the Ministry of Power, Government of India, in consultation with the Central Electricity Authority (CEA), has issued the Guidelines for Resource Adequacy for the Indian Electricity Sector. These guidelines are to be complied with by all relevant institutions and stakeholders, as specified therein.

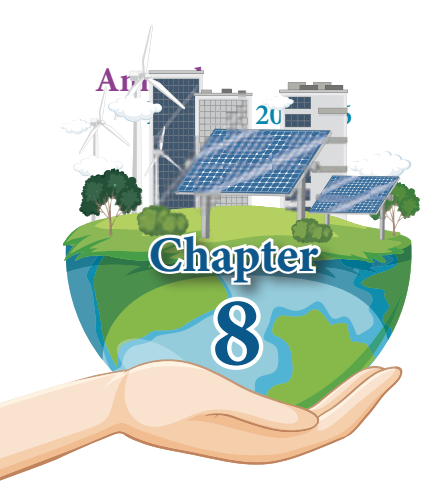
7.6.3.2 Further, the Ministry of Power has issued the Guidelines for the Resource Adequacy Planning (RAP) Framework for India in June 2023. In parallel, the Forum of Regulators (FoR) has

also issued Model Regulations for the Resource Adequacy Framework in June 2023. The objective of the RAP Framework is to ensure the availability of adequate generation capacity in line with the pace of demand growth, thereby preventing electricity shortages that could potentially impede the economic growth of the country.

7.6.3.3 The State Resource Adequacy Planning (SRAP) process facilitates that each State and Union Territory (UT) possesses sufficient energy resources to meet future electricity demand in a reliable and sustainable manner. This strategic and comprehensive planning process encompasses all 28 States and 08 UTs, and supports long-term planning for generation, transmission, and distribution infrastructure thereby enhancing energy security, grid reliability, and sustainable power sector development across the nation.

7.6.3.4 As of date, out of the 28 States, State Electricity Regulatory Commissions (SERCs) of 15 states and 07 UTs have notified their State Resource Adequacy Frameworks Regulations while 04 have issued draft notifications. Timely planning and monitoring of the SRAP is also important to achieve the targeted renewable energy capacity edition in the country. Therefore, MNRE is following up with the states and the state regulators for preparation, approval and monitoring of the SRAP.





Special Focus On North-East

8.1 Introduction

Special attention is being given to the development of renewable energy in the entire North Eastern Region (NER) through a separate budgetary allocation of 10% under various renewable energy programme.

The estimated potential of Renewable Energy in the NER, is about 113341.42 MW, out of which only about 5446.02 MW capacity has been harnessed cumulatively till 31.12.2025 as given in Table 8.1.

Table 8.1: Renewable Energy Potential and Capacity Installed in NER (31.12.2025)

(Capacity in MW)

	Solar	Wind Power	Small Hydro Power	Bio-Energy	Large Hydro	Total
Potential	46772.15	760	3261.49	567.08	61980.7	113341.42
Installed	490.76	0	384.46	15.8	4555	5446.02

Table 8.2: State Wise Renewable Energy Potential in NER

(Potential in MW)

Sl. No.	STATES / UTs	Solar	Wind Power @150m	Small Hydro Power	Bio-Energy	Large Hydro	Total including Large Hydro
1	Arunachal Pradesh	467.52	246	2064.92	18.46	50394	53190.9
2	Assam	19173.13	459	201.99	321.89	643	20799.01
3	Manipur	2293.92	0	99.95	62.31	615	3071.18
4	Meghalaya	14674.1	55	230.05	68.54	2026	17053.69
5	Mizoram	612.21	0	168.9	2.90	1926.7	2710.71
6	Nagaland	190.96	0	182.18	53.90	325	752.04
7	Sikkim	254.46	0	266.64	4.73	6051	6576.83
8	Tripura	9105.85	0	46.86	34.35	0	9187.06
	Total	**46772.15**	**760**	**3261.49**	**567.08**	**61980.7**	**113341.42**

The State Wise detail of Renewable Energy Capacity installed as on 31.12.2025, in the NER is given in Table 8.3.

Table 8.3: State Wise Renewable Power capacity Installed in NER as on 31.12.2025

(MW)

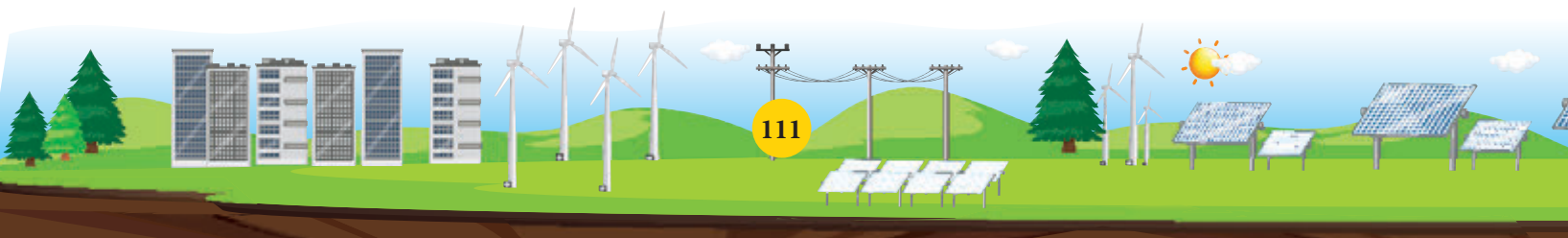
		Small Hydro Power	Bio Power	Solar Power	Large Hydro	Total RE Capacity
1.	Arunachal Pradesh	140.61	0	15.44	1365.00	1521.05
2.	Assam	34.11	2	375.91	346	758.02
3.	Manipur	5.45	0	17.52	105	127.97
4.	Meghalaya	55.03	13.80	4.28	322	395.11
5.	Mizoram	45.47	0	31.69	60.00	137.16
6.	Nagaland	32.67	0	3.34	75	111.01
7.	Sikkim	55.11	0	7.56	2282	2344.67
8.	Tripura	16.01	0	35.02	0	51.03
	Total (MW)	**384.46**	**15.8**	**490.76**	**4555**	**5446.02**

8.2 Small Hydro Programme

NE States have fairly good potential to develop small Hydro-power projects. Among the NE States, Arunachal Pradesh has the highest potential followed by Sikkim, Meghalaya and Assam. MNRE has been giving special emphasis to the development of small hydro projects in the NER. Small hydropower projects can provide energy almost uninterrupted without any major maintenance or dependence on weather. Small Hydro Power projects can generate sufficient electricity to power domestic households, schools and clinics in rural areas and trigger entrepreneurship activities. The details are given in Table 8.4.

Table 8.4: State-wise Small Hydro Potential and total installed in the NER States as on 31.12.2025

		Total Potential (MW)	Total Installed capacity (MW)
1.	Arunachal Pradesh	2064.92	140.61
2.	Assam	201.99	34.11
3.	Manipur	99.95	5.45
4.	Meghalaya	230.05	55.03
5.	Mizoram	168.9	45.47
6.	Nagaland	182.18	32.67
7.	Sikkim	266.64	55.11
8.	Tripura	46.86	16.01
	Total (MW)	**3261.49**	**384.46**



8.3 PM Kusum Scheme

PM KUSUM (Pradhan Mantri Kisan Urja Suraksha Evam Utthaan Mahabiyan) scheme to promote small Grid-Connected Solar or Other Renewable Energy Power Plants, installation of stand-alone solar-powered agricultural pumps and solarization of existing grid-connected agricultural pumps including feeder-level solarization (FLS).

For the North East Region States, Jammu & Kashmir, Ladakh, Himachal Pradesh, Uttarakhand, Lakshadweep and A&N Islands, the CFA is provided as follows: -

i. Under Component A, Performance Based Incentives (PBI) @0.40 per unit purchased or Rs. 6.6 lakh per MW of capacity installed, whichever is less, for a period of five years will be provided to DISCOMs.

ii. For all the individual farmers installing/solarizing the agriculture pumps up to 7.5HP capacity under both the Component-B and Component-C, will be provided with Central Financial Assistance (CFA) of 50% of the benchmark cost or the tender cost, whichever is lower. Further, the CFA will be available for pump capacity up to 15HP, however, it will be restricted to 10% of total installations in the state. The State Government will provide a subsidy of at least 30% and the remaining up to 20% is to be provided by bank loan/farmer.

iii. Moreover, components- 'B' and 'C' can also be implemented without State share of 30%. The CFA will continue to remain at 50% and the rest 50% will be borne by the beneficiary farmer.

iv. Under component-C (FLS), the CFA is calculated considering the cost of the solar power plant as Rs. 3.5 Crore/MW. Therefore, the CFA of Rs. 1.75 Crore/MW will be provided to States.

Table 8.5: Status of installation under PM KUSUM Scheme in the NER as on 31.12.2025

S. No.	State Name	Component-A (MW)		Component-B (Nos)		Component-C (Nos) (Individual Pump Solarization)	
		Sanctioned	Installed	Sanctioned	Installed	Sanctioned	Installed
1.	Arunachal Pradesh	0	0	700	682	0	0
2.	Assam	2	0	4000	151	0	0
3.	Manipur	0	0	450	150	0	0
4.	Meghalaya	0	0	2735	98	0	0
5.	Mizoram	0	0	1700	40	0	0
6.	Nagaland	0	0	265	149	0	0
7.	Tripura	5	0	11114	6810	3600	788
	Total	**7**	**0**	**20964**	**8080**	**3600**	**788**

8.4 Solar Parks

Ministry is implementing a Scheme for "Development of Solar Parks and Ultra Mega Solar Power Projects" with an objective to set up at least 50 nos of Solar Parks with an aggregate capacity of 40000 MW of solar power projects. All the States and Union Territories are eligible for getting benefit under the scheme.

Under the Scheme, Ministry have approved 55nos of Solar Parks in 13 States including one Solar Park of capacity 20MW in Vankal, Champhai District, Mizoram. The Solar Park at Vankal in Mizoram has been successfully commissioned.

8.5 PM-Surya Ghar: Muft Bijli Yojana

The PM Surya Ghar: Muft Bijli Yojana (PMSG:MBY) has been launched with an aim to increase the share of solar rooftop capacity in the country and empower residential households to generate their own electricity. The scheme targets to achieve rooftop solar installations for one crore households in residential sector by FY 2026-27 with an outlay of Rs 75,021 crore. The Scheme provides 10% higher CFA for NER States as compared to the other general category States. The CFA is capped at 3KW and details are given at Table 8.6:

Table 8.6: CFA to Residential Consumers of NER

Sr. No.	Type of Residential Segment	CFA (NER States)
1.	Residential Sector (first 2 kWp)	Rs 33000/kWp
2.	Residential Sector (additional 1 kWp)	Rs 19800/kWp
3.	Residential Sector (above 3 kWp)	No additional CFA
4.	GHS/RWA etc, for common facilities for up to 500 kWp (@3 kWp per house)	Rs 19800/kWp

Moreover, following three North East States have announced additional State subsidies apart from CFA as given at Table 8.7:

Table 8.7: Additional Subsidy by NER states under PMSG:MBY

State	Additional Subsidy by State
Assam	Rs. 15,000/kW up to 3kW; capped at Rs. 45,000
Mizoram	Within AMC Area: Rs 12,000/kW, up to 100 KM: Rs 14,000/kW, up to 200 KM: Rs 16,000/kW, Beyond 200 KM, Rs 18,000/KW. Subsidy up to 10 kW for all cases.
Nagaland	Rs 50000/- upto 3 KW

The progress in the NER states under PMSG:MBY as on 31.12.2025 is given in Table 8.8.

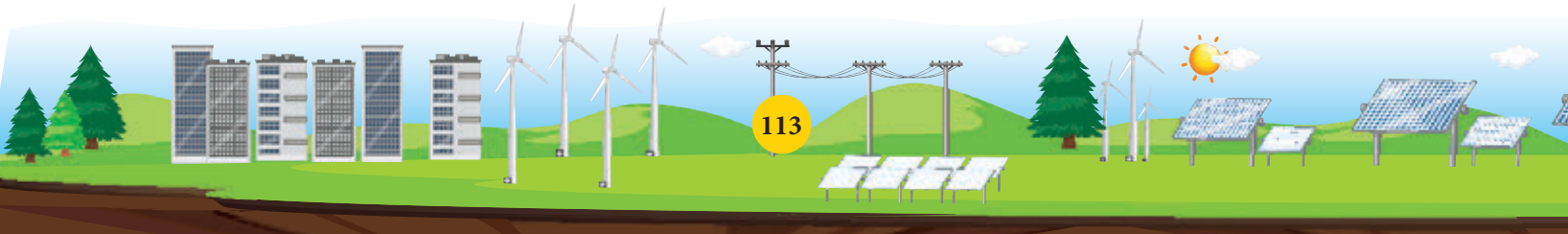


Table 8.8: Progress in the NER states under PMSG:MBY

State	State Target	Application	Households Benefitted	Subsidy Released (in Cr.)	Active Vendor (Nos.)
Arunachal Pradesh	9,970	88	1	0.01	1
Assam	2,18,000	4,76,703	72,604	494.28	1015
Manipur	25,000	1,434	711	5.66	16
Meghalaya	833	1,929	34	0.17	4
Mizoram	13,000	940	775	5.97	12
Nagaland	10,938	549	132	1.03	9
Sikkim	25,000	261	26	0.13	3
Tripura	3,667	7,704	1,859	12.72	33
Total	**3,06,408**	**4,89,608**	**76,142**	**520**	**1,093**

8.6 New Solar Power Scheme (for Tribal and PVTG Habitations/Villages) under PM JANMAN

MNRE initially issued approval for New Solar Power Scheme (for Tribal and PVTG Habitations/ Villages) under PM JANMAN on 04.01.2024, which was later revised on 18.10.2024 to also include other tribal habitations/villages and renamed as New Solar Power Scheme (for Tribal and PVTG Habitations/Villages) under Pradhan Mantri Janjati Adivasi Nyaya Maha Abhiyan (PM JANMAN) and Dharti Aabha Janjatiya Gram Utkarsh Abhiyan (DA JGUA).

The Scheme will cover electrification of One Lakh un-electrified households (HHs) in Tribal and PVTG areas identified by Ministry of Tribal Affairs (MoTA) by provision of off-grid solar systems. The scheme includes a provision for providing off-grid solar lighting in 1500 Multi-Purpose Centres (MPCs) in PVTG areas as approved under PM JANMAN. Similarly, the scheme also includes provision for solarization of 2000 public institutions through off-grid solar systems as approved under DA JGUA. The off-grid solar systems shall be provided only where electricity supply through grid is not techno-economically feasible.

As on 31.12.2025, the details of sanctioned and electrified households/ Public Institutions are as under:

S. No.	State	Scheme Component	HH/Public Institutions (PIs)	HHs/PIs Sanctioned in number	HHs reported Electrified as on 31.12.2025
1	Tripura	PM JANMAN	Households	1703	1460
2	Manipur	DA JGUA	Households	100	65
3	Arunachal Pradesh	DA JGUA	Households	3999	46
4	Assam	DA JGUA	Public Institutions	8	-

8.7 Biogas Programme

MNRE has been implementing the Biogas Programme during FY 2021-22 to FY 2025-26, under the Phase-I of National Bioenergy Programme, in the country including North East Region (NER) States for providing clean gaseous fuel mainly for cooking, lighting, decentralised power generation, including production of by products in the form of organic manure for households and dairy, poultry sector, agro/food-based industries, through the Programme Implementing Agencies (PIAs) under the Biogas Programme. Moreover, under the Biogas Programme, 20% of additional CFA over and above the standard CFA, is applicable for all the biogas plants installed in NER.

A Biogas Development and Training Centre for providing training and technical support under the Biogas Programme for all the NER States is functional at Department of Mechanical Engineering, Indian Institute of Technology, Guwahati, Assam.

8.8 Capacity Building & Skill Development in NER

(A) Human Resource Development (HRD) Programme

HRD Programme of MNRE aims to institutionalize renewable energy education and training to meet the requirement of qualified and trained manpower in the country. HRD Programme supports trainings for manpower including promoting higher studies and research courses by providing Fellowships to students and research scholars in R&D and academic institutions in Renewable Energy. Ministry also provides Support to educational and other training organizations for conducting short-term trainings on various aspects of Renewable Energy with focus on skill development at all levels. Under short-term training programmes of HRD scheme, Ministry is implementing Skill Development Programmes namely Solar PV Technician (Suryamitra), Solar Water Pumping Technician (Varunmitra), Wind Power Plant Technician (Vayumitra) and Small Hydro Power Plant Technician (Jalurjamitra) through NISE, NIWE and IIT Roorkee to train workforce for installation, commissioning, operation and maintenance of renewable energy projects.

The Ministry is creating skilled manpower in various technologies of Renewable Energy in NER. Under the Suryamitra Programme, initiated in 2015, a total of 2398 Suryamitras were trained, under Varunmitra programme, 71 Varunmitras were trained and 59 Jalurjamitras were trained under Jalurjamitra programme launched in March, 2022 in NER. The State-wise progress of trained manpower in NER under these Programmes are given in Table 8.9.

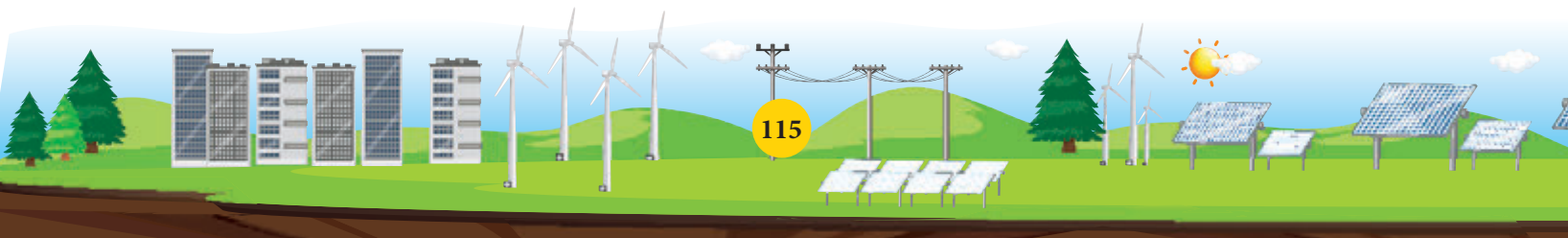


Table 8.9: State-wise progress of trained manpower in NER under HRD Programme as on 31.12.2025

SI. No.	State	Manpower trained		
		Suryamitras	Jalurjamitras	Varunmitras
1	Arunachal Pradesh	150	59	-
2	Assam	1710	-	71
3	Manipur	150	-	-
4	Meghalaya	60	-	-
5	Mizoram	0	-	-
6	Nagaland	60	-	-
7	Sikkim	30	-	-
8	Tripura	238	-	-
	Total	2398	59	71
	Grand Total	**2528**		

(B) Capacity building & skill Development under PM Surya Ghar Muft Bijli Yojana (PMSGMBY)

Ministry is aiming to create more than three (3) lakh skilled manpower through skilling, upskilling under PMSGMBY. Trainings for the Technicians/ Electricians/ Installers/ Engineers/ supervisors / vendors / DISCOM officials / trainers are undergoing for installation/design/O&M for solar roof top systems. A total of 6800 no. of candidates were trained under Capacity building component of PM Surya Ghar Muft Bijli Yojana.

Table 8.10: State-wise progress of trained manpower in NER under PMSGMBY as on 31.12.2025

SI. No.	State	No. of Manpower trained			
		Solar Technicians/ Installers	Solar PV helper	Vendors	DISCOM officials
1	Arunachal Pradesh	20	0	0	0
2	Assam	970	1118	1154	1000
3	Manipur	45	0	426	116
4	Meghalaya	88	0	0	149
5	Mizoram	20	0	0	154
6	Nagaland	20	0	0	96
7	Sikkim	85	0	0	233
8	Tripura	540	0	0	566
	Total	1788	1118	1580	2314
	Grand Total	**6800**			

MNRE'S Growth Pillars: Allied Institutes

9.1 National Institute Of Solar Energy (NISE)

9.1.1 National Institute of Solar Energy (NISE) is an autonomous specialized institute of Ministry of New and Renewable Energy (MNRE), Government of India, mandated for research and development, solar component testing, capacity building, and development of solar products and applications. The technical support of NISE complements the requirements of MNRE to become a self-reliable renewable power producing nation. During FY 2025–26, NISE continued to support the Ministry in implementing key national initiatives, including Approved List of Models & Manufacturer (ALMM) of Module and Cell, Production Linked Incentive (PLI) scheme, Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan Yojana (PM KUSUM), PM Surya Ghar initiative, and Suryamitra, Varunmitra Skill Development Programs and schemes under the National Green Hydrogen Mission (NGHM).

9.1.2 NISE serves as a premier research and testing institution dedicated to advancing solar energy and allied technologies in India. To support its mission, NISE has developed a comprehensive infrastructure featuring state-of-the-art laboratories equipped with advanced testing and characterization tools. These facilities enable cutting-edge research in photovoltaic cells and modules, solar thermal systems, battery storage, power electronics, and green hydrogen applications.

9.1.3 Research, Development and Demonstration

During the year, NISE has taken up Research, Development and Demonstration (RD&D) activities in various solar energy technologies through in-house, externally funded, and collaborative projects. These projects are identified in line with the mandate of NISE and have current relevance in catering to the changing needs of the energy sector. Key research outcomes from various projects undertaken by NISE during the year are detailed below:

9.1.3.1 Solar Potential Map of India 2025 (Ground Mounted)

Under the aegis of Seva Parv (17th – 22nd October 2025), the MNRE marked a significant institutional milestone with the formal release of the report titled "Solar PV Potential Assessment of India (Ground-Mounted)" on 23.09.2025 at New Delhi. The report was released by the Hon'ble

Union Minister for New and Renewable Energy, Shri Pralhad Venkatesh Joshi, in the presence of senior officials of the Ministry. The study has been undertaken by NISE and represents the most comprehensive and updated scientific assessment of India's ground-mounted solar photovoltaic potential.

Fig. 9.1: Release of the Solar Potential Map of India 2025 (Ground Mounted)

India is endowed with abundant solar resources, with average solar irradiance ranging from 3.5 to 5.5 kWh/m²/day across large parts of the country. Recognizing this potential, NISE has undertaken a spatially resolved and methodologically advanced assessment of ground-mounted solar PV potential. The present study substantially builds upon the earlier 2014 assessment, which estimated a potential of 749 GWp, by adopting high-resolution geospatial analysis, satellite-derived solar datasets, refined land-use and land-cover classifications, terrain and slope filters, and realistic technical design assumptions. The assessment integrates key infrastructure and engineering considerations, including inter-row spacing, shading losses, proximity to road networks, and availability of transmission substations, thereby ensuring that the estimated potential is technically feasible and implementation oriented. Such an approach enables the translation of theoretical resource availability into practical, deployable capacity.

Based on this comprehensive methodology, the report estimates a feasible ground-mounted solar PV potential of approximately 3343 GWp, utilizing only about 6.69% of the identified feasible wasteland area. While high potential continues to be observed in the desert regions of Rajasthan and Gujarat, the assessment highlights that a wide range of other states also exhibit significant potential owing to favorable solar geometry, improved land-use efficiency, and enhanced system design parameters. Importantly, the potential is well distributed across the country, reinforcing the scope for geographically balanced solar development. The findings of the report provide a policy-aligned and investment-ready framework to support national and state-level solar planning, transmission and infrastructure development, and enhanced private sector participation.

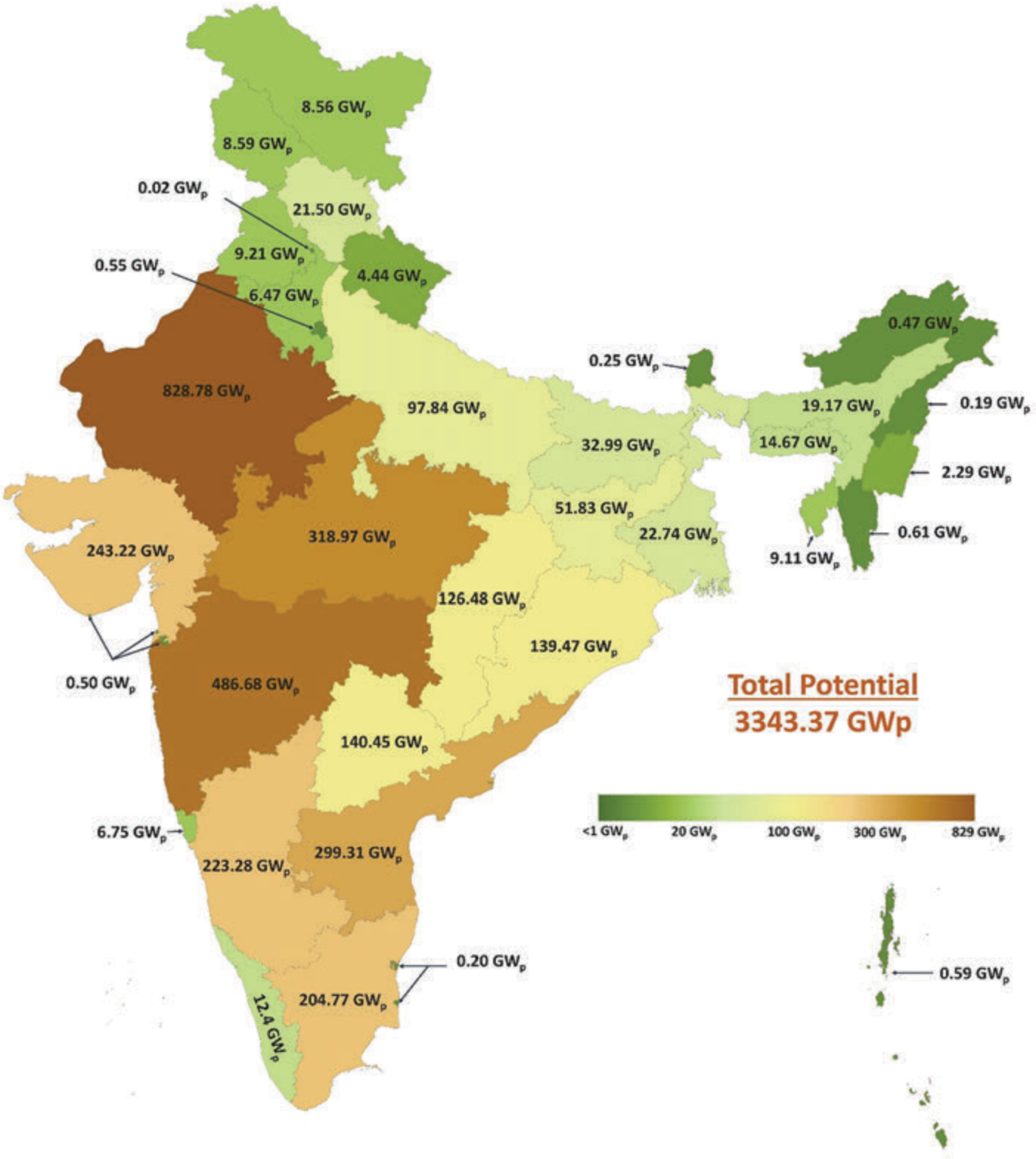


Fig. 9.2: Solar Potential Map of India 2025 (Ground Mounted) assessed by NISE