

CHAPTER 6

BIO-ENERGY, SMALL HYDRO AND WASTE TO ENERGY

- 6.1** 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.

6.2 ACHIEVEMENTS UNDER THE BIOGAS PROGRAMME

The State-wise installed number of biogas plants during the last 10 years (2014-15 to 2024-25, as on 31.12.2024) 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	38977
2.	Arunachal Pradesh	349
3.	Assam	31302
4.	Bihar	370
5.	Chhattisgarh	13646
6.	Goa	152
7.	Gujarat	8543
8.	Haryana	4762
9.	Himachal Pradesh	444
10.	Jammu & Kashmir	129
11.	Jharkhand	610

Sl No	Name of the State	Number of small biogas plants
12.	Karnataka	45576
13.	Kerala	13240
14.	Madhya Pradesh	38538
15.	Maharashtra	89134
16.	Meghalaya	1117
17.	Mizoram	898
18.	Nagaland	352
19.	Odisha	10145
20.	Punjab	26745
21.	Rajasthan	3842
22.	Sikkim	309
23.	Tamil Nadu	2435
24.	Telangana	19794
25.	Tripura	466
26.	Uttar Pradesh	4011
27.	Uttarakhand	9326
28.	West Bengal	914
29.	Others (KVIC, Mumbai)	3918
30.	Delhi	15
	TOTAL	370059

6.3 STATUS OF IMPLEMENTATION OF THE BIOGAS PROGRAMME

During current financial year annual target is setting up 25,000 small biogas plants in the States/UTs. Based on performances of UTs/States and BDTCs the targets have been revised in February keeping overall 25000 nos.

Medium sized biogas plants (above 25-2500 cubic meter/day capacity) have good potential for off-grid and decentralized energy with management of waste. The sectors covered are mostly poultry, horse shelters, Gaushala, Dairy etc. So far 361 nos of medium size biogas plants have been set up with CFA support from MNRE with a total capacity of about 11.50 MW in the country while during current year 11 plants set up of 1.60 MW capacity with support from MNRE.

A workshop on “Biogas Technology: Promoting Transition Towards Clean Cooking in Uttar Pradesh” organized by the Directorate of Environment, Government of Uttar Pradesh, in collaboration with the Ministry of New and Renewable Energy (MNRE) on 24th May, 2024, in Lucknow at the Directorate of Environment. The event addressed the challenges faced by the cooking sector in India and the exploration of innovative solutions for proliferating biogas technology for cooking purposes in rural areas.

The workshop brought together experts, policymakers, financiers, distributors, and other stakeholders concerning clean cooking to discuss and deliberate on crucial aspects of clean cooking adoption through biogas technology in Uttar Pradesh.

In August 2024, a regional workshop on ‘Bio-Energy: Potential & Challenges’ was organized for farmers in collaboration with the National Dairy Development Board (NDDB), Anand, and Vasantrao Naik

Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra. Besides the research community, several biogas plant beneficiaries attended and shared their experiences on using biogas as a cooking fuel.

During the month of October, 2024, a national review meeting under the Chairmanship of Adviser, MNRE was organized to highlight the salient features and implementation mechanism of Biogas programme. For ease of application, centralized management of biogas beneficiaries' requests, monitoring of installation, and maintenance on installed biogas plants etc. The Ministry has updated the national biogas web-portal (www.biogas.mnre.gov.in).

6.4 SUBSIDY AND OTHER CENTRAL FINANCIAL ASSISTANCE UNDER BIOGAS PROGRAMME

6.4.1 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 kW 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.

6.4.2 Biogas Success stories : Impact of MNRE's Biogas Programme on Women Empowerment

Implementation of biogas plants not only addresses energy access challenges but also promotes gender equality, health, environmental sustainability, and economic development in communities. Women are contributing to environmental sustainability by converting waste into a valuable energy resource while mitigating climate change and reducing their carbon footprint. Women's involvement in these activities can contribute to overall rural development and poverty alleviation.

Every biogas plant installed in a rural household foretells a success story. Take, for instance, Smt. Uma Devi, Smt. Daisy Boral, Smt. Ratna Adhikari, and many others like her hailing from the Panchayat of Gova, Ward No. 2, Village of Bamungaon, P.O. Amlighat, Block Mayong, Dist. Morigaon, State of Assam. All these women rear cattle and have been supplying milk to Sitajakhala Dugdha Utpadak Samabai Samity Ltd., a cooperative in Jagiroad, Assam. They also happen to be the beneficiaries of MNRE's Biogas Program. Though skeptical at first, their happiness knew no bounds when they witnessed how the cattle dung, which they used to throw away as waste, could be used as fuel for cooking. Now they were able to save money on LPG cylinders, and those who used firewood were happy that biogas use saved them time and money. Smokeless cooking was a boon to them. The slurry produced is collected and utilized by an organic farmer belonging to the same community.

6.5 BIOMASS POWER

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 with an aim to sustainably manage crop residue.

6.5.1 Biomass Potential available in the country

The potential for power generation from about 228 MMT surplus agricultural residue is estimated at about 28446 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 13866 MW. Thus, the total estimated potential for biomass power is about 42312 MW.

6.5.2 Programme for promoting installation of Biomass based projects

The Ministry has notified Biomass Programme on 2nd November, 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)

6.5.3 Achievements

More than 800 Nos. of Biomass IPP and Bagasse/non bagasse cogeneration-based power plants with aggregate capacity of 10728.207 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 2024. This includes 7935.31 MW from Bagasse Cogeneration Sector, 1871.11 MW from



Biomass IPP Sector and 921.787 MW from biomass (non-bagasse) co-generation sector.



Fig.4.8: Aarti Distilleries, Non-bagasse Cogeneration Project

6.6 SMALL HYDRO POWER

6.6.1 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

6.6.2 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 5100.55 MW been achieved as on 31st December, 2024 through 1192 Small Hydro Power projects. In addition, 90 projects of 439.80 MW are at various stages of implementation. Table 6.2 provides state-wise details of identified potential, projects completed and those under execution.

Table 6.2: State wise list of potential sites, installed projects and on-going projects in SHP sector (as on 31.12.2024)

Sl. No.	State	Total Potential		Projects Installed						Projects under Implementation	
		Nos.	Total Capacity (MW)	Upto 2023-24		2024-25		Total		Nos.	Capacity (MW)
				Nos.	Capacity (MW)	Nos.	Capacity (MW)	Nos.	Capacity (MW)		
1	Andhra Pradesh	359	409.32	45	163.31	0	0	45	163.31	1	1.20
2	Arunachal Pradesh	800	2064.92	157	133.11	1	7.50	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	0	0	10	76	0	0
6	Goa	7	4.7	1	0.05	0	0	1	0.05	0	0
7	Gujarat	292	201.97	22	91.64	1	15.00	23	106.64	1	6.66
8	Haryana	33	107.4	9	73.5	0	0	9	73.5	0	0
9	Himachal Pradesh	1049	3460.34	202	969.71	2	31.00	204	1000.71	43	220.84
10	UT of Jammu & Kashmir	103	1311.79	24	169.93	2	20.00	26	189.93	4	24.65
11	UT of Laddakh	199	395.65	31	42.99	3	2.80	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	170	1280.73	1	4.00	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	73	382.28	1	2.00	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	0	0	13	115.63	3	56.5
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

Sl. No.	State	Total Potential		Projects Installed						Projects under Implementation	
		Nos.	Total Capacity (MW)	Upto 2023-24		2024-25		Total		Nos.	Capacity (MW)
				Nos.	Capacity (MW)	Nos.	Capacity (MW)	Nos.	Capacity (MW)		
25	Tamil Nadu	191	604.46	21	123.05	0	0	21	123.05	0	0
26	Telangana	94	102.25	30	90.87	0	0	30	90.87	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	0	0	10	49.1	1	1.5
30	Uttarakhand	442	1664.31	103	218.82	1	15.00	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	1180	5003.25	12	97.30	1192	5100.55	90	439.80

6.6.3 For the year 2024-25, a target of commissioning of 100 MW small hydro projects was set. Further, during the period of 01.01.2024 to 31.12.2024, 16 projects of aggregate capacity of 113.80 MW have been synchronized to the grid (Table 6.3).

6.6.4 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 06 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 6.3: List of SHP projects commissioned during the period of 01.01.2024 to 31.12.2024

S No	Name of Project	Capacity (MW)	Agency/State	Date of Commissioning
1	Raru, UT of Ladakh	2.00	Kargil Renewable Energy Development Agency (KREDA), UT of Laddakh	Jan-24
2	Peruvannamuzhy, Kerala	6.00	Kerala State Electricity Board	Jan-24
3	Lashpathri-I, UT of Jammu & Kashmir	8.50	M/s Mass N-Ergy Pvt. Ltd., UT of J&K	Mar-24
4	Jambre SHP, Mahatrashttra	2.00	M/s Sanjay B. Patil Pvt. Ltd., Maharashtra	Apr-24
5	Mandi SHP, Jammu & Kashmir	15.00	M/s Magpie Hydel Construction/ Operation Industries Pvt. Ltd., J&K	Jul-24

S No	Name of Project	Capacity (MW)	Agency/State	Date of Commissioning
6	Mavar-Wayil SHP, Jammu & Kashmir	5.00	M/s O2Z Trading Pvt. Ltd., Jammu & Kashmir	Jul-24
7	Khangtang SHP, Arunachal Pradesh	7.50	M/s Panyor Hydro Power Pvt. Ltd.	Jul-24
8	Varun SHP, Karnataka	4.00	M/s ADD Energy Management Co. Pvt. Ltd., Karnataka	Jul-24
9	Madhyamaheshwar SHP, Uttarakhand	10.00	UJVN Ltd., Uttarakhand (2 out of 3 units)	Aug-24
10	Selti-Masrang SHP, Himachal Pradesh	24.00	M/s Ramesh Hydro Power Pvt. Ltd.	Aug-24
11	Madhyamaheshwar SHP, Uttarakhand	5.00	UJVN Ltd., Uttarakhand (1 out of 3 units)	Sep-24
12	Khandi SHP, Ladakh	1.50	Kargil Renewable Energy Development Agency (KREDA), Ladakh	Oct-24
13	Holi-II SHP, Himachal Pradesh	7.00	M/s Om Energy Generation Pvt. Ltd.	Nov-24
14	SHP-III on Saurashtra Branch Canal, Gujarat	15.00	Sardar Sarovar Narmada Nigam Ltd., Gujarat	Dec-24
15	Tsati SHP, UT of Ladakh	0.50	Ladakh Renewable Energy Development Agency, (LREDA) UT of Ladakh	Dec-24
16	Chulungkha SHP, UT of Ladakh	0.80	Ladakh Renewable Energy Development Agency, (LREDA) UT of Ladakh	Dec-24
	Total	113.80		

6.7 WASTE TO ENERGY

6.7.1 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.

In addition to crop residue management such projects have good potential industrial sector namely distillery, paper and pulp solvent extraction, dairy, starch industries, sugar mills, pharmaceutical industries and sewage treatment plants etc.



The ongoing National Bioenergy Energy Programme an umbrella scheme was announced on 02.11.2022 with an allotment of Rs 600 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. There has been good response from Developers to Waste to Energy program specifically for BioCNG component.

6.7.2 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.

6.7.3 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 dual 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.

6.7.4 This programme is complimentary to other Government of India initiatives such as Gobardhan of Department of Drinking Water and Sanitation, and the Sustainable Alternative Towards Affordable Transportation (SATAT) of Ministry of Petroleum and Natural Gas (MoPNG). Enhancing production and availability of Compressed Bio-gas (CBG) as an alternative and affordable clean fuel for cooking and transportation sector is envisaged under these initiatives.

6.7.5 Progress during the Financial year 2024-25

- i. Achievement: As on 31.12.2024, during the FY 2024-25, the capacities added in respect of various output products are given as under:



Progress of Installed Capacity Addition during FY 2024-25 (till 31.12.2024)				
Sl. No.	Output Product	No. of plants	Capacity Addition in FY 2024-25 (MWeq)	States
1	Bio CNG/CBG	18	29.57	Haryana, Uttar Pradesh, Gujarat Rajasthan, Karnataka, Jharkhand, Madhya Pradesh
2	Power	2	4.56	Maharashtra, Uttar Pradesh
TOTAL		20	34.13	

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.

6.7.6 Cumulative Achievement: As on 31.12.2024, the total installed capacity is 619.93 MWeq, including 249.74 MW capacity of Grid-

interactive Waste to Power projects, and 370.19 MWeq capacity Off-grid Waste-to-Energy projects. The installed capacity details under the programme till 31.12.2024 is given as under:

The Cumulative Installed Capacity of Waste-to-Energy Projects		
Sl. No.	Output product	Cumulative Installed capacity
1	Biogas	8,24,647 m ³ per day
2	Bio-CNG/CBG	5,66,268 kg per day
3	Power (Grid & Offgrid)	433.23 MW

6.7.7 Photographs:



Fig.6.12: 5980 kg/day BioCNG plant set up by M/s AnandMangal Infra Developers Pvt. Ltd. at Meerut, Uttar Pradesh.



Fig.6.13: 6000kg/day Bio CNG plant setup by Noble Exchange Environment solutions at Pune, Maharashtra.



CHAPTER 7

ACCELERATING THE CLEAN ENERGY ECOSYSTEM

7.1. Production Linked Incentive (PLI)

7.1.1 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.

7.1.2 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.

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

7.1.3.1 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 7th April, 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 28th April, 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.

7.1.3.2 **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. The aforesaid 39,600 MW capacity is under implementation.

7.1.4. **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.1,11,000 crore.
- iii. Creation of manufacturing capacity for Balance of Materials like EVA, Solar glass, Backsheet, etc.
- iv. Direct employment of about 43,000 persons.
- v. Impetus to Research and Development to achieve higher efficiencies in Solar PV Modules.

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

7.2.1 The Ministry of New & Renewable Energy (MNRE) supports resource assessment, research, design, development, testing, standardization, demonstration, and validation of various renewable energy technologies, processes, materials, components, subsystems, products & services to promote application-oriented research, improvements in efficiency, reliability, indigenous development and manufacturing of renewable energy systems and devices.

The Ministry's R&D initiatives aim to strengthen the global competitiveness of the Indian industry and to make renewable energy generation supply, self-sustainable/profitable there by increasing RE's share in the country's total energy mix.

7.2.2 **Policy and Guidelines**

Under the Renewable Energy Research and Technology Development (RE-RTD) Programme, the Ministry supports R&D 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 budget allotted for the Renewable Energy Research and Technology Development (RE-RTD) Programme is Rs. 228 crores for FY 2021-22 to 2025-26.



7.2.3 Research Development and Demonstration (RD&D) Focus

The projects supported for RD&D support are in line with the R&D thrust areas of the Ministry identified under solar thermal, SPV, biogas, wind, wind-hybrid, storage, small Hydro Power, hydrogen, fuel cells, geothermal, etc. The projects in other areas not covered under the R&D thrust areas are also considered for financial support based on their applications and practical importance. Participation of the industry in R&D projects is encouraged.

7.2.4 Institutional Mechanism

For faster technology commercialization, the Ministry supports the strengthening of its 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 for pursuing RD&D, resource assessment, testing, standardization, and certification in solar, bioenergy, and wind energy systems, respectively.

7.2.5 SOLAR R&D

Solar Photovoltaics

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

A. Phase III of the Ministry's flagship project in solar photo voltaics implemented by the National Centre for Photovoltaic Research and Education (NCPRE)

This flagship project of the Ministry has several workstreams, and the main highlights of progress are briefly described below.

- Advancements in Solar Cell Materials:** Solar cell research activities in Phase III of NCPRE are focused on mitigating challenges related to upscaling perovskite-silicon tandem solar cells. NCPRE is investigating novel laser-cutting processes for passivating the edges of perovskite/silicon tandems to prevent loss of cell efficiency and stability due to edge shunting. The NCPRE has demonstrated the 4T-tandem solar cell up to 29.2% efficiency @17.5 mm² and 26.9% @ 108 mm² with a bottom silicon solar cell efficiency of 25%. Third party laboratory testing shows Perovskite absorber remains unaffected upto 750 hours under damp-heat test. NIR transparent solar cells demonstrated with power conversion efficiency of ~ 18.8%.
- Advancements in Solar inverters for Grid Integration:** The grid integration group, as part of Phase III of NCPRE is focused on the development of a Medium Voltage (MV) direct grid connect inverter using high voltage Silicon Carbide (SiC) MOSFETs. The preliminary focus is on developing the entire inverter indigenously at the lab. The research is focused on the improvement of efficiency, power density and reliability.
- PV Deployment and Reliability:** NCPRE is working on Field surveys wherein a 7-year-old site in hot & humid climate was surveyed and root cause for the degradation was determined to be inner layer cracks in the backsheet leading to accelerated PID and corrosion. Weather station with an ability to host the collected data on an internal, secure website available to IIT Bombay and IISc has been designed. A vulnerability in the commercial PV modules that's currently not addressed by any

standards under High Temperature Reverse Bias operation of bypass diodes has been discovered and a setup has been developed for the assessment of the same. Effect of load applied during cleaning on the durability of the anti-soiling coating was studied using the in-house developed cleaning cycle emulator. It was found that higher number of cycles with lower load (~300 g) or low number of cycles with higher load (~1kg) are ideal for mitigating the abrasion damage to the anti-soiling coating. Any load values in between 300 g to 1000 g result in higher damage.

- **Energy Storage:** The focus is on improving the performance of the vanadium redox flow battery (VRFB) and implementing polyoxometalates (POMs) as electrolytes in redox flow batteries.
- **Training:** NCPRE conducted three industry-oriented courses in the FY 2024-25, such as “Theory and Technology of Silicon Solar Cells” (May 29–31, 2024), “Solar Photovoltaic systems connected to the bulk power grid technology and grid integrations” (Jan 12–13, 2024), and “Impact of inverter based resources on power systems” (Nov 4–5, 2024).
- **Supporting Startups :** A start-up named **ART-PV India Pvt. Ltd.** Is launched for commercialization of TSCs technology in strategic partnership with PV manufacturers. NCPRE is helping startup ‘**Giga Connect**’ to set up a state-of-the-art lab for quality monitoring and reliability testing of junction boxes. It is also working with **Tri-Nano Technologies** to assess the durability of anti-soiling coatings.
- **Industrial Collaborations:** NCPRE has signed MoU with Adani Green Energy, Grew Energy, RCT solutions, TriNano Technologies and signed NDA with Websol.

B. National Primary Standard Facility for Solar Cell Calibration – CSIR-NPL

[exemplar of international scientific cooperation to promote India’s self-reliance in solar PV cell performance measurement]

The National Physical Laboratory (a statutory body and the National Metrological Institute, NMI, of the country) has the mandate to establish and maintain national standards like its counterpart NMIs. As part of its mandate, Primary Standard Facility for Reference Solar Cell Calibration is being established at CSIR-NPL in collaboration with PTB-Germany under international scientific cooperation, supported by Ministry of New and Renewable Energy (MNRE), Govt. of India. This would contribute to a significant improvement of PV-Quality Infrastructure (PV-QI) in the country. It is therefore timely and important for the country to have primary standards and procedures for the calibration measurements of solar cells with the best possible accuracy and precision that is at par with the international WPVS laboratories.

In view of this CSIR-NPL has established the primary standard facility for reference solar cell calibration with the targeted uncertainty for short-circuit current,

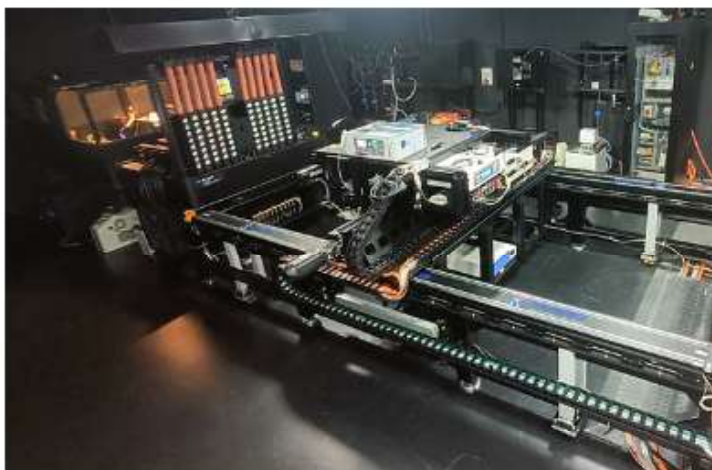


Fig. 7.1. Primary Standard Facility established at CSIR-NPL

ISTC of 0.35% (at $k=2$), the lowest amongst the WPVS laboratories across the globe as on date. This is a Primary Reference Solar Cell Calibration System based on "Laser-based Differential Spectral Responsivity (L-DSR)" and established during September, 2024 at CSIR-NPL with a motive of providing primary reference solar cell calibration services to the solar PV stake-holders in the country.

- C. Project on Flexible Perovskite Solar Cells and Intermediate Module led by IIT-Bombay** - achieved path-breaking progress on Perovskite efficiency in India to pave the way for scale-up.
- Promising results were obtained by Prof. Shaibal K. Sarkar's research group at IIT Bombay, which demonstrated **24.8% efficiency in Perovskite photovoltaic devices** (versus 25.6% world record) through solution and composition engineering of the active layer.

7.2.6 R&D In Wind Energy

A. Met-Ocean measurements in Gulf of Khambhat and Gulf of Mannar

MNRE has sanctioned project of Met-Ocean Measurements at Gulf of Khambhat and Gulf of Mannar for Fostering the Growth of Offshore Wind in the Country to NIWE with the objective of quantifying the wind potential of such regions towards demarcating the offshore wind energy blocks.

Under the project, as per the approval of the Project Monitoring Committee directions, 3 sites have been identified to map offshore wind resource in Gulf of Mannar, Tamil Nadu coast.

NIWE has identified suitable locations for deploying the Offshore Lidar at VOC port (4 to 5 km from the sea shore) and Udangudi Thermal Coal jetty (8 to 9 km from the sea shore) which together with the measurements at sub-zone 1 will cover wind profile of the Tamil Nadu coast.

The Installation and commissioning of LiDAR at above mentioned sites have been completed and measurement are under progress. One year wind measurement campaign will be completed by February 2025.

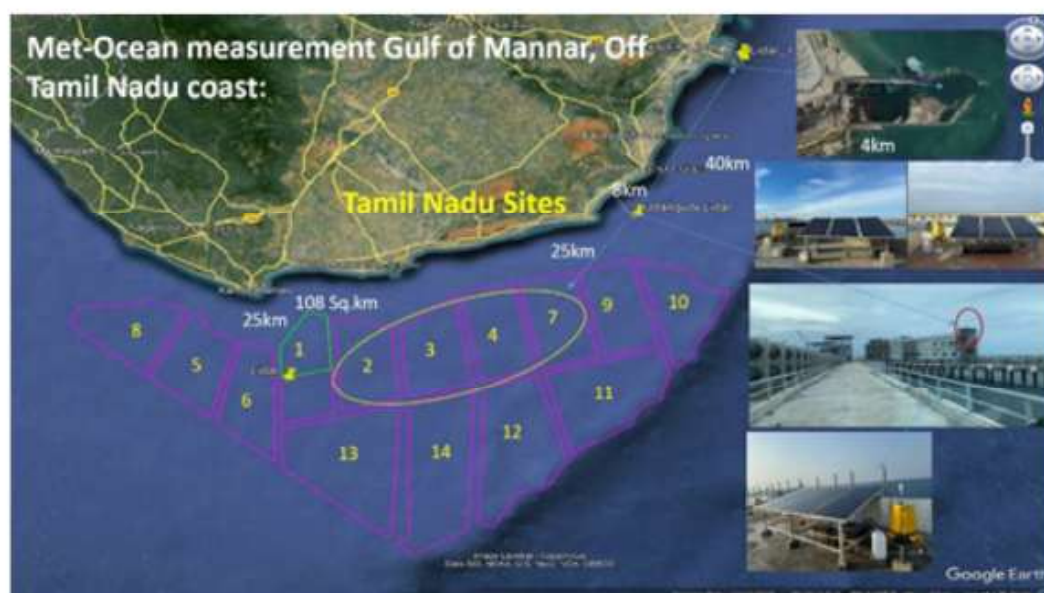


Fig. 7.2 LiDAR installed at VOC port and Udangudi, Gulf of Mannar, Tamil Nadu

LiDAR Location

Location	LiDAR Serial number	Latitude/Longitude
VOC_Port_1	ZX300M-996	8° 44' 58.2" N / 78° 13' 36.19" E
VOC_Port_2	ZX300M-997	8° 45' 19.58" N / 78° 13' 16.24" E
UDANGUDI	ZX300M-998	8°23'35.763"N / 78°8'0.686"E

B. Integrated Wind and Solar Resource Assessment through Mapping and Measurements (IWSRA)

Objective and Scope

The project was undertaken to conduct an integrated assessment of wind and solar resources across India through advanced mapping and measurement techniques. The primary objective was to generate high-resolution wind and solar potential maps to aid policymakers, developers, and other stakeholders in renewable energy planning. The project focused on developing indicative maps using numerical mesoscale modelling techniques, validating them with in-situ measurements, and establishing integrated wind-solar monitoring stations for precise data collection.

Milestones and Achievements

The project was executed in two planned phases. Phase I successfully met all key deliverables, including:

- Establishment of 24 wind monitoring stations (WMS) across eight states (Tamil Nadu, Karnataka, Andhra Pradesh, Gujarat, Maharashtra, Rajasthan, Madhya Pradesh, and Telangana) and procurement and deployment of SoDAR systems for vertical extrapolation of wind data.
- Development of 120m and 150m wind potential maps, validated through real-time measurements.

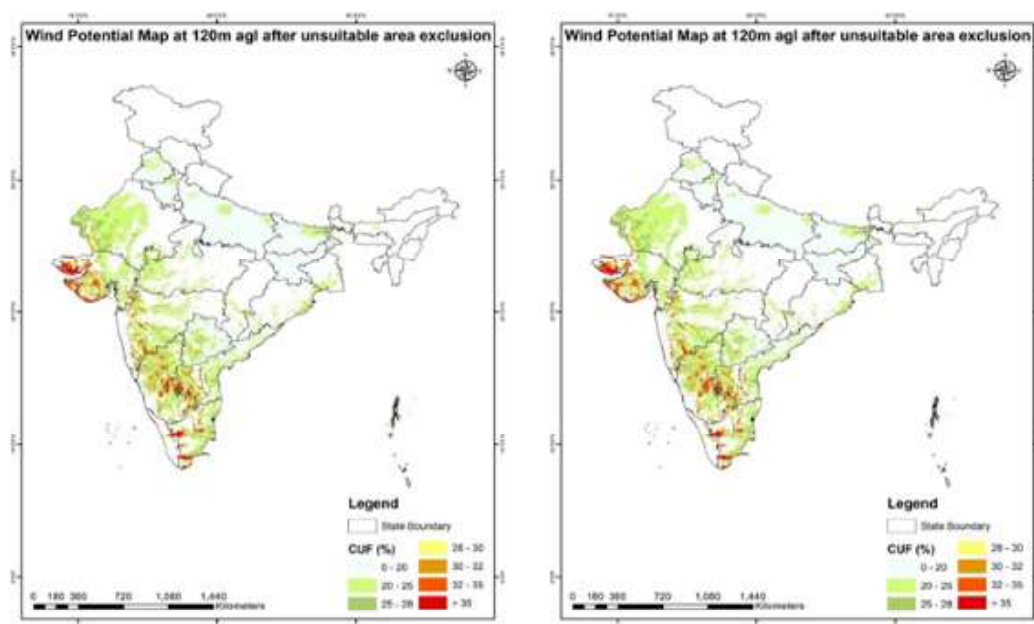


Fig. 7.3.

- Preparation of hybrid wind-solar resource maps integrating wind and solar data for a more comprehensive renewable energy assessment.

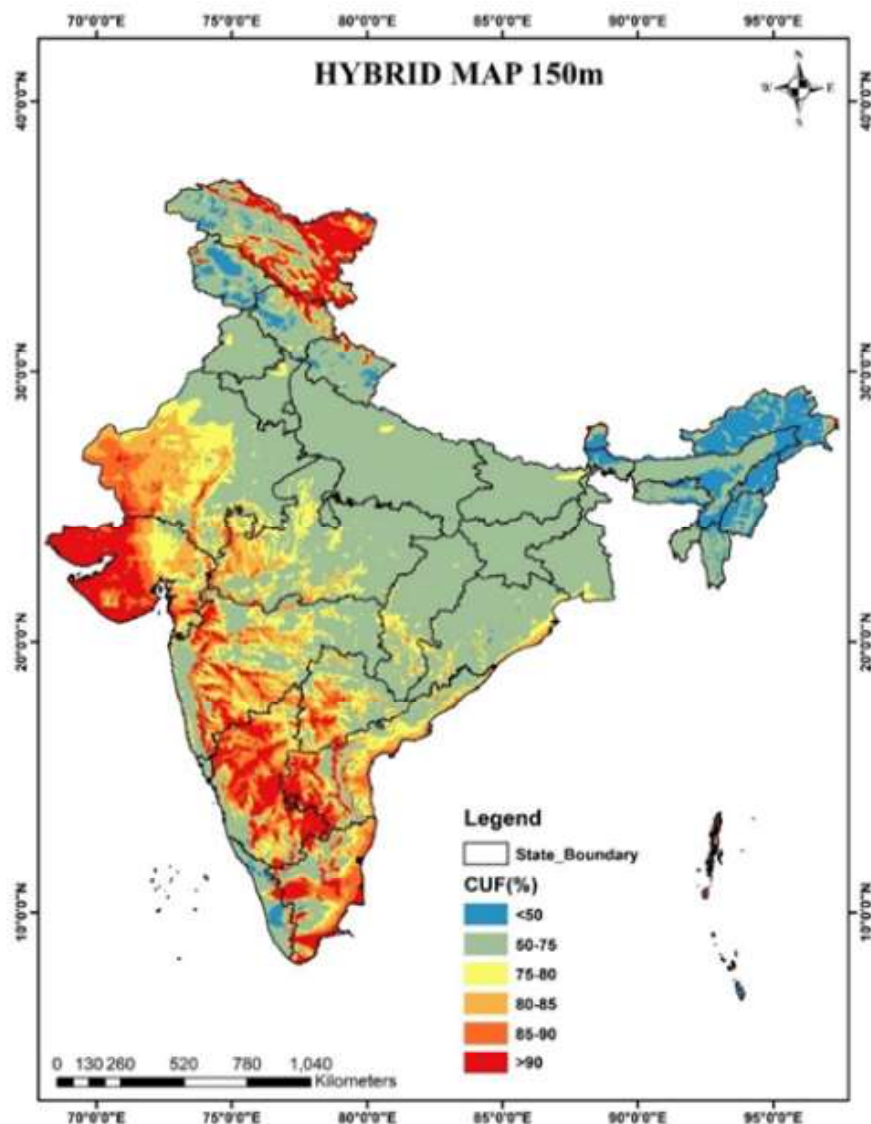


Fig. 7.4

- Creation of a dedicated web portal to provide stakeholders with easy access to resource maps and analytical tools.

URLs:

- o 120m Wind Potential Map: https://maps.niwe.res.in/resource_map/map/120m/
- o 150m Wind Potential Map: https://maps.niwe.res.in/resource_map/map/150m/
- Publication of research papers on mesoscale model bias correction, vertical extrapolation methodologies, and wind potential mapping.

Phase II was initially planned to extend the assessment by relocating measurement stations to uncovered regions and establishing additional monitoring stations. The process reached the milestone of securing No Objection Certificates (NOCs) for 13 locations, and tenders were floated for dismantling and procurement activities.

Upon thorough evaluation, it was determined that the objectives of the project had been fully achieved within Phase I, and further extension into Phase II would lead to increased timelines and additional expenditure without significant added benefits. With its successful completion, the project has provided validated and accessible renewable energy resource assessments to support India's transition to sustainable energy. The developed datasets, maps, and research outputs will serve as critical references for future wind and solar energy planning, benefiting policymakers, researchers, and industry stakeholders.

7.2.7 R&D In Waste to Energy (WtE)

A. **Densification of agro-waste and assessment for its application in the gasifier, SSS National Institute of Bio Energy (NIBE), Kapurthala.**

During 2024-25 significant progress has been made for completion of the objectives of the project entitled 'Densification of agro-waste and assessment for its application in gasifier'. During this period objectives of the project were taken up by procurement and installation of the instruments for the project work. A portable producer gas analyzer has been procured and installed for analysis of producer gas composition from the gasifier. A small Biomass pellet machine with capacity of 15-20 kg/hr has been procured for the pelletization of various agro-waste samples such as paddy straw, corn stover, cotton stick, millet, sweet sorghum and mustard crop residue with and without binders. An agro residue-based downdraft gasifier supplied with gen set has been installed for the gasification of the agro-waste pellets to assess its power production potential. The electrical output of the downdraft gasifier is 10 KVA.



Fig.7.5: Agro-residue based downdraft gasifier with 10 KVA gen set

The pelletization of six biomasses (paddy straw, corn stover, sweet sorghum, millet, cotton stick, and mustard crop residue) in this project had been undergoing with three different binders (waste lubricant

oil, oil cake and press mud). Agro-wastes are mixed with the binders at different proportions upto 20 wt% for the pelletization. Further, different combinations of the pellets are characterized for its elemental composition, calorific value and other physical properties to check its suitability for application in gasifier. Finally, the methodology for the techno-economic analysis of using the agro-waste pellets for power production application has been finalized and will be carried out using the experimental data.

B. Biomass Gasification through Plasma Pyrolysis technology for Chemicals Production, IIT-Roorkee

This project was also sanctioned in the FY 2022–23 with the three-fold objective of: (i) to fabricate and install a plasma pyrolysis system for handling bagasse and rice husk initially, with the potential to treat other organic wastes in the future; (ii) **thermo-chemical characterization of various biomass sources and gases produced after gasification**; and (iii) **optimization of reactor design and input conditions**.

In terms of updates, the **installation of the Plasma Pyrolysis Facility for biomass** gasification is completed. (Fig.7.4 below). Detailed characterization studies of biomass (sugarcane bagasse) samples were done deploying different techniques, and the high volatile matter (77.6%) and low ash (8%) content present in the sugarcane bagasse suggested potential applications for pyrolysis and gasification³. Higher heating values (range of 17-20 MJ/kg) were also found, which is comparable to good quality lignin coal.



Fig. 7.6: Plasma reactor unit for biomass gasification being installed by IIT-Roorkee

7.2.8 R&D In Green Hydrogen

A. Green Hydrogen Mobility Project at Leh implemented by NTPC – first ever field trial of commercial fuel cell bus in Leh, Ladakh achieved to aid in its decarbonization.

The project being implemented by NTPC Ltd. is ready to produce green hydrogen (80 kg/day) using solar power and to compress, store, and dispense green hydrogen safely into Fuel Cell Buses (5 nos.) which will run hydrogen buses on intra-city routes (Leh, Ladakh) at an altitude of 3400 m, within a temperature range of -25 C to +30 C. The foundation of the project was laid by the Hon'ble Prime Minister on 30.07.2022.

Key activities and progress achieved by the project are listed below and depicted in Fig.7.5:

- In a significant achievement, the first field trial of a hydrogen Fuel Cell Electric Bus (manufactured by Ashok Leyland) in Leh, Ladakh, took place on 17th August 2023. The Homologation certificate

for the bus has been received on 07.08.2024. Manufacturing of four(4) more buses have been completed and a total of 4 buses are stationed in Leh from 6.11.2024. The Fuel Cell Buses would be plying in and around Leh, each covering a total distance of 200 km each day, and are expected to mitigate 300 tons of CO₂ emission annually. The pilot project would be the first commercial-scale deployment of FCEV vehicles in Indian conditions and accelerate decarbonization of the mobility sector in Ladakh and subsequently for the whole country.

- **Green Hydrogen fueling station (80 kg/day):** The station is commissioned in 07.11.2024. The station is ready for operation.
- **1.70 MW Solar Plant for H₂ production:** The plant is commissioned on 06.06.2024



Fig. 7.7: Progress by Green Hydrogen Mobility Project at Leh implemented by NTPC

B. Design and development of 20kW Low-Temperature Polymer Electrolyte Membrane (LT-PEM) fuel cell with high indigenous content – first-of-its-kind automated PEMFC components/stack fabrication pilot line in India

PEM fuel cell (PEMFC) is currently the leading technology for deployment in various applications, including both stationery and transport applications. However, the fuel cell demonstrations, which are under development in India are reliant on imported, costly, LT-PEM fuel cell stacks.

This project has resulted in a significant breakthrough through the establishment of an automated PEMFC components

/stack fabrication pilot line (Fig. 7.6) for improving mass manufacturability, process simplification, and standardization. Additionally, indigenously developed catalyst-coated membranes using an in-house electrocatalyst, gas diffusion layer, and bipolar plates are being used for stack fabrication using the automated assembly line. This is the first-of-its-kind facility in India, providing a much-needed impetus to the manufacturing capability for PEMFC stack fabrication in the country, which remains one of the major R&D gaps hindering cost reduction and implementation of this technology.



Fig. 7.8: Automated PEMFC Assembly Pilot line facility at ARCI-CFCT – first of its kind in India

C. Setting up of a Centre of Excellence on Hydrogen Energy at the National Institute of Solar Energy (NISE), Gwal Pahari, Haryana

MNRE has funded the Project to NISE for setting up a Centre of Excellence on Green Hydrogen at NISE, with the main objective to operation and maintenance the existing Green Hydrogen Station at NISE and to provide a platform for demonstration of Hydrogen fuelled vehicles. The existing station was installed under MNRE funding in 2014 and is India's first Green Hydrogen production cum dispensing station. The facility comprises of a dedicated 120 kWp Solar PV plant that powers an alkaline electrolyser with output of 99.999% purity Fuel Cell Grade Hydrogen. The station has an H35 dispenser which can refuel Hydrogen at 350 bar to the vehicles at the rate of the rate of 1kg/min.

Under this Project, NISE has augmented the Hydrogen production capacity by commissioning a new 10 Nm³/hr electrolyser. The station is being revived by NISE to be used as a platform for conducting field trials of Hydrogen fuelled vehicles and to organize workshops, trainings, and awareness programmes related to the Green Hydrogen Ecosystem, in-line with the National Green Hydrogen Policy.



Fig.7.9: Centre of Excellence on Hydrogen Energy - India's first Solar based Green Hydrogen production cum dispensing station at NISE

7.2.9 R&D In Small Hydro

A Centre of Excellence for Small Hydropower at Department of Hydro and Renewable Energy, IIT Roorkee, initiated this project in April 2023 with the three main objectives of (a) Development of Ultra Low Head Turbine (ULH), (b) Development of Hydro Kinetic Turbine (HKT) and (c) Development of Guidelines for performance prediction of Small Hydro turbines & reversible Pump turbine by Computational Fluid Dynamics (CFD).

The major activities/outcomes under specific research objective are detailed as follows:

a. Development of Ultra Low Head Turbine (ULH)

The project aims to establish a state-of-the-art Ultra Low Head (ULH) turbine model test laboratory with the following objectives:

- Study and develop procedure for selection of ULH technology for a selected site.
- Design reference model using CFD or other design tools and test them in ULH turbine laboratory.
- To develop the procedure for installation, field testing and performance monitoring under variable operating conditions.
- Provide an open design of ULH hydro turbine to the small hydro turbine manufacturers and hydro power researchers to explore their capabilities and enhance their skills.

Currently, under this project, the design and analysis of Axial Flow Propeller turbines and Screw turbine is under progress. The experimental test facility for these turbines is under construction.

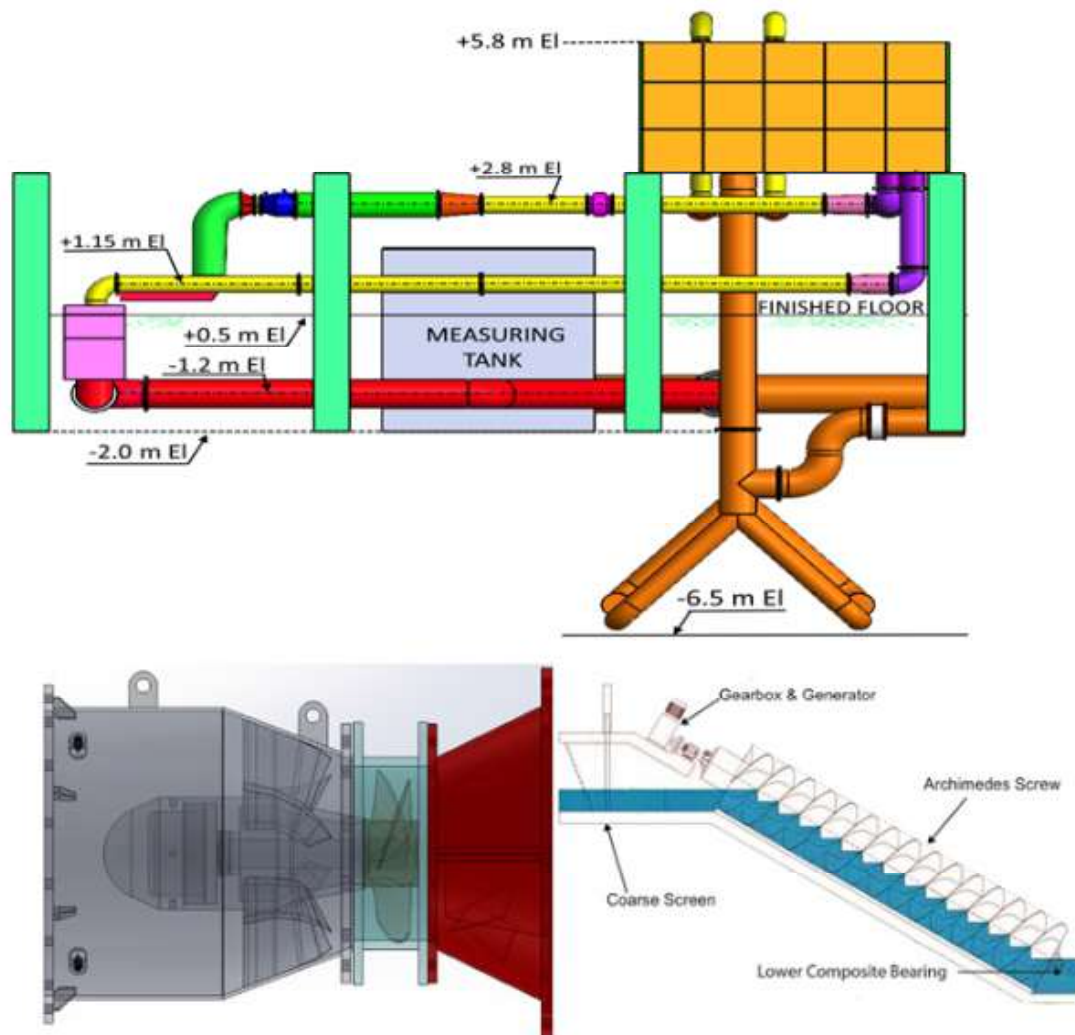


Fig.7.10: Test facility and turbines for Ultra Low Head turbines

b. Development of Hydro Kinetic Turbine (HKT)

The aim is to develop hydrokinetic turbines (HKT) for zero-head applications in rivers, canals, and ocean currents. Currently in the development phase, the project focuses on identifying potential HKT deployment sites in India, conducting CFD-based design selection using high-performance computing facilities at HRED, IIT Roorkee, and performing model and prototype testing. As part of this initiative, a **20-meter-long experimental facility** for HKT testing, equipped with **Particle Image Velocimetry (PIV)** for detailed flow analysis, is under construction at IIT Roorkee. This will be **India's first such large-scale setup** and is expected to be fully operational by the end of 2025. Additionally, **optimal designs for cross-flow and axial-flow HKTs** have been finalized through CFD simulations. After completing model testing at the experimental setup, **field testing of HKT prototypes** will be carried out at selected sites across India to validate their real-world performance.

An **International Workshop on Hydrokinetic Technology 2024** was held on 5th-6th July, 2024 under the Department's Centre of Excellence, supported by MNRE, to foster global collaboration and knowledge exchange. Experts from industries, academia, manufacturers, and government organizations discussed potential assessments, technological advancements, and R&D in hydrokinetic technology. Key topics included performance improvements, installation challenges, and solutions for accelerating development. The workshop concluded that HKT technology aims to achieve Technology Readiness Level (TRL) 9 by 2030, ensuring its full-scale commercial viability for sustainable energy generation.

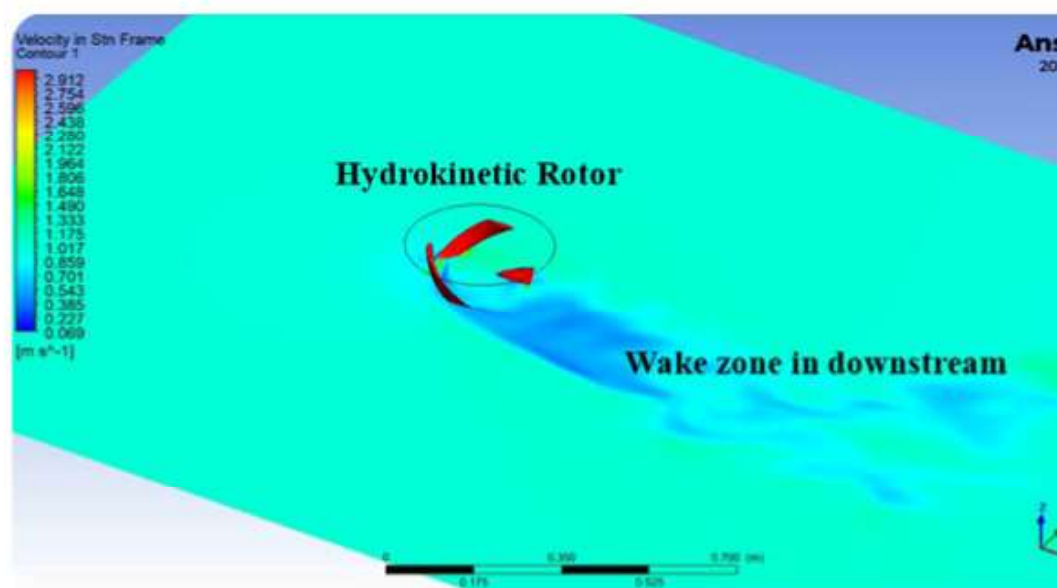


Fig.7.11: CFD analysis of Cross-flow Hydrokinetic turbine (Velocity Contour)

c. Development of Guidelines for performance prediction of Small Hydro turbines & reversible Pump turbine by Computational Fluid Dynamics (CFD)

An accurate prediction of the flow field within a turbine unit is challenging due to complex flow phenomena, such as separation around the turbine blades, pressure variations within the runner, and swirling flows in the draft tube. Various CFD methodologies can be employed to predict turbine performance. A universal methodology or set of guidelines specific for Francis turbines for industries is a requisite in the present times. The project aims to evaluate the reliability of different CFD simulation methodologies in predicting turbine performance, focusing on the sensitivity of different turbulence models, grid types, and modeling

approaches for accurate numerical solutions and reducing the product development cycle time and cost. A state-of-the-art high performance computing (HPC) facility has been developed in the lab. The simulations are to be performed on different Francis turbine models viz., High, Medium, and Low Specific Speed along with the Reversible pump turbines.



Fig.7.12: High Performance Computing Facility (96×4 = 384 Core, 4×768 = 3072 GB RAM)

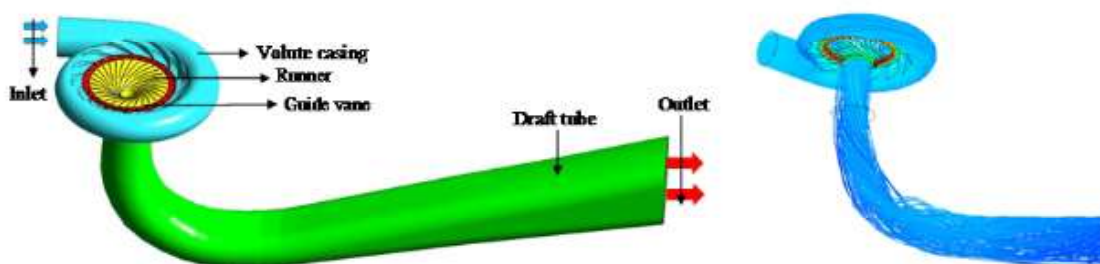


Fig.7.13: CFD modelling and simulation of High Head Francis Turbine

7.2.10 R&D Projects Under Implementation

Given below is a list of R&D projects under implementation during FY 2023-24:

Solar PV

SL no.	Title of the Project	Name of the PI and Institution
1	National Centre for Photovoltaic Research and Education (NCPRE) Phase-II	Indian Institute of Technology Mumbai
2	National Primary Standard facility for cell calibration	National Physical Laboratory (NPL), Delhi
3.	Flexible Perovskite Solar Cells and Intermediate Module	Indian Institute of Technology Bombay, Powai, Mumbai

Wind energy

Sl. no.	Title of the Project	Name of the PI and Institution
1	Integrated Wind and Solar Resource Assessment	National Institute of Wind Energy Chennai
2	Met-Ocean Measurements (Wind, Wave, Tide, Current, Water Level, etc.) at the Gulf of Khambhat and the Gulf of Mannar	National Institute of Wind Energy Chennai

Waste to Energy

Sl. no.	Title of the Project	Name of the PI and Institution
1	Biomass Gasification through Plasma Pyrolysis Technology for Chemicals Production	IIT Roorkee
2	Densification and co-firing of agro-waste for power generation through gasification	SSS-NIBE

Hydrogen energy

Sl. no.	Title of the Project	Name of the PI and Institution
1.	Design & development of 20kW Low-Temperature Polymer Electrolyte Membrane Fuel Cell (LTPEMFC) with high indigenous content	ARCI-CFCT, Chennai
2.	Setting up of a Centre of Excellence on Hydrogen Energy at the National Institute of Solar Energy (NISE), Gwal Pahari, Haryana	NISE, Gurgaon
3.	Green Hydrogen Mobility Projects at Leh	NTPC

Small Hydro

1.	Centre of Excellence for Small Hydropower, IIT Roorkee	IIT Roorkee
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7.2.11 ENERGY STORAGE

Renewable Energy sources are variable and intermittent in nature and as integration of high volumes of Renewable into Grid, there would be a challenge in terms of grid security, stability & safety. Grid scale Energy Storage Systems (ESS) would help in smoothening the renewable generation output and thereby improving the power quality, helping grid stability. This will also result in reduction of transmission network congestion and making better use of network infrastructure. Solar Energy Corporation of India Ltd (SECI), along with other REIAs and State Entities, are bringing tenders for Energy storage. Details of tenders issued by SECI (till 31.12.2024) are given below:



7.2.11.1 In Developer Mode

- i. 1200 MW ISTS- connected RE projects with Peak Power Supply (ISTS-VII). Letter of Award (LoA) was issued in Feb 2020, associated storage capacity is 600 MW/ 2850 MWh. Out of the awarded capacity 289.63 MW of project capacity has been commissioned, balance capacity is currently under implementation.
- ii. 400 MW Round-the-Clock (RTC) Supply of RE Power(RTC-I) LoA was issued in June 2020, associated storage capacity is 2 MW/ 8 MWh. The projects are currently under implementation.
- iii. 1200 MW ISTS- Connected RE Projects with assured Peak Power Supply (Tranche VI). LoA was issued in April 2023, associated storage capacity is 1630MW/ 1630 MWh, the projects are currently under implementation.
- iv. 1200 MW IS TS-Connected Solar PV Power Projects with 600 MW/1200 MWh ESS in India (ISTS-XV), e- Reverse Auction (e-RA) for the tender was conducted and LoAs were issued in July 2024. Associated storage capacity is 600MW/1200 MWh.
- v. 630 MW Firm and Dispatch able Power from ISTS- connected Renewable Energy(RE)Power Projects to Delhi and GIFT PCL (SECI-FDRE-IV), e-RA for the tender was conducted by SECI in July 2024. Subsequently, LoAs were issued in August 2024. Associated storage capacity is 66MW/177MWh.
- vi. 2000 MW ISTS- Connected Solar PV Power Projects with 1000 MW/4000 MWh ESS in India (ISTS-XVII), RfS for the tender was issued by SECI in July 2024 , e-RA was conducted and LoA were issued in December 2024. Associated storage capacity is 1000 MW/ 4000 MWh.
- vii. Assured Peak Supply of 8000 MWh (2000 MW x 4 Hrs.) from ISTS- Connected RE Projects (FDRE-VI). RfS for the tender was issued by SECI in September 2024. Subsequently e-RA was conducted in October 2024 and LoAs were issued for 200 MW in January 2025. Associated storage capacity is 200 MW/ 800 MW.
- viii. 1200 MW RTC Power from ISTS-Connected RE Power Projects in India (SECI-RTC-IV), RfS was issued by SECI in October 2024, currently the tender is under bidding stage.
- ix. SECI issued a tender for setting up a cumulative 1.8 MW of Solar project with 1.117 MWh BESS in November 2024, currently the tender is under award finalisation stage.
- x. SECI has issued Notice Inviting Tender (NIT) in January 2025, for setting up of 4 MW floating solar with 2.5 MW/ 16 MWh BESS in Agatti and 5 MW floating solar with 2.5 MW/ 16 MWh BESS in Kavaratti under RESCO Mode.

7.2.11.2 STANDALONE BESS

- i. SECI has also come up with a tender for setting up of 500 MW/1000 MWh ISTS- connected standalone Battery Energy Storage System (BESS) project at Fatehgarh-III substation in Rajasthan. LoA was issued in January 2023.
- ii. SECI issued a tender for 125 MW/ 500 MWh Stand alone BESS in Kerala with VGF(ESS-3) in December 2024, currently the tender is under bidding stage.



7.2.11.3 In CAPEX Mode

- i. 100 MW solar project with 40 MW/120 MWh Battery Energy Storage System (BESS) at Rajanand gaon, Chhattisgarh: In February 2024, SECI unveiled India's largest solar battery project. Over its 25-year lifespan, the solar plant will reduce approximately 49 lakh metric tons of CO₂ emissions, which is equivalent to planting around 88 lakh trees.
- ii. 1.7 MWp SPV Project with 1.4 MWh BESS in Kavaratti & Agatti Islands, Lakshadweep : In December 2023, SECI commissioned the first on-grid solar project with state-of-the-art Battery Energy Storage System (BESS). SECI's project is anticipated to save Rs. 250 crore, reduce diesel consumption by 190 lakh litres while offsetting 58,000 tonnes of CO₂ emissions during its anticipated technical life span.
- iii. 25 MW with 20 MW/50 MWh BESS at Leh, SEC issued the RfS for selection of EPC contractor in April 2024 and awarded the EPC contract in November 2024, project is currently under implementation.
- iv. 2 MW SPV Power Plant with 01 MWh BESS at Kaza, Himachal Pradesh, India. The project is under implementation; it was set up through one of SECI's JV companies.

7.2.12 STANDARDS & QUALITY CONTROL IN RENEWABLE ENERGY SECTOR

Quality Control of any sector (product, services), is a key to ensure the availability quality products to the consumers. It is the responsibility of the government to ensure and check the quality of the products being traded in the country. Quality Control for Renewable Energy sector in India mainly is based on the various Indian Standards developed/adopted by BIS, International Standards and the guidelines/specifications given in the RE schemes documents notified by MNRE.

Bureau of Indian Standards (BIS) is the National Standards Body of India. BIS develop & publish Indian Standards, adopt international standards, implement conformity assessment schemes, implement standard marks, recognise & run laboratories for conformity assessment, work for consumer empowerment, conduct capacity building programs on quality assurance.

7.2.12.1 Quality Control Order (QCO) SPV products

The technical regulation for quality control of SPV Systems, Components and Devices as per Quality Control (Requirement for Compulsory Registration under BIS Act) Order 2017, which was notified by MNRE vide Government of India Gazette Notification No. 2561 dated 5th September, 2017 was implemented as per schedules notified time to time. Active interaction was made with industry, test labs, and BIS for implementation of the said quality control order, which includes SPV Modules, Inverters and battery storage used in SPV power projects. All products listed in the said order should conform to specified Indian Standard/corresponding IEC, and products qualifying the standards from BIS recognized test labs are required to be registered by the respective manufacturers with BIS.

2. 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 27th January 2025. This revised order supersedes 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

Sl. No	Programme	Product and Standard Title	Standards
1.	Solar Power	Crystalline Silicon Terrestrial Photovoltaic (PV) Modules (Si wafer based)	IS 14286 (Part 1) : 2023/ IEC 61215-1 : 2021, IS 14286 (Part 1/Sec 1) : 2023/ IEC 61215-1-1: 2021, IS/ IEC 61730-1: 2016, IS/IEC 61730-2 : 2016
		Thin Film Terrestrial Photovoltaic (PV) Modules a-Si, CIGS and CdTe)	IS 14286 (Part 1): 2023/ IEC 61215-1: 2021, IS 14286 (Part 1/Sec 2): 2023/ IEC 61215-1-2: 2021 + Amd-1:2022, IS 14286 (Part 1/Sec 3): 2023/ IEC 61215-1-3: 2021 + Amd-1:2022, IS 14286 (Part 1/Sec 4): 2023/ IEC 61215-1-4 : 2021 + Amd-1:2022, IS/IEC 61730-1 : 2016, IS/IEC 61730-2 : 2016
		Power Invertors for use in Photovoltaic Power Systems	IS 16221 (Part 2): 2015/ IEC 62109-2: 2011 IS/IEC 61683: 1999
		Utility-Interconnected Photovoltaic Inverters	IS 16221 (Part 2): 2015/ IEC 62109-2: 2011, IS 16169: 2019/ IEC 62116: 2014, IS 17980: 2022/IEC 62891:2020
		Storage Batteries for SPV Applications	IS 16270: 2023

At present, the QCO 2017 stands implemented for SPV inverters up to 100 kW capacity w.e.f. 01.01.2024 and for inverters above 100 kW, the implementation of QCO,2017 is extended up to 31.12.2025, or till further orders, whichever is earlier.

7.2.12.2 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 31.12.2024 is given in Table 7.2. Out of 617 nos. manufacturers who were granted registration for SPV Products, 342 Nos. are domestic manufacturers (55.43%). 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 (CRO) 2017 till 31.12.2024

Sl No.	Product Name	No. of Registrations		
		Domestic	Foreign	Total
1	SPV Modules	258	166	424
2	SPV Inverters	72	109	181
3	Storage Batteries	12	0	12
	Total	342	275	617

7.2.12.3 Quality Control on Solar Water Heating Systems:

The Ministry of New and Renewable Energy also notified a Quality Control Order for Solar Water Heating Systems vide gazette notification dated 08th October 2024. It shall come into force on the expiry of one hundred and eighty days from the date of its publication in the Official Gazette (i.e., 6th April 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 Water Heaters

Sl. No	Programme	Product and Standard Title	Standards
1	Solar Water Heating Systems	Solar Flat Plate Collector for Solar Water Heating Systems	IS 12933 (Part 1): 2003 IS 12933 (Part 2): 2003
		All Glass Evacuated Tubes Solar Water Heating System	IS 16544: 2016
		Storage Water Tank for All Glass Evacuated Tubes Solar Water Heating Systems	IS 16542: 2016

7.2.12.4 Standards on Renewable Energy

In addition to the standards mentioned in the previous paras, the standards followed in various programmes being implemented by MNRE are given in Table 7.4.

Table 7.4: Standards followed under various MNRE programmes

Sl. No	Programme	Product and Standard Title	Standards
1.	Wind Power (As per RLMM)	Wind turbine	
		- Wind turbines- Part 22: Conformity Testing and Certification. - Type and Component Certification Scheme	IS/IEC 61400-22 IECRE OD-501
2.	Small Hydro Power (as per SHP Schemes Guidelines)	Turbines and generator (rotating electrical machines)	IEC 34 – 1: 1983 IEC 61366-1: 1998 IEC 61116-1992 IS: 4722-2001 IS 12800 (part 3) 1991 IEC 60308
		Governing system for hydraulic turbines	IS 3156 – 1992
		Transformers	IS 2705 – 1992 IS 2026 - 1983
		Inlet valves for hydro power stations & systems	IS 7326 - 1902

7.2.12.5 Standards and Labeling Program for Grid-Connected Solar Inverter.

The Bureau of Energy Efficiency with the concurrence of Ministry of New and Renewable Energy, Government of India has come out with Standards and Labeling Program for Grid-Connected Solar Inverter up to capacity of 100 kW. The launch of the Standards and Labeling Program for the solar inverter under voluntary phase was done by then Union Power and New & Renewable Energy Minister Shri R. K. Singh in New Delhi on March 15, 2024. The Program for Grid Connected Solar Inverter has been launched under voluntary phase, valid from 15th March, 2024 till 31st December, 2025. The minimum efficiency for the program is as follows:

Table 7.5: Minimum Overall Efficiency Requirement

Rated Output Power (kW)	Minimum Overall Efficiency Requirement
Rated Output Power < 1	92%
$1 \leq \text{Rated Output Power} < 3$	93%
$3 \leq \text{Rated Output Power} < 5$	95%
$5 \leq \text{Rated Output Power} < 10$	96%
$10 \leq \text{Rated Output Power} < 20$	97%
Rated Output Power ≥ 20	98%

7.2.12.6 Development of New Standards in Renewable Energy Sector:

Ministry of New and Renewable Energy (MNRE) is implementing Biomass Programme under the umbrella of National Bioenergy Programme with a focus on manufacturing of biomass pellets/briquettes. BIS has been requested to develop the Indian Standard for Biomass Pellets/briquettes. Further, BIS has also been requested for development of Indian Standards for Small Hydro Power sector. BIS has also formed a committee for development of Standards in Small Hydro Power sector which is Technical Committee of BIS, WRD 29.

7.2.12.7 Quality Control Order on Solar DC Cables:

Department for Promotion of Industry and Internal Trade (DPIIT), Ministry of Commerce and Industry had notified a Quality Control Order (QCO) for 'Solar DC Cable and Fire Survival Cable' on 25th August, 2023, which has come into force from six months from the date of notification i.e., February 25, 2024. Indian Standards mentioned in this QCO are as follows:

Table 7.6: Standards mentioned in DPIIT's QCO

Goods or articles	Indian Standard	Title of Indian Standard
(1)	(2)	(3)
Solar DC Cable	17293: 2020	Electric Cable for Photovoltaic Systems for rated voltage 1500 V DC
Fire Survival Cable	17505 (Part 1): 2021	Thermosetting Insulated, Fire Survival Cables for working voltages up to and including 1100 V AC and 1500 V DC

CHAPTER 8

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 1,29,509 MW, out of which only about 4990 MW capacity has been harnessed cumulatively till 31.12.2024 as given in Table 8.1.

Table 8.1: Renewable Energy Potential and Capacity Installed in NER

(capacity in MW)

	Solar	Wind Power	S m a l l H y d r o Power	Bio-Energy Biomass Power	Waste To Energy	L a r g e Hydro	Total
Potential	62300	760	3261	567	16	62604	129508
Installed	280	nil	384	16	nil	4309	4989

Table 8.2: State-wise Renewable Energy Potential in NER

(Potential in MW)

SL No.	STATES / UTs	Solar	Wind Power @150 m	Small Hydro Power	Bio-Energy Biomass Power	Waste To Energy	Large Hydro	Total including Large Hydro
1	Arunachal Pradesh	8650	246	2064.92	18.46		50064	61043.38
2	Assam	13760	459	201.99	321.89	8	650	15400.88
3	Manipur	10630	0	99.95	62.31	2	1761	12555.26
4	Meghalaya	5860	55	230.05	68.54	2	2298	8513.59
5	Mizoram	9090	-	168.9	2.9	2	2131	11394.8
6	Nagaland	7290	-	182.18	53.9		1452	8978.08
7	Sikkim	4940	-	266.64	4.73		4248	9459.37
8	Tripura	2080	-	46.86	34.35	2	0	2163.21
	Total	62300	760	3261.49	567.08	16	62604	129508.57

The State-wise detail of Renewable Energy capacity installed as on 31.12.2024, in the NER is given in Table 8.3.

Table 8.3: State-wise Renewable Power capacity installed in the NER as on 31.12.2024

S. No.	States	Small Hydro Power (MW)	Bio Power (MW)	Solar Power (MW)	Large Hydro (MW)	Total RE Capacity (MW)
1	Arunachal Pradesh	140.61	0	14.85	1115	1270.46
2	Assam	34.11	2	185.44	350	571.55
3	Manipur	5.45	0	13.79	105	124.24
4	Meghalaya	55.03	13.8	4.28	322	395.11
5	Mizoram	45.47	0	30.39	60	135.86
6	Nagaland	32.67	0	3.17	75	110.84
7	Sikkim	55.11	0	7.56	2282	2344.67
8	Tripura	16.01	0	21.23	0	37.24
	Total	384.46	15.8	280.71	4309	4989.97



Fig. 8.1: Honourable Minister for NRE Reviewing PM KUSUM Scheme in Tripura



Fig. 8.2: Honourable Minister for NRE Reviewing PM KUSUM Scheme in Tripura

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 Nos. 8.4 and 8.5

Table 8.4: State-wise Small Hydro Potential and total installed in the NER States as on 31.12.2024

Sl. No.	State	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	168.90	45.47
6	Nagaland	182.18	32.67
7	Sikkim	266.64	55.11
8	Tripura	46.86	16.01
Total		3261.49	384.46

Table 8.5: Small Hydro Power Projects currently under implementation in NER as on 31.12.2024

Sl. No.	Name of project	Capacity (MW)	Implementing Agency
Arunachal Pradesh			
1	PakhanKha SHP	0.50	Department of Hydro Power Development
2	Tiru Nallah SHP	0.10	Department of Hydro Power Development
3	Fure SHP	0.05	Department of Hydro Power Development
4	Kush SHP	2.00	Department of Hydro Power Development
5	Taksang Chu SHP	3.40	Hydro Power Development Corporation of Arunachal Pradesh Ltd.
Meghalaya			
6	Riangdo SHP	3.00	Meghalaya Power Generation Corporation Ltd.
Nagaland			
7	Duilumroi SHP	2.40	Department of Power, Govt. of Nagaland

8.3 PM KUSUM SCHEME

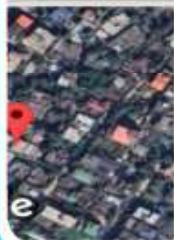
PM-KUSUM (Pradhan Mantri Kisan Urja Suraksha Evam Utthaan Mahabhiyan) scheme to promote small Grid-Connected Solar or Other Renewable Energy Power Plants, installation of stand-alone solar-powered agricultural pumps and solarisation of existing grid-connected agricultural pumps including feeder-level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

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

- Under Component A, Procurement Based Incentives @ Rs. 0.40 per unit for five years will be provided to DISCOMs.
- For all the individual farmers installing/solarising 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 15 HP, 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.
- Moreover, components- 'B' and 'C' can also be implemented without a State share of 30%. The CFA will continue to remain at 50% and the rest 50% will be borne by the beneficiary farmer.
- Under 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.



GPS Ma



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21, Kalindripriya Das Path, Kalyanpur, Ganeshguri, Guwahati,
781005, India
Lat 26.153488°
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Fig 8.3

Table 8.6: Status of installations under PM KUSUM Scheme in the NER as on 31.12.2024

S. No.	State	Component-A (MW)		Component-B (Nos)		Component-C (Nos) (Individual pump solarisation)	
		Sanctioned	Installed	Sanctioned	Installed	Sanctioned	Installed
1	Arunachal Pradesh	-	-	700	427	-	-
2	Assam	10	0	4000	0	1000	0
3	Manipur	-	-	150	78	-	-
4	Meghalaya	-	-	3035	96	-	-
5	Mizoram	-	-	1700	40	-	-
6	Nagaland	5	0	265	65	-	-
7	Tripura	5	0	10895	3617	2,600	50
	Total	20	-	20,745	4,323	3,600	50

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 40,000 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. CFA to Residential Consumers of NER: 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 8.7:

Table 8.7: CFA to Residential Consumers of NER

Sr. No.	Type of Residential Segment	CFA (NER States)
1.	Individual Households (first 2 kWp)	Rs 33,000/kWp
2.	Individual Households (additional 1 kWp)	Rs 19,800/kWp
3.	Individual Households (above 3 kWp)	No additional CFA
4.	GHS/RWA etc, for common facilities for up to 500 kWp(@3 kWp per Households)	Rs 19,800/kWp

Moreover, following two North East States have announced additional State subsidies apart from CFA as given at Table 8.8:

Table 8.8: Additional subsidy by NER states under PMSG: MBY

State	Additional Subsidy by State
Assam	Rs 15,000 per kW for maximum capacity upto 3 kW
Mizoram	Within Aizawl Municipal Corporation (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.

The progress in the NER states under PMSG: MBY as on 31.12.2024 is given in Table 8.9.

Table 8.9: Progress in the NER states under PMSG: MBY

State	State Target (Nos.)	Registration (Nos.)	Application (Nos.)	Households Benefitted (Nos.)	Subsidy Released (in Rs)	Active Vendor (Nos.)
Arunachal Pradesh	17,000	1,299	92	-	-	14
Assam	2,18,000	17,51,327	2,91,386	6,856	41,75,99,193	428
Manipur	25,000	2,727	680	170	1,09,80,288	24
Meghalaya	833	8,409	1,894	17	8,28,168	18
Mizoram	3,00,000	3,044	611	93	62,12,382	7
Nagaland	1,61,350	1,204	236	7	4,63,650	10
Sikkim	25,000	477	57	4	85,800	9
Tripura*	-	12,193	2,707	126	75,04,794	29
Total	7,47,183	17,80,680	2,97,663	7,273	44,36,74,275	539

*Tripura has fixed target of 11 MW capacity under residential category.



Fig 8.4

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

MNRE initially issued approval for New Solar Power Scheme (for 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 solarisation 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.

Till 31.12.2024, among NER states only Tripura state has submitted a proposal for electrification of 1703 PVTG households, which has been sanctioned and the state agency has reported that after tendering process Letter of Award has been issued and work is under progress.



Fig 8.5

8.7 Biogas Programme

MNRE is implementing the Biogas Programme under Umbrella National Bioenergy Programme in the NER States for providing clean gaseous fuel mainly for cooking, lighting, decentralized power generation needs of users and production of organic manure for households and dairy, poultry sector, agro/food-based industries in the NER States through State Government Nodal Departments/ State Nodal Agencies. MNRE has allocated targets to the State Nodal Agencies/ Departments for implementing the Biogas Programme in the NER during the year 2024-25. 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 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 2140 Suryamitras were trained, under Varunmitra programme, 71 Varunmitras were trained and 29 Jalurjamitras were trained under Jalurjamitra programme launched in March, 2022 in NER. The State-wise detail of manpower trained in NER under these Programmes as on 31.12.2024 is given in Table 8.10.

Table 8.10: Progress of trained manpower in NER states under HRD Programmes

Sl. No.	State	Manpower trained		
		Suryamitras	Jalurjamitras	Varunmitras
1	Arunachal Pradesh	60	29	-
2	Assam	1662	-	71
3	Manipur	150	-	-
4	Meghalaya	30	-	-
5	Mizoram	0	-	-
6	Nagaland	60	-	-
7	Sikkim	0	-	-
8	Tripura	178	-	-
	Total	2140	29	71
	Grand Total	2240		

CHAPTER 9

MNRE'S GROWTH PILLARS: ALLIED INSTITUTION

9.1 NATIONAL INSTITUTE OF SOLAR ENERGY (NISE)

9.1.1 National Institute of Solar Energy (NISE) is an autonomous institution under MNRE tasked with coordinating research, development, and other activities as outlined under the National Solar Mission. NISE is registered as a society on 28th October, 2013, with Registration No. HR 018 2013 1092 under the Haryana Registration and Regulation of Societies Act, 2012. Situated at Gwal Pahari on the Gurugram-Faridabad Road in Haryana, NISE is mandated for research and development, solar component testing, capacity building, and development of solar products and applications.

9.1.2 NISE has established itself as a leading institute in the field of solar energy, specializing in resource assessment, research and development, and the design, development, and demonstration of solar energy technologies for various applications. These include testing and standardization, monitoring and evaluation, economic and policy planning, human resource development, and active collaboration with prominent national and international organizations. The institute's quality policy underscores its commitment to providing performance evaluation and testing services for solar cells, photovoltaic (PV) modules, solar water pumping systems, inverters, charge controllers, batteries, advanced lighting systems, as well as the calibration of solar cells, PV modules, pyrheliometers, and pyranometers.

9.1.3 The technical support of NISE complements the requirements of MNRE to become a self-reliable renewable power-producing nation and accept the series of challenges that intervened amidst the implementation of the National Solar Mission (NSM). NISE has established itself in the solar energy sector through continuous efforts by developing newer technologies and standards and catering to the changing needs of the industry. Furthermore, NISE envisions accelerating the proliferation of the renewable energy sector by intently working together with the Government of India.

9.1.4 RESEARCH & DEVELOPMENT

During the year, NISE undertook following Research, Development, and Demonstration (RD&D) activities:-

- Design, Development and Qualification of Large Area (156 mm X 156 mm) Secondary Reference Solar Cell
- Performance Analysis of Bifacial Module at NISE
- Framework (Guidelines & Testing Criteria for Re-Use) for Secondary Life PV Module
- Recycling of PV Module



- Development of I-V Translation Procedure for Bifacial Module for Outdoor Conditions
- R&D on Agri-Photovoltaic System
- Comprehensive Solar Potential Assessment: National and State-Level Studies
 - i. **National-Level Assessments:**
 - a. **Ground-Mounted Solar Potential:**
 - NISE carried out a thorough assessment of India's ground-mounted solar potential by analyzing land availability, solar irradiance, and the proximity to infrastructure.
 - The study made use of satellite imagery, GIS mapping, and topographical data to identify potential sites across various terrains and regions.
 - The results were documented in a detailed report submitted to the MNRE. This report provides essential insights for scaling up large-scale ground-mounted solar projects, thereby contributing to India's ambitious renewable energy targets.
 - b. **Floating Solar Potential:**
 - A comprehensive nationwide assessment of floating solar potential was conducted, identifying opportunities across India's reservoirs, lakes, and water bodies.
 - Bathymetric data was utilized to assess water depth and surface conditions, ensuring the technical feasibility of installations.
 - The study is currently undergoing a verification process, with datasets being cross-referenced for accuracy. The final database is intended to serve as a key foundation for India's floating solar deployment roadmap.
 - ii. **State-Specific Assessments:**
 - a. **Odisha:**
 - A district-wise analysis of both ground-mounted and floating solar potential was conducted, integrating geospatial data and bathy metric assessments. The study identified high-potential zones, considering parameters like solar irradiance, land availability, and water body conditions. The report is submitted to Orissa Renewable Energy Development Agency (OREDA) and GRIDCO, to guide future solar energy initiatives in the state.
 - b. **Karnataka:**

NISE carried out a focused assessment of Karnataka's ground-mounted solar potential, leveraging high-resolution GIS tools and solar radiation data. The final report, submitted to Karnataka Renewable Energy Development Ltd. (KREDL), includes actionable recommendations to enhance solar capacity in the state.
- Design, development, installation and commissioning of test setup for reliability, durability and performance of solar water pumping systems at NISE:
- Micro Grid/ Local Grid
- Solar cooking with Energy Storage System



- Solar Cabin with Thermal Energy Storage

9.1.5 Testing and Standardization Activities:

NISE is committed to provide performance evaluation and testing services for Solar Cells, PV Modules, Solar Water Pumping System, Inverters, Charge Controllers, Batteries, Advanced Lighting System and calibration services for Pyrheliometer and Pyranometer. The test facilities established at NISE meet the requirements to conduct the tests as per the National/International Standards. Our state-of-the-art facility is equipped with world-class infrastructure, skilled human resources, and advanced testing equipment and instruments, using the best engineering practices, continuous upgradation of the infrastructure, and continues improvement in the effectiveness of the Quality Management System as per International Standard ISO 17025:2017.

The Photovoltaic Testing and Calibration Facility at NISE is dedicated to testing solar PV modules and system components in accordance with both national and international standards. Furthermore, NISE is actively involved in the standardization of various solar energy-related activities. Calibration of pyranometers, reference PV modules, and solar simulators is conducted to enhance quality control within the country.

Both in-house and on-site testing services are provided based on specific requirements, offering flexibility to accommodate the quality control needs of MNRE and support product development. In addition to routine testing, NISE also undertakes experimental and theoretical research projects aimed at promoting the development of high-quality solar-related products by the industry.

9.1.5.1 Solar Cell Characterization Facility

The Advanced Solar Cell Characterization Laboratory at NISE is a state-of-the-art facility that includes an ISO Class 8 cleanroom. The laboratory is equipped with advanced instruments for measuring the optical constants of textured and thin-film solar cells. It also features equipment for the automatic single- and multi-point mapping of sheet resistance and resistivity in silicon wafers and solar cells. Additionally, the facility supports the measurement of film thickness, surface roughness, two-dimensional stress, and surface texture. It also enables laser ablation and Local Back Surface Field (LBSF) microstructure analysis of front-side metallization.

9.1.5.2 Solar PV Module Testing Laboratory (Indoor)

The Solar Photovoltaic Module Testing Facility at NISE is dedicated to advancing research and testing of solar PV modules in alignment with both national and international standards. This state-of-the-art facility boasts world-class infrastructure, skilled personnel, and advanced testing equipment, offering both in-house and on-site testing services to meet the comprehensive quality control needs of MNRE and facilitate new product development.

9.1.5.3 Solar PV Module Testing (Outdoor)

The PV module's performance is evaluated through outdoor testing under real field conditions, with results translated to reference conditions as per IEC 60891: 2021. Long-term outdoor performance and reliability measurements are conducted to assess the durability and effectiveness of both grid-tied and off-grid PV systems. Additionally, on-site health and performance assessments are performed to ensure compliance with performance guarantees for solar power plants. This facility facilitates to evaluate the degradation and



different failure modes of PV modules under different climatic conditions.

9.1.5.4 Power Electronics Laboratory

The Power Converter Test Laboratory at NISE specializes in testing power conditioning units (PCUs). This laboratory is equipped to assess hybrid, standalone, and grid-tied inverters, as well as pump controllers, in accordance with IEC 61683:1999 standards. Additionally, the laboratory supports research on islanding prevention for utility-interconnected photovoltaic inverters. With its advanced capabilities, the laboratory provides a strong platform for innovation in power electronics, contributing to the resilient and efficient integration of renewable energy.

9.1.5.5 Battery Test & Characterization Laboratory

The Battery Test & Characterization Facility provides extensive research capabilities for evaluating secondary battery storage technologies, with a focus on performance, reliability, and life cycle analysis. Equipped with state-of-the-art tools, including deep-cycle battery testers, programmable power supplies, advanced hardware and software, data loggers, and temperature-controlled water baths, the laboratory enables rigorous testing across various battery chemistries, such as Lead-Acid, Nickel-Cadmium, and Lithium-Ion. This advanced infrastructure supports a wide range of experimental investigations, fostering advancements in battery technology for renewable energy storage.

9.1.5.6 Advanced Solar PV system & lighting Laboratory

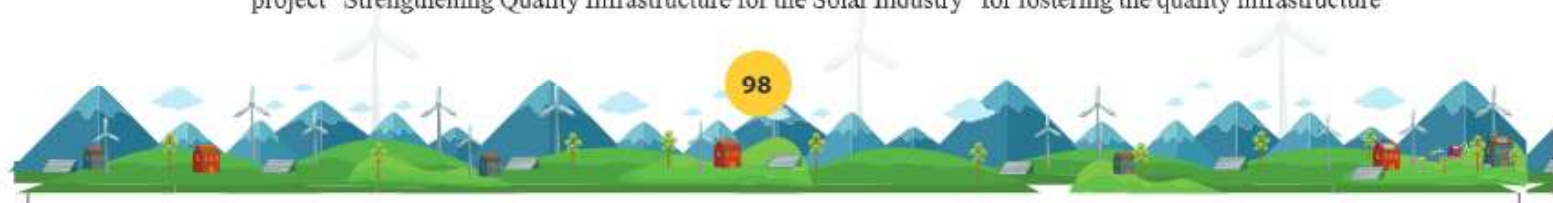
The Solar Photovoltaic (SPV) and Lighting Laboratory offers significant research potential for advancing off-grid solar technologies through rigorous performance and reliability testing. The lab is equipped to conduct tests in accordance with various standards for electrical and photometric measurements of solid-state lighting products. It provides a robust platform for experimental research aimed at improving the efficiency, durability, and adaptability of solar lighting and other off-grid applications.

9.1.5.7 Solar Water Pumping System Testing

The Solar Water Pump Test Facility is a fully automated, state-of-the-art research centre designed for advanced performance testing of photovoltaic (PV)-based water pumps in compliance with national and international standards. This cutting-edge laboratory is capable of testing systems up to 50 hp. Equipped with the latest testing technologies, it supports comprehensive research on a wide range of pump types, including submersible, surface, AC, and DC systems.

9.1.5.8 Solar Radiation Calibration Laboratory

Solar Radiation Calibration Laboratory (SRCL) at NISE has a highly precise reference standard sensors such as the primary standard sensor/Absolute Cavity Radiometer (Highest Solar Radiation Standard) and a number of secondary standard reference sensors for achieving radiometric calibration traceable to the World Radiometric Reference (WRR) scale with high accuracy and precision. The calibration facility at NISE can now transfer the latest radiometer calibration factors to the radiometric sensors from industry. In 2024-25 (till December 2024), 12 sensors were calibrated at Solar Radiometric calibration facility of NISE. Additionally, inter lab comparison and calibration of solar radiometers were carried out at Physikalisch-Technische Bundesanstalt, Berlin. This was under the ambit of Indo-German Cooperation project "Strengthening Quality Infrastructure for the Solar Industry" for fostering the quality infrastructure



for selected metrology and testing laboratories. NISE has also initiated the onsite calibration of radiometers. One such calibration service was provided to Department of Defence at Bengaluru.

9.1.6 Industrial Research and Technical Consultancy

The Industrial Research and Technical Consultancy Division at NISE serves as a key driver for advancing the implementation of solar technology across industries, the private sector, and government organizations. As a dedicated knowledge hub, we are committed to promoting the widespread adoption of high-quality solar technologies through our specialized consultancy services. Our expert team is prepared to support professionals, developers, and technology users in various technical areas, ensuring optimal outcomes for your projects.

In the year 2024-25, NISE provided consultancy services including technical vetting, field inspections, and field testing for solar projects. Additionally, NISE is offering technical support to the Solar Energy Corporation of India (SECI) for the development, validation, and implementation of qualitative requirements and acceptance test procedures for the establishment of a 3000 MW per annum cell and module manufacturing facility in India. NISE has also partnered with UNICEF India on the implementation of solar-based solutions for public healthcare facilities under the project "Sustainable Innovations for Clean Energy in Immunization and Primary Healthcare in India." As part of this initiative, NISE provided technical facilitation for the solarisation of various public healthcare facilities in Uttar Pradesh. Furthermore, the institute's technical team was engaged in conducting a technical audit of solar photovoltaic power parks implemented by Rewa Ultra Mega Solar in Madhya Pradesh. The team was also involved in the technical inspection of solar power plants installed by the Agency for New and Renewable Energy Research and Technology under the Solar City (Trivandrum) program.



Fig. 9.1: Assessment of Solar PV cell manufacturing facility



Fig. 9.2: Omkareshwar Floating Solar Power Park

9.1.7 Skill Development and Capacity Building

9.1.7.1 Suryamitra Skill Development Programme (Solar PV Installer)

The Suryamitra Skill Development Programme is a commendable initiative by the MNRE in 2015 to address the skill gap in the renewable energy sector, particularly in solar PV systems. By focusing on training technicians for system design, installation, operation, maintenance and repair of solar PV systems at grass root level, the Suryamitra Skill Development Programme plays a pivotal role in ensuring the availability of a skilled workforce critical to achieving India's net-zero targets by 2070. This initiative supports the deployment, operation, and maintenance of renewable energy systems, particularly solar power, which is a cornerstone of India's clean energy transition. MNRE has entrusted the NISE with the responsibility of coordinating and implementing the Suryamitra Skill Development Programme. This strategic collaboration ensures the systematic and effective training of technicians to support India's expanding solar energy sector.

By decentralizing Training Centers, the program has reached rural and semi-urban areas, enabling local communities to participate in the renewable energy transition. With a strong foundation, the Suryamitra program, currently operating across 30 states (<https://suryamitra.nise.res.in/>), aims to achieve its skilling target of 12,800 individuals for FY 2024-25. This initiative is set to play a pivotal role in supporting India's ambitious renewable energy goals, including achieving 280 GW of solar power capacity by 2030 and meeting its net-zero commitments. To bridge the skill gap and enhance the employability of trained Suryamitras, a "Networking Event with Suryamitra Training Partners, Solar PV Developers, and EPCs" was held at NISE on December 17, 2024.

Achievements of the Suryamitra Programme (till December 31, 2024):

- **Total Trained Suryamitras:** 57,372 individuals have successfully completed the training program.
- **Placement Success:** Of these, 28,500 Suryamitras have secured employment in the solar energy sector, showcasing the program's impact on workforce development and job creation.
- **Nationwide Reach:** Training has been conducted through a network of Training Partners Centers across the country, ensuring widespread access and regional inclusivity.



Fig. 9.3: Participants in the Networking Event with Suryamitra Training Partners, Solar PV Developers, and EPCs



Fig. 9.4: Valedictory function organised by NISE under ITEC initiative of MEA

9.1.7.2 Varunmitra Skill Development Programme (Solar Water Pumping Training)

Solar PV water pumping systems are a key application of solar energy, addressing irrigation needs sustainably and efficiently. Under the PM-KUSUM scheme, the government aims to incentivize farmers for transition to solar-powered water pumps for irrigation, reducing dependence on conventional fuels. However, the installation, commissioning, and maintenance of these systems require a skilled workforce, leading to the establishment of the Varunmitra Programme. The Varunmitra Programme is designed to:

- Train individuals in the design, installation, and commissioning of solar water pumping systems.
- Provide skills for operation, safety, troubleshooting, and maintenance of these systems.
- Build a pool of skilled technicians to support the rapid rollout of solar water pumps under PM-KUSUM.

For FY 2024-25, the programme has set a skilling target of 510 individuals, contributing to the manpower needed for the increasing demand for solar water pumps.

Achievements of the Varunmitra Programme (till December 31, 2024)

- **Total Trained Varunmitras:** 1,266 individuals have successfully completed the training program.
- **Nationwide Reach:** A network of training centers and partners ensures regional inclusivity and wide

Future Targets

9.1.7.3 PM Surya Ghar: Muft Bijli Yojana – Empowering Residential Solar Adoption

The Government of India's approval of the PM Surya Ghar: Muft Bijli Yojana on February 29, 2024, marks a significant milestone in promoting solar rooftop installations in the residential sector. To support the ambitious goals of PM Surya Ghar: Muft Bijli Yojana and address the demand for a skilled workforce, the NISE developed and proposed training modules. These were officially approved by the MNRE on October 9, 2024, and implementation is now underway. Training Modules Approved by MNRE are:

a. Solar PV Installers

- **Target:** 20,000 candidates
- **Objective:** Train individuals in the installation of solar PV systems, focusing on safety, efficiency, and quality.

b. Rooftop Solar Supervisors

- **Target:** 10,000 candidates
- **Objective:** Equip supervisors with advanced knowledge for overseeing rooftop solar installations, including project management, troubleshooting, and compliance.

c. On-the-Job Training (OJT) for Trained Installers/Suryamitras

- **Target:** 25,000 candidates
- **Objective:** Provide practical, hands-on experience to existing trained personnel, enhancing their skills for real-world challenges.

During the year, NISE conducted a Master Trainers Training Programme on Solar PV Installation for faculty members of National Skill Training Institutes (NSTI) from June 24-25, 2024. This marked the foundational training programme under the PM Surya Ghar - Muft Bijli Yojana scheme. Allotment letters were issued to Training Centers with the goal of training a total of 55,000 candidates, in alignment with the MNRE's targets for workforce readiness in the solar rooftop sector. This initiative aims to cover all levels of expertise, from installers to supervisors, ensuring widespread access, regional inclusivity, and a skilled workforce across the country.



Fig. 9.5: Participants in the Master Trainers Training Programme Training Program

9.1.7.4 National & International Training Programmes

During the calendar year 2024 (January 2024 to December 2024), NISE conducted eleven (11) numbers of National Training programs and 1 International Training program.

9.1.8 Outreach Activities

9.1.8.1 Approved List of Models and Manufacturers

To ensure reliability of Solar PV products and to protect the consumer interests and ensure better energy security of the country, MNRE on 02.01.2019, has issued “Approved Models and Manufacturers of Solar Photovoltaic Modules (Requirements for Compulsory Registration) Order, 2019”. The order provides for the enlistment of eligible models and manufacturers of solar PV cells and modules complying with the BIS Standards and publishes the same in a list called the “Approved List of Models and Manufacturers” (ALMM). Only the models and manufacturers included in this list will be eligible for use in Government/ Government assisted Projects/Projects under Government Schemes & Program, installed in the country, including Projects setup for the sale of electricity to the Government. NISE has been designated as an implementation support agency for processing applications and carrying out inspections, verifications, and quality checks on behalf of MNRE.

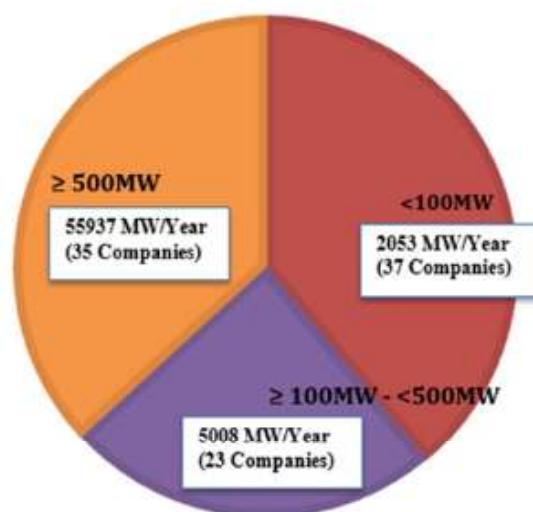


Fig. 9.6: Capacity-wise distribution of ALMM inspected companies

As on 31st December 2024, a total of 95 manufacturing plants are enlisted in ALMM with a cumulative installed manufacturing capacity of 63 GW/Year (62,998 MW/Year). Since April 2024, 83 inspections (which includes New Application, Renewal, Model Addition, & Capacity Addition) of various manufacturing plants have been conducted with installed manufacturing capacity of 59.75 GW/Year.

9.1.9 Administration and Finance

The Government of India has sanctioned 41 regular posts for NISE, including the post of Director General. The affairs of NISE are managed by a Governing Council (GC), chaired by Secretary, MNRE (ex-officio

President, NISE), in accordance of rules, regulation and bylaws of the society, which are duly approved by administrative Ministry i.e. MNRE. Secretary MNRE is president of Society (NISE) and Director General is Principal Executive Officer of the Society (NISE).

The funds of the Society are managed by following Sources:

- Core Grants made by Government of India for furtherance of the objects of Society.
- Contribution from other Sources like various projects.
- Income from Investments.
- Receipts of the society from revenue generation activities like ALMM, Testing, Consultancy, Skill development activities etc.

NISE is following the General Financial Rules 2017, Fundamental and Supplementary Rules and such other rules (mutatis mutandis) as applicable to Central Government.

9.2 NATIONAL INSTITUTE OF WIND ENERGY (NIWE)

9.2.1 National Institute of Wind Energy (NIWE) is a technical arm of the Ministry for the smooth development of the wind energy sector in the country. NIWE's main activities include Wind (onshore & offshore) and Solar Resource Assessment; preparation of standards for wind turbines; testing and certification of wind turbines and associated systems; information dissemination; human resource development; and offer various consultancy services to customers. The major activities of NIWE during this period are given below:

9.2.2 OFFSHORE WIND DEVELOPMENT

A. Met-Ocean measurements in Gulf of Khambhat and Gulf of Mannar

The MNRE has sanctioned project Met-Ocean Measurements at Gulf of Khambhat and Gulf of Mannar for Fostering the Growth of Offshore Wind in the Country to NIWE with the objective of quantifying the wind potential of such regions towards demarcating the offshore wind energy blocks.

Under the project, 3 sites have been identified to map offshore wind resource in Gulf of Mannar, Tamil Nadu coast.

NIWE has identified suitable locations for deploying the Offshore Lidar at VOC port (4 to 5 km from the sea shore) and Udangudi Thermal Coal jetty (8 to 9 km from the sea shore) which together with the measurements at sub-zone 1 will cover wind profile of the Tamil Nadu coast.

The Installation and commissioning of LiDAR at above mentioned sites have been completed and measurement are under progress.

LiDAR Location

Location	LiDAR Serial number	Latitude/Longitude
VOC_Port_1	ZX300M-996	8° 44' 58.2" N / 78° 13' 36.19" E
VOC_Port_2	ZX300M-997	8° 45' 19.58" N / 78° 13' 16.24" E
UDANGUDI	ZX300M-998	8°23'35.763"N / 78°8'0.686"E

B. Offshore studies/ survey in Sub-Zone 1 in Gulf of Mannar off Tamil Nadu coast

NIWE has initiated the offshore wind resource assessment and geophysical & geotechnical investigation

for development of offshore wind farm of 500 MW at sub zone 1 Gulf of Mannar off Tamil Nadu coast under Model A.

The floating buoy was successfully deployed at Sub-zone-1 Gulf of Mannar, Tamil Nadu coast on October 2024 and data is being received at NIWE server.

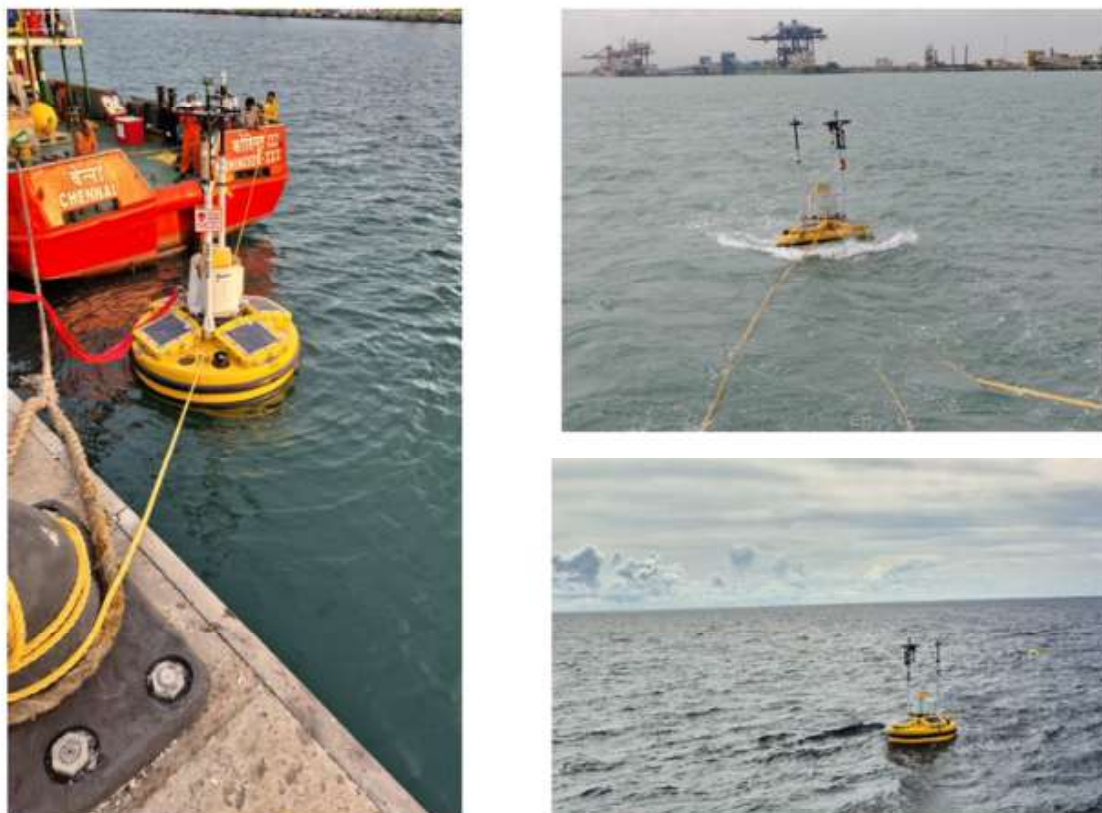


Fig. 9.7: Floating Buoy deployed at Gulf of Mannar

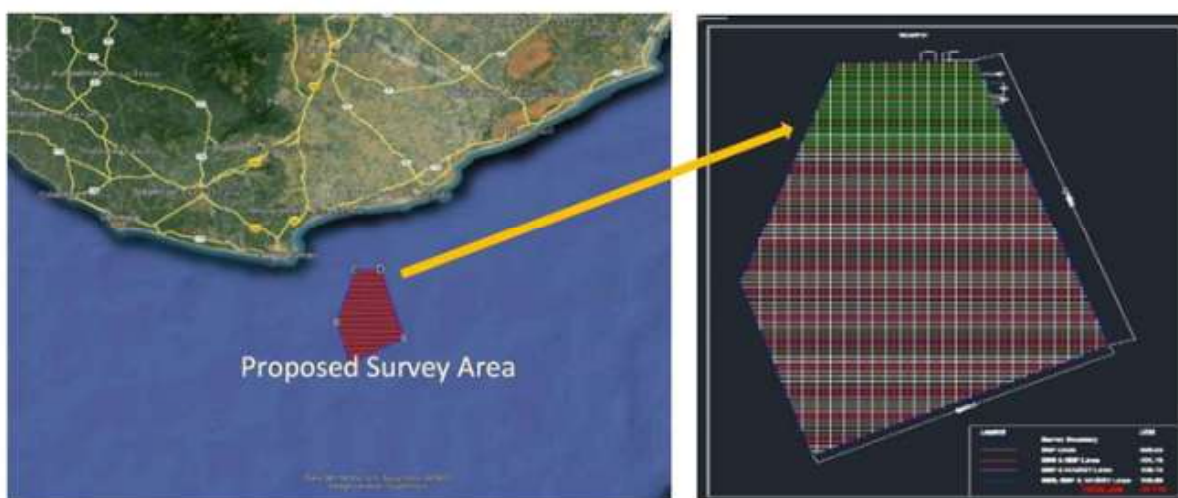




Fig. 9.8: Deployment of Side scan sonar and Data interpretation

C. Environment Impact Assessment (EIA) study at Dhanushkodi:

EIA study for the offshore National Test Centre at Dhanushkodi / Greening of Rameshwaram has been completed.



Location of seawater, seabed sediments and biological sampling - Palk Bay

Fig. 9.9: Location of EIA Study for Offshore National Test Centre

9.2.3 WIND & SOLAR RESOURCE MEASUREMENTS

Wind Resource Assessment (WRA) programme data is being used widely to identify the potential site for establishment of Wind Farms in the country. Under this programme of the Ministry, 916 dedicated wind monitoring stations & 115 dedicated Solar Radiation Resource Assessment stations have been established with the support of State Nodal Agencies & other institutions.

9.2.4 WIND TURBINE TESTING STATION (WTTS)

Testing

- The testing facilities are certified as per the requirements of ISO 9001:2015 and accredited as per the requirements of ISO / IEC 17025:2017. In the year 2024-25 (till December 2024), the division has carried out Type Testing measurements on Power Performance, Load measurements, Safety & function testing as per IEC Standards for a wind turbine with 3.3 MW power booster mode operation at a site located in Gujarat and issued the Test reports for the same. In addition, Test reports have been issued on Load Measurements for a 3 MW wind turbine, Power Performance & Load measurements for a 225 kW wind turbine and Acoustic Noise Measurements for a 2.7MW wind turbine as per IEC Standards.
- NIWE has successfully undergone the NABL onsite reassessment audit as per ISO / IEC 17025:2017 held on 27th and 28th July, 2024 at WTTS, Kayathar for renewal of accreditation of Testing services and NABL has granted Certificate of Accreditation valid till 02.08.2026.

Inter Lab Comparison (ILC)

- As per MNRE lab policy, an Inter Lab Comparison (ILC) on Power Performance and Load Measurements as per Standards viz., IEC 61400-12-1 and IEC 61400-13 respectively with 3 other Test laboratories viz., M/s. DNVGL, M/s. Deutsch Windguard and M/s. UL was organized and completed. All labs are within the Z-Score requirements of ISO/IEC 17043.

Development of Test Facilities

- An agreement has been signed by Madhya Pradesh Industrial Development Corporation (MPIDC), Madhya Pradesh with NIWE on 25.06.2024 for development of Common Test Facility (CTF) on Calibration Wind Tunnel for Special Economic Zone (SEZ) proposed by Madhya Pradesh Industrial Development Corporation (MPIDC), Madhya Pradesh.

9.2.5 STANDARDS AND CERTIFICATION

Certification

NIWE has obtained International Accreditation for the certification services as per the requirements of ISO/IEC 17065 standard from the National Accreditation Board for Certification Bodies (NABCB), Quality Council of India (QCI) in the year 2020 which is valid upto 2027.

Accreditation for the certification services has benefited the wind industry to avail accredited Type & Component certification services within India in line with International best practices.

Accredited Type Certificates have been issued for 5 Wind Turbine models.

NIWE has obtained International Accreditation for Inspection Services from NABCB as Type 'A' Inspection Body as per the requirements of ISO/IEC 17020 in the year 2024 which is valid upto 2027.



Accreditation for the Inspection services for various wind turbine components such as Hub & Nacelle Assembly, Rotor Blade, Tower, Generator, and Power Transformer as per the requirements of ISO/IEC 17020 will benefit the wind industry to avail accredited inspection services within India in line with International best practices.

Standards

NIWE is involved in the preparation of Indian standards on wind turbines by supporting Bureau of Indian Standards (BIS). BIS is the National Standards Body which issues Indian standards. A committee viz., Wind Turbines Sectional Committee (ETD 42) has been formulated by BIS for the preparation of Indian standards and to carry out the standards related works on wind turbines, under the Chairmanship of Director General, NIWE. Standard & Regulation division of NIWE, which is part of BIS ETD 42 committee, provides the technical support to BIS on a continuous basis in all the standards related works. Based on the contribution, Thirty Indian standards on wind turbines have been finalized, so far.

Revised List of Models and Manufacturers of Wind Turbines (RLMM):

MNRE has been issuing Revised List of Models and Manufacturers of wind turbines (RLMM) periodically for the healthy and orderly growth of wind power projects in the country. S&R division, which is part of RLMM committee, has been providing support to MNRE in verification of documentation submitted along with application and in handling RLMM related works. During the period (01st April, 2024 to 31st December 2024), review of documentation has been completed for 24 RLMM applications of various wind turbine models and the review comments have been submitted to MNRE / RLMM committee.

Prototype Wind turbine Models:

NIWE is implementing MNRE guidelines on installation of prototype wind turbine models in India which facilitates the installation of prototype wind turbine models to carry out the type testing for obtaining type certificate. NIWE has formulated a committee to take a suitable decision on issuing the recommendation letters in connection with grid synchronization. During the period (01st April, 2024 to 31st December 2024), NIWE has issued the recommendation letter in connection with grid synchronization for two prototype wind turbine models i.e. one with a rated capacity of 3100kW and another with a power booster mode of 3300kW for the purpose of Type Testing.

Quality Management System:

NIWE has carried out various preparatory works in maintaining the QMS of NIWE as per ISO 9001:2015 standard. During the period, successfully undergone the Second periodic audit of quality management system on 04.07.2024 & 08.07.2024 as per ISO 9001:2015 at WTTS Kayathar and NIWE, Chennai respectively. Based on successful completion of the second periodic audit, DNV recommended the continuation of the ISO certificate issued to NIWE.

9.2.6 NIWE'S GLOBAL R&D IMPACT THROUGH INTERNATIONAL COLLABORATIONS

(A) IEA Wind TCP

NIWE continues to play a significant role in the International Energy Agency's Wind Technology Collaboration Program (IEA Wind TCP). Alternate Member representing India, delivered the country presentation at the 95th Executive Committee meeting held online from November 12-14, 2024. This global gathering brought together over 70 R&D lab heads and country representatives to discuss cutting-edge research and development in the wind energy sector. NIWE's WRA Division has taken the lead in

Task 52 - Large-Scale Deployment of Wind Lidar, in collaboration with the Fraunhofer Institute Germany.

(B) Global Partnerships

In partnership with the University of Massachusetts, Amherst (UMAAS), and with the support of the Ocean Energy Pathway (OEP) and the Global Wind Energy Council (GWEC), India, NIWE is undertaking a comprehensive desktop study to identify global and local best practices for advancing community engagement in offshore wind development. This study will focus on the Gulf of Mannar region in Tamil Nadu. By leveraging international collaborations and innovative research, NIWE is committed to driving the growth of sustainable and responsible wind energy development in India and globally.

9.2.7 SKILL DEVELOPMENT AND TRAINING

NIWE has conducted the following five National / customized training courses:

- Special course on “Wind Energy Technology” held during 24th to 26th July 2024 for 24 officials of M/s. Gail (India) Ltd.
- 26th National Training Course on “Wind Energy Technology” held during 21st to 23rd August 2024 and trained 46 participants from 9 States and 2 Union Territories of India.
- Special course on “Wind Energy Technology” held during 21st to 25th October 2024 for 15 officials of M/s Envision Wind Power Technologies India Pvt. Ltd.
- Special course on “Wind Energy Technology” held during 11th to 16th November 2024 for 25 officials of M/s ReNewPvt. Ltd.
- 27th National Training Course on “Wind Energy Technology” held during 18th to 20th December 2024 and trained 48 participants from 8 States and 1 Union Territory of India.

9.2.8 VAYUMITRA SKILL DEVELOPMENT PROGRAMME

During 2024-25, NIWE has successfully conducted 3 nos. of Training of Trainers (ToT) batches and trained, assessed, and certified 85 trainers. In addition, 6 nos. of Training of Participants (ToP) have been completed and trained 180 participants under VSDP.



Fig. 9.10: Training of Trainers programme of Vayumitra Skill Development Programme



Fig. 9.11: Training of Participants programme of Vayumitra Skill Development Programme

9.2.9 National Council for Vocational Education and Training (NCVET)

NIWE was granted the status of an Awarding Body and Assessment Agency (Dual Recognition) by National Council for Vocational Education and Research (NCVET), Ministry of Skill Development and Entrepreneurship, Government of India and also developed a Qualification Pack titled “Wind Farm Engineer” which has been subsequently uploaded in the National Qualification Register (NQR). An Agreement to this effect was signed on 27.08.2024 between NCVET and NIWE for having obtained Dual Recognition as Awarding Body (AB) and Assessment Agency (AA).



Fig. 9.12: Dual Recognition Certificate from NCVET

9.2.10 STUDENT VISIT AT NIWE CAMPUS

NIWE has arranged and coordinated campus visits to create awareness and to motivate students towards research on wind energy, achieving indigenization and also to create an awareness about the activities and services of NIWE among the students. 1000 students were benefitted from this arrangement during 2024-25.



Fig. 9.13: Students visit at NIWE Campus

9.2.11 NIWE-ACADEMIC ASSOCIATE PROGRAMME (NIWE-AAP)

The “NIWE-Academic Associate Programme” (NIWE-AAP) aims to encourage students and provide an opportunity to choose renewable energy as their career option. To create awareness and interest in the field of renewable energy research among the young talented Science, Management and Engineering students NIWE invites applications from the eligible candidates for the “NIWE-Academic Associate Programme” (NIWE-AAP).

The duration of the Internship is two weeks to six months. NIWE-AAP will provide opportunities for the graduate students/post graduate students/ Lecturers/Professors to work with scientists/engineers on NIWE’s projects.

During 2024-25, 158 applications received, 79 admitted and 70 students have successfully completed their internship and Certificates were issued.

9.3 SARDAR SWARAN SINGH NATIONAL INSTITUTE OF BIO-ENERGY (SSS-NIBE)

Sardar Swaran Singh National Institute of Bio-Energy (SSS-NIBE), Kapurthala is an autonomous Institution under the Ministry of New and Renewable Energy (MNRE), Govt. of India, set up as an apex Institution for carrying out state-of-the-art research and developmental activities, biomass resource assessment, testing, validation and training for promotion of bioenergy in the country.

During this year, the Institute took key initiatives to further extend R&D activities in bio-energy and bioproducts. The research findings have been published in reputed journals of the frontier bioenergy area. Furthermore, the Institute participated in all technical programs and meetings of MNRE, particularly related to bioenergy sector for activities such as recent research developments, strategy and policy, progress and dissemination of knowledge and technology in the area. Likewise, some of the laboratory testing methods went through NABL review process during December 2024. The activities taken during the tenure are given below:

9.3.1 EXTERNALLY FUNDED PROJECTS

SSS-NIBE has been awarded several research projects, funded by GOI are as follows:

Project title	Funding Agency	Project Cost	Start w.e.f.	Project Duration
Composition analysis of different types of pellets/briquettes received from unknown sources	Central Power Research Institute, MOP	Rs 37,00,000	2022	1 year
Complete heating and emission analysis of raw biomass and pellets during combustion	Central Power Research Institute, MOP	Rs 66,00,000	Mar 2022	2.5 years
Complete Ash Analysis of biomass pellets and co- combusted fuels	Central Power Research Institute, MOP	Rs 2,70,00,000	Mar 2022	3 years
Densification of agro-waste and assessment for its application in the gasifier	MNRE	Rs 40,45,320	Mar 2022	2.5 years
Advanced Microalgal Biorefinery approach for the recycling of domestic sewage wastewater for a cleaner and greener Indian Himalayan region* funded by National Mission on Himalayan Studies (NMHS), G.B. Pant National Institute of Himalayan Environment (NIHE) KosiKatarmal, Almora - 263643, Uttarakhand, India (Under the Ministry of Environment, Forest and Climate Change (MoEF CC), Govt. of India).	MoEF	Rs 96,75,520	July 2023	3 years
To optimise the mixing and co-milling of biomass pellets (agro-residues) with coal for use in thermal power plants with minimal modifications to existing systems	DST	Rs 72,63,000	June 2024	2 Years

The first project titled “Composition analysis of different types of pellets/briquettes received from unknown sources” is mainly concerned with forming a regression-based method to obtain the composition of an unknown pellet or briquette. This research study carried out as part of SAMARTH mission for co-firing of biomass in thermal power plant. This project has relevance to thermal power plants to ensure maximum utilization of paddy straw in pellets for co-combustion and solution for stubble burning. The objective of the project is to find the percentage of paddy straw in unknown biomass pellets, which involved finding the

right biomarker that would determine the percentage of paddy straw in unknown biomass pellets.

The second project titled “Complete heating and emission analysis of raw biomass and pellets during combustion”, and is concerned with the burning rate, thermal efficiency and emission analysis with the pellets during combustion and to generate a database and recommendation for appropriate thermo and environmental analysis for meeting the desired standards. Biomass samples native to Punjab, Jammu and Kashmir and Himachal Pradesh and Uttarakhand (wheat stalk, rice stalk, pine etc.) were collected to determine the burning rate, thermal efficiency etc. of the biomass samples. Basic characterization (Proximate, ultimate and calorific value) of the pure biomass samples has been completed.

The third project titled “Complete ash analysis of biomass pellets and co-combusted fuels” is concerned with studying the ash fusion behaviour and obtaining the various metallic oxides, halides and sulphur present in the ash. Ash was prepared using BS EN ISO 18122: 2015 standards and SEM-EDS and XRD studies were done to observe their morphology and composition. Also, 26 different varieties of bamboo species native to the state of Tripura were collected to study their potential as fuel source and to study their ash properties. North-eastern states of India account for around 28% of the India’s bamboo stock and Tripura has 23% of its geographical area covered with bamboo forests. There is immense scope for utilizing waste bamboo and unused bamboo of Tripura and northeast India for charcoal production and subsequent use in coal-based powerplants. A MoU was signed between Tripura Forest Department and SSS-NIBE for knowledge exchange.



Fig. 9.14: Various bamboo species sourced from Tripura: solid and powdered form

For the MNRE project titled ‘Densification of agro-waste and assessment for its applications in the gasifier’, significant work has been done for completion of objectives of the project.

The project from National Mission on Himalayan Studies, MoEF&CC, Govt. of India titled “Advanced microalgal refinery approach for recycling of domestic sewage/wastewater for cleaner and greener Himalayan region”, is a collaborative project with NIT Hamirpur and implementing agency being Jal Shakti Vibhag, Hamirpur, at one of its Sewage Treatment Plant (STP), Hamirpur. The project aims to develop a sustainable process to treat domestic sewage wastewater using algal and conversion of harvested algal biomass into biogas, biocrude, biochar, and high-value products.

The DST Funded project includes a virtual simulation platform, a co-milling design guide, and improved practices for biomass utilisation to enhance efficiency and reduce emissions. In this direction, the numerical study has been initiated using the computational fluid dynamics (CFD) analysis performed in ANSYS fluent.

9.3.2 During the year, following important activities have been carried out under Thermo-chemical Conversion Division:-

- Improved biomass cook-stove testing and certification
- Advance biomass cookstove testing, demonstration and dissemination in collaboration with Fire and Combustion Research Center (FCRC), Jain University, Bengaluru
- Biochar Kiln

Biochar – a beneficial soil conditioner and carbon negative material. Instead of indiscriminate burning, paddy straw can be converted into biochar for soil conditioning purposes. In this regard, a biochar kiln was constructed using bricks and mortar, equipped with a chimney and fan to burn off volatiles, among other components.

9.3.3 Collaboration Project - Prediction of biomass to Hydrogen production potential in India using GCAM modeling

- In house Project “Design and development of Rotary Drum torrefaction reactor”

9.3.4 In house Project “Development of a Producer gas combustor”

9.3.5 During the year, following important activities have been carried out under Biochemical Conversion Division:-

- Thermophilic anaerobic consortium enrichment for enhanced biogas/ biomethane Production
- Upgradation of biogas to Bio CNG via microbial electro methanogenesis
- Integrated approach of Sequential dark and photo fermentation for hydrogen generation from paddy straw
- Exploration of lignocellulolytic enzymes producing thermophiles from hot springs of Western Himalayan region for biorefinery applications
- Optimizing Ammonia Pretreatment of Lignocellulosic Biomass for Enhanced Bioethanol Production
- Advanced microalgalbiorefinery approach for recycling of domestic sewage/wastewater for cleaner and greener Himalayan region

9.3.6 Activities under Chemical Conversion and Electrochemical Process Division

- Hydrothermal liquefaction for phenolic rich bio-oil production;
- Biochar for Phosphorus and Nitrogen adsorption from wastewater;
- Comprehensive characterization of sawdust-derived biochar for energy applications.
- Paddy straw valorization through thermochemical processes for the production of bio-oil and biochar, and the application of biochar as an adsorbent.
- The Electrochemical Process Division at SSS-NIBE is actively conducting research on utilizing both conventional and underexplored biomass sources to synthesize carbon materials for various electrochemical applications, including the Hydrogen Evolution Reaction (HER) and Oxygen Evolution Reaction (OER).
- Synthesis of activated carbon from bamboo
- Synthesis of Carbon Quantum Dots from bamboo



9.3.7 During the year, following important activities have been carried out under Biomass and Energy Management division:-

- Development of a static National Biomass Atlas of India

BEMD has developed a National Biomass Atlas for easier understanding of the from crop residual biomass availability scenario in the country, based on the study by ASCI for MNRE. The salient features of the National Biomass Atlas are:

- Graphically presents state-wise total and surplus biomass availability in the country.
- State-wise and Crop-wise surplus biomass availability for different important crops.
- State-wise and crop-wise fractions of the different residues available per crop for the various important crops.
- Images of the different crops considered with their crop residue ratios.

District level Biomass Atlas of India - graphically presents the District-wise Power Potential and Surplus Biomass availability. The division is working on upgrading the existing National Biomass Atlas and extending it to a district level. Initially, a study is being conducted to update the atlas with recent data at a District-level for the state of Punjab. Based on the study by ASCI for MNRE, Biomass and Energy Management Division had developed a National Biomass Atlas for easier understanding of the biomass availability scenario in the country. Some of the salient features of atlas were the graphical representations of the total and surplus biomass availability at the state-level in the country. The atlas also shows the availability of different residues per crop for the different important crops with surplus biomass in each state.

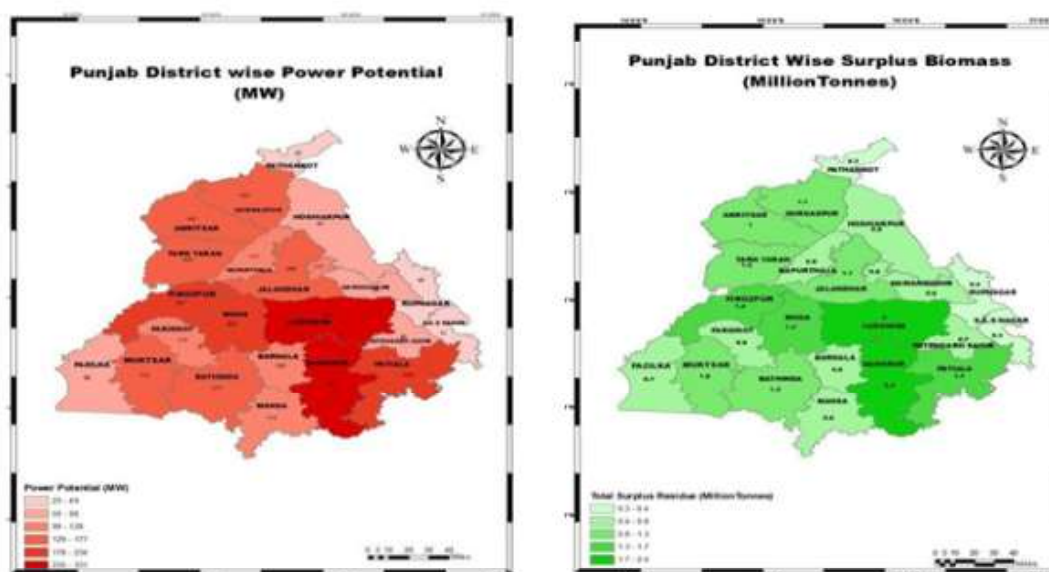
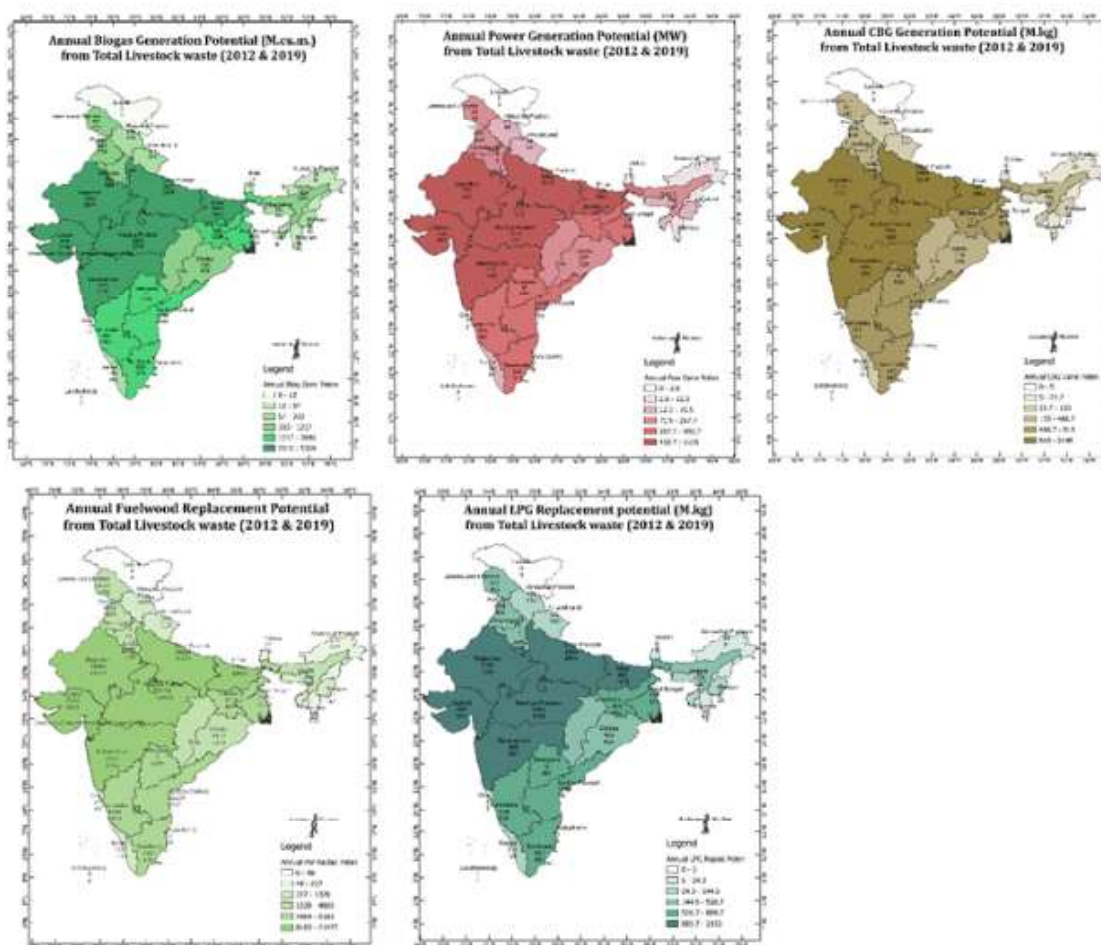


Fig. 9.15: District level Biomass Atlas of India

9.3.7.2 Development of Livestock-waste energy atlas of India

Livestock rearing has been one of the primary sources of income in the rural India, gradually finding its place in the semi-urban Indian locations as well. However, there still exists scope on proper research and development (R&D) when it comes to livestock waste assessment and its utilization for energy production

in India. In this study, the state wise census of livestock: cattle, buffalo, piggery, poultry, sheep, and goat, has been captured from the Livestock census, 2012 and 2019. Thereafter, the state wise biogas generation from each of the above livestock category waste, has been calculated, followed by the estimation of power generation for electricity, CBG generation for transportation, and LPG and fuelwood replacement potential for cooking. It is observed that the annual biogas generation potential from total livestock for 2012 is 31,603 Mm³, and that for 2019 is 33,689 Mm³, contributed maximum by cattle waste. State wise contribution is observed to be the maximum from Uttar Pradesh, followed by Rajasthan, and Madhya Pradesh. The power generation potential, CBG generation potential, and LPG/fuelwood replacement potential from the total livestock for 2019 has been estimated as 7122 MW, 13,475 M.kg, 14967/134756 M.kg, respectively.



based algorithms developed at NIBE that can ensure precise temperature control and efficient energy management in biogas plants. It integrates renewable energy sources like solar, biomass, and waste heat, making it sustainable and economical.



(a)



(b)

Fig. 9.17: (a) Lab-scale model of smart hybrid anaerobic digester (Phase I); (b) Smart hybrid pilot-scale biogas plant (Phase II)

9.3.8 Collaborations

During the year 2023-24, SSS-NIBE signed MoU's with various institutions to facilitate collaborative research and exchange of students for academic work. The MoU's signed are:

- 9.3.8.1** The extension of MoU between SSS-NIBE and IBA, Gurugram was signed on 09.01.2024.
- 9.3.8.2** A strategic MoU was signed between SSS NIBE and Indian Institute of Technology, Roorkee (IITR) on 09.02.2024. This MoU will explore several avenues for collaboration in the field of bioenergy and bioproducts, starting with research scholars enrolling for PhD programs at IITR, commencement of jointly new academic programs – integrated PhD, exchange of faculty as visiting scientists, jointly submission of proposals, training etc.



Fig. 9.18:

- 9.3.8.3** MoU was signed between SSS NIBE and Organic Recycling System Limited (ORS) on 8th April, 2024 to collaborate on sustainable technology development. SSS-NIBE and ORS Joins Hands, To Propel Napier Grass Based Anaerobic Digestion Process for Biogas Generation. Strategic Partnership Aims to Maximize Biogas Potential of Napier Grass Advancing India's Renewable Energy Agenda.

9.3.9 Technology outreach and demonstration

SSS-NIBE exhibited a stall at the Biofuels Expo, PragatiMaidan, New Delhi from 5-7th June. The technologies/products developed at NIBE were showcased at the stall and generated a lot of interest in the expo visitors. Similarly, institute participated in The Renewable Energy India Expo (REI Expo), organized at the India Expo Centre and Mart, Greater Noida, Uttar Pradesh from 3rd- 5thOctober 2024. The MNRE booth in the Bioenergy Pavilion was managed by SSS NIBE. Posters from NIBE's work activities and research were also exhibited at the stall. Dr Sachin Kumar and Dr Vandit Vijay with research scholars from NIBE attended the expo and exhibited the stall. Dr Sachin Kumar also gave a talk in the international conference organized during the expo on 5thOctober 2024.

9.3.10 Training/Workshop/Seminar

SSS NIBE is devoted to the promotion of bio-energy, with this aim, the institution organised outreach programmes and events on many facets of bio-energy. The institute organised the following capacity building programs.

- SSS-NIBE and Indian Biogas Association (IBA) jointly organized a five-day National hands-on training program on 'Biogas Technology and its Implementation' in hybrid mode between 19 and 23 Feb 2024.
- A two days National Workshop on, Biomass-based Clean Cooking Solutions was organized from 29th Feb. to 1st March, 2024.
- A two-day National Workshop on "Specialized Hands-on-Training cum Workshop on Agro-biomass Sampling and Characterization Techniques for Thermal Power Plant Applications" on 4th July - 5th July, 2024, for NTPC officials.
- A one-day National Seminar was organised by the division on "Biomass Supply Chain Management: Challenges, Opportunities, and Developments" on 5th September 2024 at MGSIPA Complex, Chandigarh.
- SSS NIBE jointly organized a National Hands-on Training Programme on Biogas Technology and its Implementation with the Indian Biogas Association (IBA) from 21st – 25th October, 2024.

9.3.11 Events

- Hindi Pakhwada: During the Hindi Fortnight celebration, the institute organized various competitions and a KaviSammelan. Prominent among these competitions were the Hindi essay competition, quiz competition, and debate competition, all of which saw active participation from institute employees.
- Expert's Visit: Visit by Dr. Ajay Mathur, Director General, International Solar Alliance to the institute
- 75th Republic Day Celebration: The 75th Republic Day was celebrated on 26th January, 2024 with enthusiasm in the Institute. On this occasion, DG NIBE hoisted the flag, which was followed by tree plantation and cultural program was conducted by research fellows, staff and their families.
- Workshop: SSS NIBE conducted a one-day workshop on 30th April, 2024 on the theme Idea, Research, Innovation, Intellectual Property Rights and Technology Transfer jointly supported by PSCST and DST Govt. of India.

9.3.12 Publications

No. of Journals - 41

No. of Book Chapters - 11

No. of Books/ Conference Proceedings - 4 No. of Patents - 4



9.4 SOLAR ENERGY CORPORATION OF INDIA LIMITED (SECI)

9.4.1 INTRODUCTION

Solar Energy Corporation of India Ltd. (SECI) is a Section- 3 Company under the Companies Act, 2013, with 100 percent Government of India ownership, under the administrative control of the Ministry of New and Renewable Energy (MNRE). SECI is a Schedule- A Central Public Sector Undertaking (CPSU). SECI was accorded the status of Navratna Central Public Sector Enterprise (CPSE) on 30.08.2024. The company is an implementing and executing arm of Govt. of India for development of Renewable Energy (RE) sector in the country.

9.4.2 BUSINESS ACTIVITIES

9.4.2.1 Tenders for Large-scale Solar projects

SECI is an implementing agency of MNRE for development of solar projects under the National Solar Mission (NSM). Under this mode (referred as developer-mode), SECI floats tenders on pan-India/state-specific basis for selection of developers for setting up of solar projects, who are selected through a transparent tariff-based e-bidding and e-reverse auction process. Investment in these projects is made by the respective project developers. SECI signs long term Power Purchase Agreements (PPA) with the developers and long term Power Sale Agreements (PSA) with various DISCOMs/ buying entities for off-take of power, as a power trading intermediary.

Presently, tenders are being floated on tariff- bidding based on Standard Bidding Guidelines. As on 31.12.2024, the cumulative awarded solar capacity is 45.326 GW of which, 5.15 GW has been awarded during FY 2024-25. Of the total awarded capacity 18.89 GW capacity of projects have been commissioned (till 31.12.2024).

9.4.2.2 Tenders for Wind Power Projects

SECI brings out tenders for setting up of large-scale Wind Power Projects on Pan-India basis in developer-mode, towards fulfilment of National target.

Cumulative awarded wind capacity by SECI is 16.39 GW (till 31.12.2024), of which, 100 MW has been awarded during FY 2024-25. Of the total awarded capacity over 6.82 GW has been commissioned (till 31.12.2024).

9.4.2.3 Tenders for Hybrid Projects

To cater to offtakers' demand for bringing firmness and flexibility in RE power, SECI has issued tenders with different configurations, viz. Solar-Wind Hybrid, RE with assured supply during peak hours and Round the Clock (RTC) RE, with provision for combination of different RE/energy technologies and/or energy storage, as applicable.

Cumulative awarded capacity in this segment is 11.8 GW (till 31.12.2024), of which 2.43 GW was awarded in FY 2024-25. Of the total awarded hybrid capacity, 1.73 GW hybrid capacity have been commissioned till 31.12.2024.

In response to the growing share of RE and to better integrate the RE capacities into the National Grid, the company has been at the forefront of innovation. In FY 2024-25, SECI awarded 630 MW of Firm and Dispatchable RE(FDRE) projects in August 2024. The lowest tariff discovered is Rs. 4.98 per unit setting



a new benchmark in the sector for RE supply on “demand-following” basis. FDRE ensures that energy buyers receive power tailored to their needs, these models signify a pivotal shift in the dynamics between energy buyers and suppliers. They must adhere to pre-defined demand schedules provided by buyers, with penalties imposed for any shortfalls in meeting these requirements as per tender conditions.

Similarly in July 2024, SECI awarded 1200 MW of solar projects with 600 MW/1200 MWh ESS. The lowest tariff discovered for the project was Rs. 3.41/kWh. The projects will be used for meeting peak energy demands of buying entities.

9.4.2.4 Grid Connected Roof-Top Programme

SECI has played a pivotal role in promoting Rooftop Solar through competitive bidding route in the country under various schemes of MNRE.

As one of the Scheme Implementation Partners (SIP) of MNRE for PM Surya Ghar: MuftBijliYojana, SECI has been allotted 12 Ministries which includes Min. of Home Affairs, Min. of Education, Min. of Tourism, Min. of Shipping, UT of Puducherry, UT of Andaman & Nicobar islands etc.

Under the PM Surya Ghar: MuftBijliYojana, SECI has finalised over 19.667 MW of tenders and for more than 38.737 MW bids are under process as on 31.12.2024.

9.4.2.5 Other Schemes of MNRE for promotion of RE

SECI is also implementing MNRE schemes with the role of disbursement of Central Financial Assistance (CFA) to the implementing agencies based on pre-determined progress milestones. Ongoing schemes are: (a) Solar Parks Scheme; (b) CPSU Scheme

The company has six joint venture companies with states –Andhra Pradesh, Karnataka, Uttar Pradesh, Madhya Pradesh, Kerala and Himachal Pradesh-these have been set up primarily to set up large scale Solar Parks and related infrastructure.

PLI (Tranche-II) scheme for module manufacturing: PLI Scheme for National Programme on High Efficiency Solar PV Modules was brought out by the Government for achieving manufacturing capacity of Giga Watt (GW) scale in High Efficiency Solar PV modules with outlay of Rs. 24,000 crore. SECI is the implementing agency for the Production Linked Incentive (PLI) Scheme (Tranche-II) Scheme for High Efficiency Solar PV Modules with an outlay of Rs. 19,500 crore. As a part of tranche II of the scheme SECI awarded 39,600 MW of fully/partially integrated solar PV module manufacturing capacities in April 2023.

9.4.2.6 Project Development

Recently, SECI added 101.7 MW of RE capacity to its own projects portfolio. Currently there are 122.7 MW of operational RE Projects under SECI's CAPEX projects. Projects which were commissioned in FY 2023-24 are-

In February 2024, SECI unveiled India's largest solar-battery project- 100 MW solar project with 40 MW/120 MWh Battery Energy Storage System (BESS)- in Chhattisgarh. Over its 25-year lifespan, the solar plant will reduce approximately 49 lakh metric tons of CO2 emissions, which is equivalent to planting around 88 lakh trees.

In December 2023, SECI commissioned the first on-grid solar project, with state-of-the-art Battery Energy Storage System (BESS), 1.7 MW with 1.4 MWh BESS in Lakshadweep islands. SECI's project



is anticipated to save Rs. 250 crore, reduce diesel consumption by 190 lakh liters while offsetting 58,000 tonnes of CO2 emissions during its anticipated technical lifespan.

The company seeks to expand its footprint in the Renewable Energy sector. SECI has 1325 MW of RE projects in under implementation/ pipeline stages-

Type	Location	Capacity (MW)
Floating solar	Getalsud, Jharkhand	100
Solar + BESS	Leh, UT of Ladakh	25
Solar	Ramagiri, Andhra Pradesh	300
Solar	Radhanesda, Gujarat	700
Solar	Madhya Pradesh	200

9.4.2.7 Providing Consultancy Services to Other Entities

SECI offers Project Management Consultancy in RE sector to public Sector / Government entities, which includes services such as Feasibility Studies, Bid process Management, Construction Monitoring and Management, Commissioning etc. It has been catering to domestic clients and is now looking to expand its scope to international clients as well. Over 350 MW of projects have been commissioned under this model.

9.4.2.8 Power Trading

SECI is the intermediary power procurer between developers and offtakers for Solar Wind, Hybrid projects set up through SECI tenders. SECI has a Category I Trading License from Central Electricity Regulatory Commission (CERC) to carry out power trading on pan-India basis. SECI has signed Power Sale Agreements (PSAs) of 55.72 GW capacity (cumulative, till 31.12.2024). SECI has traded 42.935 Billion Units of renewable energy in FY 2032-24, this is a growth of 22 % from the previous year.

9.4.2.9 New Initiatives

SECI is expanding into emerging areas in the renewable energy sector, including Green Hydrogen, Energy Storage, and Greening the Transport Sector. In doing so, SECI is actively collaborating with relevant stakeholders to explore and tap into the potential of these emerging opportunities.

Green Hydrogen: In line with the National Green Hydrogen Mission, SECI awarded 412,000 metric tons of green hydrogen production capacity and allocated 3 GW of electrolyser manufacturing. As on 31.12.2024, following tenders are under tendering/ evaluation stage-

Technology	Capacity	Tender
Green Ammonia Production	7,39,000 MT	RfS for Production and Supply of Green Ammonia in India under SIGHT Scheme (Mode-2A-Tranche-I)
Green Hydrogen Production	4,50,000 MT	RfS for Setting up Production Facilities for Green Hydrogen in India under SIGHT Scheme (Mode-I-Tranche-II)
Hydrogen Hub	At least 2,00,000 MT	Call for Proposals for Setting up of Green Hydrogen Hubs in India under National Green Hydrogen Mission

Offshore Wind- SECI has issued the tenders for 'Leasing out Seabed for development of 4 GW of Offshore Wind Power Projects' and 500 MW Offshore wind projects with VGF off the coast of Tamil Nadu and Gujarat respectively.

Supply of Green Power in Transport Sector: In the transport sector, SECI has partnered with NCRTC and BPCL to promote clean energy through electric vehicles.

Solarisation of Ladakh: As the Implementing agency for 13 GW RE projects in Ladakh, SECI has identified land for the RE park. Various studies are ongoing.

Greening of Islands: Govt. has designated SECI as Nodal agency for greening of all the islands of the country. Various RE projects are being planned in different islands to reduce the dependency on fossil fuels for electricity generation.

9.4.2.10 Financial Performance

Highlights of Financial performance for fiscal year 2023-24, with comparative position of the previous year, are mentioned below-

Particulars	FY 2023-24	FY 2022-23(for comparative reference)	% Increase in FY 2023-24 over FY 2022-23
Net Worth	2,811.76	2376.31	18.32%
Total Revenue	13,135.80	10,864.43	20.91%
Profit Before Tax	584.45	423.6	37.97%
Profit After Tax	436.03	315.65	38.13%

9.5 INDIAN RENEWABLE ENERGY DEVELOPMENT AGENCY LIMITED (IREDA)

9.5.1 Background

Indian Renewable Energy Development Agency Limited (IREDA) is a Navratna Central Public Sector Enterprise (CPSE) under the administrative control of Ministry of New and Renewable Energy (MNRE). IREDA is a Public Limited Government Company established as a Non-Banking Financial Institution in 1987 engaged in promoting, developing and extending financial assistance for setting up projects relating to new and renewable sources of energy and energy efficiency / conservation, with the motto: ENERGY FOR EVER.

9.5.2 Financial & Operational Performance

- During the Financial Year 2023-24, IREDA has achieved highest-ever loan sanctions of ₹37,353.68 Crore, thereby registering an increase of 14.63% over the previous year's sanctions of ₹32,586.60 Crore and highest ever loan disbursements of ₹ 25,089.04 Crore with a growth of 15.94% over the previous year's disbursement of ₹ 21,639.21 Crore. The revenue from operations increased to ₹ 4,963.94 Crore, registering a growth of 42.56% over the previous year's revenue of ₹ 3,481.97 Crore. Profit Before Tax (PBT) and Profit After Tax (PAT) increased to an all-time high of ₹ 1,685.24 Crore (47.93% increase over last year) and ₹ 1,252.23 (44.83% increase over last year) respectively at the end of FY 24. The loan book of the Company has grown from ₹ 47,075.52 Crore as on 31st March, 2023 to ₹ 59,698.11 Crore as on 31st March, 2024 registering a growth of 26.81%.
- The loans sanctioned during Financial Year 2023-24 (includes co-financed projects / takeover loans)

would support power generation capacity addition of 2,526.19 MW, RE Equipment Manufacturing of 14,284.00 MWp per annum, Biofuel Ethanol production of 3,895 KLPD, Biomass (CBG) 55.10 TPD, Waste to Energy (Biogas from waste) 9.40 TPD and Green Ammonia 900 MTPD.

- (iii) The sector wise breakup of sanctions and disbursements for the Financial Year 2024-25 and the cumulative achievements as on 31.12.2024 are given below in Table 10.8 and Table 10.9.

Table 9.8: IREDA Sector-Wise Break-up of Loan Sanctions and Disbursements during FY 2024-25 as on 31.12.2024

Amount: Rs Crore

Sector	Sanctions	Disbursements
Solar Energy	3,559.55	2,326.49
Wind Power	966.63	746.26
Hydro Power	4,903.06	1,867.51
Waste to Energy	-	33.08
Short Term Loan	1,076.52	880.14
Electrical Vehicle (EV)	425.37	179.54
Biomass (Briquetting, Gasification & Methanation from Industrial Effluents)	376.69	193.30
Loan Facility to State Utilities	7,850.00	5,600.00
Hybrid Wind & Solar	1,943.09	1,044.00
Ethanol	2,927.60	2,417.52
Manufacturing	3,161.96	1,242.80
Miscellaneous (Transmission Lines, Emerging Technology, Guarantee Assistance)	4,258.83	705.45
Total	31,449.30	17,236.09

Table 9.9: IREDA – Sector-Wise Break-up of Cumulative Loan Sanctions and Disbursements as on 31.12.2024

Amount: Rs Crore

Sector	Sanctions	Disbursements
Solar Energy	53,524.23	33,873.05
Wind Power	37,660.22	27,659.50
Hydro Power	22,054.47	13,099.42
Biomass Power & Cogeneration	5,640.38	3,591.65
Energy Efficiency & Conservation	1,381.71	441.54
Waste to Energy	1,144.93	716.18
National Clean Energy Fund (NCEF)	156.57	127.14

Sector	Sanctions	Disbursements
Bill Discounting	181.97	161.76
Bridge Loan	223.86	152.90
Short Term Loan	13,184.35	7,959.57
Electrical Vehicle (EV)	2,058.17	1,140.66
Biomass (Briquetting, Gasification & Methanation from Industrial Effluents)	1,011.12	460.28
Guaranteed Emergency Credit Line (GECL)	565.10	539.84
Loan Facility to State Utilities	41,262.00	37,495.00
Hybrid Wind & Solar	5,228.58	2,278.78
Ethanol	10,103.65	5,977.14
Manufacturing	13,945.93	5,434.43
Miscellaneous (Transmission Lines, Emerging Technology, Guarantee Assistance)	12,584.59	2,043.92
Total	2,21,911.83	1,43,152.76

9.5.3 MoU with MNRE

IREDA has signed a Memorandum of Understanding (MoU) with the Ministry of New and Renewable Energy (MNRE), Government of India setting key targets for the Financial Year 2024-25. The performance of the Company for the financial year 2023-24 has been rated as "Excellent" by DPE. This marks the fourth consecutive year that IREDA has received 'Excellent' rating, showcasing its unwavering commitment to operational excellence and highest standards of corporate governance.

9.5.4 Resource Base

The total borrowings of IREDA stood at ₹ 49,686.86 Crore as on March 31, 2024 as against ₹ 40,165.28 Crore in the previous year. During the Financial Year 2023- 24, IREDA has mobilized ₹16,401.18 Crore from domestic as well as international sources.

Net Worth of the Company increased to ₹ 8,559.43 Crore at the end of the Financial Year 2023-24, registering an increase of 44.22 % over the previous year's Net Worth of ₹5,935.17 Crore. The authorized and paid-up capital of IREDA stood at ₹6,000 crore and ₹ 2,687.76 respectively at the end of Financial Year 2023-24.

9.5.5 "Navratna" status to IREDA

IREDA has achieved a significant milestone by being conferred with the 'Navratna' status by the Government. Department of Public Enterprises (DPE) vide its OM dated 26th April, 2024 has granted "Navratna" status to IREDA. The elevation to "Navratna" status will enhance autonomy for the company, empowering it to catalyse the renewable energy development in India through strategic initiatives and enhanced operational autonomy.

9.5.6 Opening of office in GIFT City, Gandhinagar

IREDA has incorporated a wholly owned subsidiary in the International Financial Services Centre (IFSC) located in GIFT City, Gandhinagar, Gujarat, named “IREDA Global Green Energy Finance IFSC Limited”, which will specialize in providing debt options denominated in foreign currencies. This facilitates natural hedging and significantly reduces financing cost for Green Hydrogen & its derivatives as well as Renewable Energy Manufacturing projects. This strategic initiative will play a pivotal role in advancing the nation’s progress toward an environment friendly and ‘atmanirbhar’ future.

9.5.7 MNRE Schemes

IREDA is the Implementing Agency for the four MNRE Scheme / Programmes, namely:

- Central Public Sector Undertaking (CPSU) Scheme - Phase-II (Government Producer Scheme)
- National Programme on High-Efficiency Solar PV Modules under Production Linked Incentive (PLI) Scheme (Tranche -I)
- National Bioenergy Programme
- Generation Based Incentive Schemes

9.5.8 Human Resource Development

IREDA’s high-performance culture is fueled by its highly motivated and skilled workforce. To harness the full potential of its human capital, the company invests in specialized training programs offered by premier institutes and organizations. Additionally, it conducts comprehensive in-house training sessions tailored to the evolving needs of its employees. By organizing customized virtual programs, masterclasses on emerging technologies, and other need-based initiatives, IREDA ensures that its employees remain at the forefront of the latest developments in their respective fields.

IREDA fosters a safe and inclusive work environment that supports employees’ professional and personal growth. Daily yoga and meditation sessions are conducted to promote overall well-being, while regular preventive health check-ups are organized to ensure employees remain in good health. During the year, IREDA celebrated key events such as International Yoga Day, Vigilance Awareness Week, Hindi Pakhwada, and Women’s Day. The company also actively participated in the Swachhata Hi Seva 2024 campaign, embracing the theme ‘SwabhavSwachhata – SanskaarSwachhata’ to reinforce its commitment to cleanliness and values-driven initiatives.

IREDA adheres to the Government of India’s reservation policy for Scheduled Castes, Scheduled Tribes, Other Backward Classes, Persons with Disabilities, and Economically Weaker Sections. The company meticulously follows the reservation rosters prescribed by the government. Employee relations remained highly cordial and harmonious throughout the financial year, with no loss of man-days reported.

IREDA is committed to providing equal growth opportunities for women, aligning with the Government of India’s vision of gender inclusivity. Women employees play significant roles in critical and strategic functional areas across all hierarchical levels. Representing 27.64% of the total workforce, women continue to make valuable contributions to the organization’s success.

As on 31.12.2024, the Company has 170 fulltime employees comprising of 154 Executives (including 02 Board Level Executives) and 16 Non-Executives.



9.5.9 Corporate Social Responsibility

IREDA being committed to operate and grow in a socially and environmentally sustainable manner; aims to optimally contribute towards the overall benefit to the public at large, under its CSR policy and the communally responsible regulatory regime executed by the Government of India from time to time through investment of funds in economically, socially and environmentally sustainable projects.

IREDA promotes and will continue to facilitate enhancement of its value creation in society through contribution in sustainable community and environmental projects in the field of healthcare, nutrition, renewable energy, energy efficiency, clean technologies etc. towards environmental and social development of the country.

For the Financial Year 2024-25, a CSR Budget of ₹ 2436.48 Lakhs is available. As on 31st December 2024, total amount of Rs. 779.78 Lakhs has been sanctioned out of the total budget amount.

During the Financial Year 2024-25, following activities / projects were undertaken by the Company under its CSR initiatives as shown in Table 9.10.

**Table 9.10: CSR Initiatives undertaken by IREDA during the year 2024 - 25
(1st April, 2024 to 31st December, 2024)**

S. No	Description	₹ / Lakhs
1	Financial assistance to Samphia Foundation, Kullu, Himachal Pradesh towards operational expenses of two Mobile Medical Vans for FY 2024-25 for running the "Therapy on Wheels" program for serving children with disabilities, under CSR funds of IREDA	48.96
2	Financial assistance to M/s SEWA-THDC for development of Sport Science Centre Hall at Koteshwar, Tehri, Uttarakhand	105.00
3	Assistance for ease of transit of Physically Challenged staff and students, visitors and Senior Citizens by donating 4 nos. of in-campus Battery Operated Vehicles to Guru Gobind Singh Indraprastha University under the 7th goal of Sustainable Development i.e. Affordable and Clean Energy	20.80
4	Financial assistance (@₹500 per month/intern) for 50 interns (on pilot project basis) for a duration of 12 months from the Company's CSR funds for FY 2024-25 under the Prime Minister's Internship Scheme (PMIS)- Pilot Project.	3.00
5	Financial assistance to M/s VidyaBharati Gujarat Pradesh towards developmental works in Sainik School at MotaRandha, Silvassa, Union Territory of Dadra & Nagar Haveli & Daman & Diu.	97.46
6	Financial assistance to M/s UPSIC (Banda). for supply and installation of 3 kWp off-grid solar power systems at 120 nos. of Anganwadi Canfers and 50 nos. of health centres at the aspirational district of Chandauli, Uttar Pradesh	504.56
Total		779.78

9.5.10 Awards

IREDA's contribution towards development and promoting Renewable Energy Sector in the country have been recognized with the following awards:

- a. "Maximum Loans disbursed to RE Sector in NBFC Category in achieving 200 GW" award by Ministry of New and Renewable Energy on 16th September, 2024.
- b. Gold Awards in the Mini Ratna category for "Corporate Governance" and "Corporate Social Responsibility & Sustainability." Additionally, IREDA received the Silver Award for "Operational Performance Excellence," at the 14th PSE Excellence Awards, hosted by the Indian Chamber of Commerce in New Delhi on 21.12.2024.

