CHAPTER

8

RENEWABLE ENERGY IN THE NORTH-EASTERN REGION STATES

RENEWABLE ENERGY IN THE NORTH-EASTERN REGION STATES

8.1 INTRODUCTION:

Special attention is being given to the development of renewable energy in the entire North Eastern region through a separate budgetary allocation of 10% under various Renewable Energy programmes for deployment of grid and off-grid Solar Energy Systems, Wind Energy Systems, Small Hydro Projects and Bio-gas Plants among others, in the region.

8.2 A total of estimated potential for renewable energy in the North Eastern Region from Solar, Small Hydro and Bio-energy is around 65,837 MW, a substantial part of which is suitable for grid connected applications. State-wise details are shown in **Table 8.1**.

Table 8.1: State-wise Renewable Energy Potential in the North Eastern States of India

Sl. No.	STATES & UTs	Small Hydro Power	Bio-Energy		Solar	Total
			Biomass Power	Waste To Energy		
		(MW)	(MW)	(MW)	(MW)	(MW)
1	Arunachal Pradesh	2064.92	8	-	8650	10723
2	Assam	201.99	212	8	13760	14182
3	Manipur	99.95	13	2	10630	10745
4	Meghalaya	230.05	11	2	5860	6103
5	Mizoram	168.90	1	2	9090	9261
6	Nagaland	182.18	10	-	7290	7482
7	Sikkim	266.64	2	-	4940	5209
8	Tripura	46.86	3	2	2080	2132
Total		**3261.49**	**260**	**16**	**62300**	**65837**

8.3 The state-wise status of Grid-Connected, Renewable Energy capacity installed, as on 31.12.2020, in the North-Eastern Region is given in **Table 8.2.**

Table 8.2: State-wise installed capacity, of Grid Connected Renewable Power as on 31.12.2020

S. No.	States & Union Territories	Small Hydro Power	Bio-Power	Solar Power	Total Capacity	Capacity Addition during 2020-21
1	Arunachal Pradesh	131.105		5.61	136.72	0
2	Assam	34.11	2.00	42.99	79.10	3.76
3	Manipur	5.45		6.36	11.81	1.2
4	Meghalaya	32.53	13.80	0.12	46.45	0
5	Mizoram	36.47		1.53	38.00	0.01
6	Nagaland	30.67		1.00	31.67	0
7	Sikkim	52.11		0.07	52.18	0
8	Tripura	16.01		9.41	25.42	0
Total (MW)		**338.46**	**15.80**	**67.09**	**421.35**	**4.97**

8.4 SMALL HYDRO POWER PROGRAMME

North-Eastern States of India have a fairly good potential to develop Small Hydro Power projects. Among the NE States, Arunachal Pradesh has the highest potential followed by Sikkim, Meghalaya and Mizoram. MNRE has been giving special emphasis for the development of Small Hydro projects in the NE region. SHP projects can provide energy almost uninterrupted without any major maintenance or dependence on weather. The region, which is beleaguered by large energy deficits and poor quality of energy services, can benefit from greater decentralization and accountability associated with

Small Hydro Power projects. Small Hydro Power projects can generate sufficient electricity to power domestic households, schools and clinics in rural areas and catalyse entrepreneurship activities. The State-wise installed capacity vis-a-vis potential in North-Eastern States & Sikkim is given in **Table 8.3** below:

Table 8.3: State wise list of potential sites and installed projects SHP Projects in NE Region (as on 30.11.2020)

Sl. No.	State	Total Potential		Total Installed	
		Numbers	Capacity (MW)	Numbers	Capacity (MW)
1	Arunachal Pradesh	800	2064.92	156	131.11
2	Assam	106	201.99	6	34.11
3	Manipur	110	99.95	8	5.45
4	Meghalaya	97	230.05	5	32.53
5	Mizoram	72	168.9	18	36.47
6	Nagaland	98	182.18	12	30.67
7	Sikkim	88	266.64	17	52.11
8	Tripura	13	46.86	3	16.01
Total		**1384**	**3261.49**	**225**	**338.46**

Following are the major Small Hydro Power Projects which are currently under implementation is given in **Table 8.4:**

Table 8.4: Small Hydro Projects Under Implementation in the North-Eastern States of India

Sl. No.	Name of the Project	Capacity (MW)	Implementing Agency
Arunachal Pradesh			
1	Tirru Nallah in Longding Dist.	0.1	Department of Hydro Power Development
2	Fure in Kurukungme Dist.	0.05	Department of Hydro Power Development
3	Pakhankha in Changlang District	0.5	Department of Hydro Power Development
4	Payu at Pinchi in Kurung Kumey Dist.	0.5	Department of Hydro Power Development
5	Khajalong in West Kameng Dist.	2.0	Department of Hydro Power Development
6	Sumbachu SHP in Tawang Dist.	3	Hydro Power Development Corp. of Arunachal Pradesh
7	Taksang Chu SHP in Tawang Dist	3.4	Hydro Power Development Corp. of Arunachal Pradesh
8	Kinmey Gompa in Tawang Dist.	0.1	Department of Hydro Power Development
Meghalaya			
9	Ganol SHP West Garo Hills Dist.	22.50	Meghalaya Power Generation Corp. Ltd.
10	Riangdo SHP in West Garo Hills Dist.	3.0	Meghalaya Power Generation Corp. Ltd.
Mizoram			
11	Kawlbem in Champhai Dist.	3.50	Power & Electricity Dept. Government of Mizoram
12	Tlawva SHP in Champhai Dist.	5.00	Power & Electricity Dept. Government of Mizoram
Nagaland			
13	Ponglefo SHP in Kiphire Dist.	1.00	Department of Power, Government of Nagaland
Sikkim			
14	Chatten Stage-II in North Sikkim Dist.	3 .00	Sikkim Power Development Corp. Ltd.

8.5 PM'S PACKAGE FOR ARUNACHAL PRADESH

The Hon'ble Prime Minister had announced a package of ₹550 crore to electrify and illuminate border villages of Arunachal Pradesh. Accordingly, a plan was made to electrify and illuminate 1,053 un-electrified villages of all border districts of Arunachal Pradesh by installation of 5,758 SPV Home Lighting Systems and 153 Micro Hydel and Small Hydel Projects. The project is completed except commissioning of five Small Hydro Power Projects by the Department of Hydro Power Development.

8.6 SOLAR PARKS

Ministry is implementing a Scheme for Development of Solar Parks and Ultra Mega Solar Power Projects. The main objective of Scheme is to scale up setting up of solar projects in a short span of time. Under the Scheme, it is proposed to set up at least 50 Solar parks targeting setting up of 40,000 MW of Solar power projects by 2021-22. All the States and Union Territories are eligible for getting benefit under the scheme. The capacity of the Solar parks shall be 500 MW and above. However, smaller parks are also considered in States where there is shortage of non-agricultural land. The following Solar Parks have been approved in the under mentioned States of NE region as given in **Table 8.5**:

Table 8.5: Solar Parks approved in the North-Eastern States of India

Sl. No.	Name of the State	Capacity (MW)	Implementing Agency	Land identified at
1	Arunachal Pradesh	20	Arunachal Pradesh Energy Development Agency (APEDA)	Tezu township in Lohit Dist.
2	Manipur	20	Manipur Tribal Development Corporation Ltd. (MTDCL)	Bukpi village, Pherzawl Dist.
3	Meghalaya	20	Meghalaya Power Generation Corporation Ltd (MePGCL)	Thamar, West Jaintia Hills & Suchen, East Jaintia Hills Dist
4	Mizoram	20	Power & Electricity Department	Vankal, Champhai Dist.

The 70 MW Amguri Solar Park in Assam and 23 MW Solar Park in Nagaland were cancelled due to slow progress. Further, the capacity of Solar Park in Arunachal Pradesh was reduced from 30 MW to 20 MW on request of the State Government.

Fig. 8.1: *Transmission System in 20 MW Vankal Solar Park in Mizoram*

8.7 GRID-CONNECTED ROOFTOP AND SMALL SOLAR POWER PLANTS PROGRAMME IN THE NORTH-EASTERN STATES

PHASE II:

Under the Phase II of the Grid-connected Rooftop Solar Programme Central Financial Assistance (CFA) upto 40% of the benchmark cost is provided for RTS projects up to 3 kW capacity and 20% for RTS system capacity beyond 3 kW and upto 10 kW in residential sectors. For Group Housing Societies (GHS) and Residential Welfare Associations (RWA), CFA is limited to 20% for RTS plants for supply of power to common facilities maximum upto 500 kW capacity.

Fig. 8.2: *Ramakrishna Mission School 50 kW West Tripura*

During the year 2020-21, a total of 77.8 MW capacity has been allocated to Electricity Departments or DISCOMs of various NE States, thereby leading to overall allocated capacity of 84.3 MW to 6 North-Eastern States as on 31.12.2020 under the programme, details of which are given in **Table 8.6**:

Table 8.6: Grid-Connected Rooftop Solar Programme Phase-II – Capacity Allocated

S. No.	State	Capacity allocated in FY 2019-20 (MW)	Capacity allocated in FY 2020-21 (MW)	Total allocated capacity (MW)
1	Assam	--	2.0	2.0
2	Manipur	0	1.0	1.0
3	Meghalaya	0	70.0	70.0
4	Mizoram	0.5	1.0	1.5
5	Nagaland	1.0	3.8	4.8
6	Sikkim	5.0	0.0	5.0
Total		**6.5**	**77.8**	**84.3**

The Phase II of the programme has provision of incentives to DISCOMs. As per the scheme DISCOMs will get the incentive for achieving in the financial year above the baseline capacity as on 31st March of the previous year. There is no incentives for capacity addition up to 10% capacity. There is 5% incentives for addition beyond 10% and up to 15%; and 10% incentives for addition beyond 15%.

Phase I

An amount of Rs. 4.03 crore has been released to Manipur Renewable Energy Development Agency towards partial settlement of projects. Overall installed capacity (with or without CFA) as on 31.12.2020 is given in **Table 8.7**:

Table 8.7. Grid-Connected Rooftop Solar Programme Phase-I Capacity Installed as on 31.12.2020

Sl.No.	State /UTs	Installed Capacity (MW)
1	Arunachal Pradesh	0.22
2	Assam	32.32
3	Manipur	6.04
4	Meghalaya	0.12
5	Mizoram	1.43
6	Nagaland	0.08
7	Sikkim	0.07
8	Tripura	2.83
Total		**43.11**

Fig. 8.3: *ONGC Cachar, Srikona, Silchar,Assam- 85 kW*

8.8 OFF-GRID SOLAR PV PROGRAMME

Solar Off-grid Programme is being implemented in the North Eastern Region through Off-grid and Decentralized Solar PV Applications Scheme Phase-III and PM KUSUM Scheme. Under Off-grid and Decentralized Solar PV Applications Scheme Phase-III, Solar Study lamps, solar street lights and off-grid solar power plants (upto 25 kW) are being installed in North Eastern Region. Under PM-KUSUM Scheme, grid-connected solar power plants upto 2 MW, standalone solar pumps and solarization of existing grid-connected agricultural pumps are being supported. Under Atal Jyoti Yojana (AJAY) Phase-II, which was discontinued with effect from 01.04.2020, sanctioned solar street lights are being installed in North-Eastern States.

Under Off-grid and Decentralised Solar PV Applications Scheme Phase-III, the projects for installation of off-grid solar power plants which have been completed or under implementation are shown in **Table 8.8.**

Table 8.8: Off-grid and Decentralised Solar PV Power Plants Scheme Phase-III Completed or Under Implementation

State	Sanctioned Projects	Status
Manipur	25 kWp capacity Solar Power Plant at Deputy Commissioner's Office, Kangpoki Dist.	Completed
Mizoram	24 Solar Power Plants of aggregate 230 kWp capacity for various Government buildings.	Completed
	53 Solar Power Plants of aggregate 460 kWp capacity in Community Hall, Government Offices, Schools, multi-farming Cooperative Society.	Under Installation
	29 Solar Power Plants of aggregate 249 kWp capacity in Government buildings.	Completed

Further, under the Phase-III Scheme, 35,333 nos. of Solar Street Lights have been installed and 3.28 lakh Solar Study Lamps have been distributed in North Eastern States. Detailed status of cumulative installation or distribution as on 31.12.2020 is as given in **Table 8.9.**

Table 8.9: Progress of Solar Street Lights Installation and Solar Study Lamps Distribution in the North-Eastern States

State	Solar Street Lights Installed (Nos.)	Solar Study Lamps Distributed (Nos.)
Arunachal Pradesh	8,733	57,850
Assam	3,116	--
Manipur	10,250	--
Mizoram	4,792	80,689
Nagaland	4,872	--
Tripura	3,570	1,89,431
Total	**35,333**	**3,27,970**

Under PM KUSUM Scheme following allocations were made in the North Eastern Region during FY 2019-20, which are under installation is given in **Table 8.10**:

Table 8.10: Allocation Made under PM-KUSUM Programme in 2019-20 under implementation in the year 2020-21

State	Component-A Grid-connected Power Plants up to 2 MW	Component-B Standalone Solar Pumps (Units)	Component-C Solarization of existing grid based agricultural pumps (Units)
Meghalaya	10 MW	1,700	60
Tripura	5 MW	1,300	1,300
Manipur	--	100	--

Under the Atal Jyoti Yojana (AJAY): Phase-II, 2,000 Solar Street Lights are available for installation in Lok Sabha constituencies of the North Eastern States including Sikkim. Solar Street Lights sanctioned till 31.03.2020 are being installed. Sanctions were received from District Administrations of the concerned Lok Sabha constituencies for **13,005 lights**, out of which **5,945 lights** have been installed upto 31.12.2020.

Details of all SPV Systems and standalone SPV Power Plants in the North Eastern States as on 31.12.2020 are given in the **Table 8.11**.

Table 8.11: SPV Systems and standalone SPV Power Plants in the North Eastern States as on 31.12.2020

Sl. No.	Name of the States	Solar Home Light (No. of Units)	Solar Lamp (No. of Units)	Solar Street Light (No. of Units)	Solar Pump (No. of Units)	Solar Power Plant (kW)
1	Arunachal Pradesh	35,065	76,401	13,741	22	963.2
2	Assam	46,879	6,47,761	16,338	45	1605
3	Manipur	24,583	9,058	22,217	40	1580.5
4	Meghalaya	14,874	40,750	5,800	19	2004
5	Mizoram	12,060	91,201	10,117	37	3,665.6
6	Nagaland	1,045	6,766	11,107	3	1506
7	Sikkim	15,059	23,300	504	0	850
8	Tripura	32,723	2,53,443	6,242	151	867

8.9 BIOGAS PROGRAMME

Different Agencies have been actively implementing MNREs New National Biogas and Organic Manure Programme (NNBOMP) Programmes for providing clean gaseous fuel mainly for cooking, lighting and organic manure to rural and semi-urban households in the North Eastern Region States through State Government Nodal Departments or the State Nodal Agencies. The status is as follows:

- MNRE has allocated targets to the State Rural Development Departments for implementing the NNBOMP in the States of Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura during the year. A target of 5,400 Biogas plants are being set up in the North Eastern region for the year 2020-21.
- A Biogas Development and Training Centre for all the NER States to provide training and technical support under the NNBOMP has been continued and functional at Department of Mechanical Engineering, Indian Institute of Technology, Guwahati, Assam.

» The progress of implementation of the Biogas Programmes including New National Biogas and Organic Manure Programme (NNBOMP); Biogas based Power Generation (Off-Grid) Programme; and Activities and Targets of Biogas Development and Training Centre in North Eastern Region States during the current year 2020-21 has been reviewed on virtual platform under the Chairmanship of Secretary MNRE, on 23rd October, 2020 and also a virtual learning session has been conducted for using national Biogas portal and Mobile App. for NNBOMP scheme on 24th December 2020.

8.10. STATUS OF WIND ENERGY PROGRAMME IN THE NORTH-EASTERN STATES

National Institute of Wind Energy (NIWE) in collaboration with RISO DTU, Denmark had prepared the Indian Wind Atlas for the country including NE Region during the year 2010. According to this Indian Wind Atlas, the wind potential of NE at 50 meter level is estimated to be 406 MW. The State-Wise break-up is given in **Table 8.12.**

Table 8.12: State-wise Wind Power Potential Estimation of NE Region

Sl.No.	States	Estimated potential (MW)
1	Arunachal Pradesh	201
2	Assam	53
3	Manipur	7
4	Meghalaya	44
5	Nagaland	3
6	Sikkim	98
	Total	**406**

In NE States, there are scattered potential pockets available for Wind farm development due to the localized Wind flows. To tap these, the Ministry decided to carry out extensive Wind Resource Assessment studies in NE regions including Sikkim. Accordingly, as on 31.12.2020, a total of 97 Wind Resource Assessment instrumentation using 25 meter and 50 meter meteorological masts were carried out at NE regions and currently four 50 meter Wind Resource Assessment stations are operational and the remaining stations were closed down after completion of requisite data collection. The State-Wise break-up is given in **Table 8.13**.

Table 8.13: Wind Resource Assessment Stations

State	No. of Stations installed & commissioned	Level of Wind Resource Assessment stations	No. of Stations in operation
Arunachal Pradesh	17	25 m & 50 m	3
Assam	18	25 m & 50 m	Nil
Tripura	11	25 m & 50 m	Nil
Manipur	15	25 m & 50 m	Nil
Mizoram	9	25 m & 50 m	Nil
Nagaland	6	25 m & 50 m	Nil
Meghalaya	17	25 m & 50 m	1
Sikkim	4	25 m	Nil
Total	**97**		**4**

In addition, Wind Resource Assessments are also carried out at NE region using the existing Telecommunication towers. As on 31.12.2020, a total 80 of telecom towers of heights ranging from 40m to 60m were utilised for this purpose. The details are given in **Table 8.14.**

Table 8.14: Utilisation of Telecom Towers for Wind Resource Assessment

State	No. of Stations installed & commissioned	Level of Wind Resource Assessment stations	No. of Stations in operation
Meghalaya	15	50 m & 60 m	Nil
Mizoram	5	40 m & 60 m	2
Tripura	6	50 m & 60 m	3
Arunachal Pradesh	5	40 m & 50 m	Nil
Nagaland	7	50 m	Nil
Manipur	9	40 m & 60 m	9
Assam	33	50 m & 60 m	22
Total	**80**		**36**

NIWE had prepared and submitted two Detailed Project Reports on 3.5 MW Grid Connected wind-solar hybrid power plant at Phangrei, Manipur (**Fig. 8.4**) and 2.5 MW Grid connected wind-solar hybrid power plant at Chawangkining, Manipur.

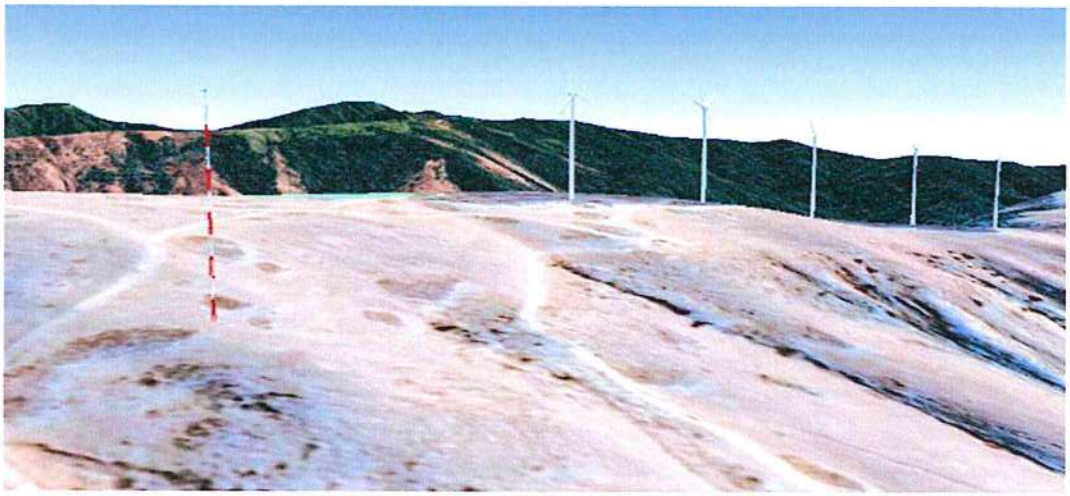

Fig. 8.4: *Proposed Wind Farm at Phangrei, Manipur*

CHAPTER

9

GREENING OF ISLANDS OF ANDAMAN & NICOBAR AND LAKSHADWEEP

GREENING OF ISLANDS OF ANDAMAN & NICOBAR AND LAKSHADWEEP

9.1 SCHEME FOR SETTING UP OF 52 MW DISTRIBUTED GRID-CONNECTED SOLAR PV POWER PROJECTS IN ANDAMAN & NICOBAR, AND LAKSHADWEEP ISLANDS WITH CAPITAL SUBSIDY FROM MNRE

9.1.1 Introduction:

MNRE, on 05.04.2016 had issued the Administrative Approval for Implementation of a scheme for setting up Distributed Grid-Connected Solar PV Power Projects of an aggregate capacity of 40 MW (now increased to 52 MW) in Andaman & Nicobar (A&N) and Lakshadweep Islands with an estimated Central Financial Assistance (CFA) of ₹192.20 crore.

9.1.2 Objective:

The objective of the scheme is to develop carbon free islands by phasing out use of diesel for generation of electricity and to contribute to the National Action Plan on Climate Change. The initiative will also help in reduction in cost of electricity generation.

9.1.3 Spatial Coverage:

Distributed grid-connected solar PV power projects of an aggregate capacity of 52 MW would be established in different islands in Andaman & Nicobar Islands and Lakshadweep Islands.

9.1.4 Types of Projects Supported:

The Scheme supports setting up of standalone Solar PV Power Project, standalone Battery Energy Storage System (BESS), Solar PV plant with Battery Energy Storage System (BESS), Transmission System for Solar PV Power Plant and Floating Solar PV power plants (with or without Battery Energy Storage System) in Andaman & Nicobar Islands and Lakshadweep Islands.

9.1.5 Implementation Arrangement:

The scheme will be implemented through Central Public Sector Undertakings (CPSUs) viz., NTPC Limited (NTPC), NLC India Limited (NLC), Rajasthan Electronic & Instruments Ltd. (REIL), Solar Energy Corporation of India Limited (SECI) etc. or by UT Administration on Build, Own and Operate (BOO) basis. The arrangements are as follows:

- Procurement of all Services and Hardware for setting up the power plants by Implementing Agencies (IAs) viz. NTPC, NLC, REIL, SECI etc. or UTs would be done through competitive bidding process.
- The total project cost will include cost of solar power plant, battery storage of upto six hours and cost of infrastructure development such as land development, evacuation & transmission among others.
- A&N and Lakshadweep Administrations will buy the electricity from the Implementing Agencies at a tariff determined by JERC/CERC by taking into account the Central Financial Assistance (CFA).

Fig. 9.1: *Govt Sr. Sec School Malacca, Car Nicobar, Andaman & Nicobar Islands -50 kW*

9.2 CENTRAL FINANCIAL ASSISTANCE (CFA):

9.2.1 Eligibility

The total eligible Financial Assistance and its release pattern will be as under:

- Ministry will provide 40% of the project cost discovered through competitive bidding process as grant;
- No additional grant for the preparation of Detailed Project Report (DPR), conducting field survey, fund handling or service charge will be provided.
- The Capital Subsidy will be released in three tranches as mentioned below:
  - 15% on completion of site development and civil works at site;
  - 60% on successful commissioning of the plant; and
  - Balance 25% after one year of operation of the plant.

The amount and sequence of funds released during implementation period can be modified if necessary with the approval of the Competent Authority.

9.2.2 Status of Projects under MNRE'S Scheme (As of 31.12.2020)

- A 20 MW Solar PV power plant with 8 MWh Battery Energy Storage System (BESS) by NLC India Limited, at Attampahad and Dollygunj in UT of Andaman & Nicobar Islands, has been commissioned on 30.06.2020.

» Solar Energy Corporation of India Limited (SECI) is implementing solar PV power plants of aggregate 1.95 MW capacity and Battery Energy Storage Systems of aggregate 2.15 MWh capacity, at four different Islands of Union Territory of Lakshadweep. The details are shown in **Table 9.1**:

Table 9.1: Capacities of Solar PV Plants and Battery Energy Storage Systems

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

CHAPTER

10

SPECIALISED INSTITUTIONS

SPECIALISED INSTITUTIONS

10.1 NATIONAL INSTITUTE OF SOLAR ENERGY (NISE)

10.1.1 National Institute of Solar Energy (NISE), an autonomous institution under Ministry of New and Renewable (MNRE), is the National Research and Development (R&D) institution in the field of Solar Energy. NISE supports the Ministry of New and Renewable Energy (MNRE) in implementing the National Solar Mission (NSM). NISE carries out R&D activities in various aspects of Solar Energy and also in the field of Hydrogen energy. NISE also host various skill development programmes in the field of solar energy.

10.1.2 NISE has established itself as a leading Institute in the field of Solar Energy through Resource Assessment, Research & Development, Design, Development and Demonstration of Solar Energy Technologies for various applications such as Testing, Certification and Standardization, Monitoring and Evaluation, Economic and Policy Planning, Human Resource Development and Active collaborations with prominent National & International organisations etc.

10.1.3 NISE is maintaining NABL accredited Solar Photovoltaic module testing laboratory, lighting system test laboratory, battery testing facility and solar water pumping system test rig and outdoor test facilities. The Institute has fully developed testing facility for small and large size Solar Thermal Systems and Solar Resource Assessment.

10.1.4 Research and Development

Details of various research and development projects being carried out at NISE are given in **Table 10.1**

Table 10.1 Details of ongoing R&D Projects at NISE

Sl. No.	Project	Funding Agency	Remarks
	R&D Solar PV		
1.	*"Development of high efficiency (21%/ 19%) PERC type of c-Si/ mc-Si solar cells".* A joint project between NISE and BHEL for developing PERC type solar cells with benchmark efficiencies in the country.	MNRE	The test & characterization equipment in this project such as Spectral Response Measurement System (QE-SRMS), Spectroscopic Ellipsometer, Optical Microscope, Semi-Automatic Four Probe resistivity meter, have been commissioned.
2.	*"All India Survey of PV module"* A joint project between NISE and NCPRE, IITB for doing the reliability analysis of PV modules across various locations in India.	NISE & IIT B	Report published

3.	*"High-Efficiency Solar Water Pumping Systems"* NISE has collaborated with different stakeholders to develop new and improved models of solar water pumping Systems under this project.	MNRE	The project aims to design and develop low cost high efficiency specialized controller and to improve overall wire to water efficiency up to 45 % from existing level (around 30 to 40 %) and to prepare and publish the practices and guidelines. Installation of test rig and development of efficient controller are in progress.
4.	*"Supply of Clean Drinking Water through IoT based solar-powered station at a large village in Haryana through automated dispensing while improving the water table: Pilot – Faridpur"*	DST	A joint project between NISE and Saurya Ener Tech Pvt Limited for the developing and installing of clean water purification set up using solar PV modules. The project has been installed. Commissioning is in progress. The project will provide 30,000 liters per day of RO quality water to the village.
5.	*"Performance analysis of bifacial solar PV modules"*	NISE	An in-house project of NISE for the performance and reliability analysis of bifacial PV module. Installation is in progress.
6.	*"PV Back sheet performance analysis through sequential testing as per IEC 61215 and customized test conditions"*	NISE & DuPont	An inhouse project with DuPont, a back sheet manufacturer company to analyze the performance of different back sheets of different make. An MoU signed with the industry partner. Measurements are in progress.
7.	*"Optimization of parallel row spacing between the PV array of solar power plant"*	NISE	An inhouse project on the performance enhancement of PV power plant. Development is in progress.
8.	*"Comparison of NOCT and NMOT temperature"*	NISE	An inhouse project on the comparison of NOCT and NMOT temperature and its use in performance modelling. Development is in progress.
9.	*"Performance evaluation of a solar module under wind load stress"*	NISE	An inhouse project on the reliability analysis and testing condition design for PV module. Development is in progress.
10.	*"UV radiation effect on the performance of the PV module"*	NISE	An inhouse project on the reliability analysis of PV module under UV radiation. Development is in progress.
11.	*"Making improvements in the I-V test set up for solar cells"*	NISE	An inhouse project on the designing of rig for testing of solar cell. Development is in progress.
		R&D -Solar Thermal	
12.	*"Solar Dryer cum Space Heating System"*	NISE	An inhouse project for drying of agricultural products and or space heating during winters. Product developed and commercialized.

13.	*"Designing of Solar Based Space Heating"*	NISE	An inhouse project for drying of agricultural products and or space heating during winters. Product developed and commercialized.
14.	*"Design Improvements and Deployment of solar (SPV) Cold Storage with Thermal Storage"*	NISE	Collaborative project with an industry on Solar Cold Storage with integration of solar photovoltaic and thermal storage system for 24x7 operation. Product developed and commercialized.
15.	*"Solar Powered Bulk Milk Cooler using Thermal Storage "*	NISE	Collaborative project with an industry on powered bulk milk chiller with integration of solar photovoltaic and thermal storage system for 24x7 operation. Product developed and commercialized.
16.	*"Modular Central Receiver Concentrated Solar Power Plant For Decentralized Power Generation"*	MNRE	Project for power generation using central receiver concentrated solar power technology. Project Closed.

Fig. 10.1: *Advanced PV Characterization Laboratory, clean room facility at NISE*

10.1.5 Solar Photovoltaic Testing Facility (PVTF)

The Photovoltaic Module Testing Facility at NISE has National Accreditation Board for Testing & Calibration Laboratories (NABL) accredited laboratory as per ISO/IEC 17025:2005 standard for Qualification Testing and Customised Testing as per customers' requirements. This facility is recognized by the Bureau of Indian Standard (BIS) for PV Module Testing as a Type 2 category facility. The laboratory is well equipped with facilities for testing as per IEC/IS standards, IEC 61215: 2016/ IS 14286, IS/IEC 61701: 2011, IS/IEC 61730-1, 61730-2: 2016, IEC 61853-part I: 2011/IS 16170: Part 1, IEC 61853-2, and IS 17210-1-2019/IEC TS 62804: 2015/MNRE specifications.

The photovoltaic testing laboratory has upgraded its facilities with the addition of these equipments and systems, i.e., (i) Leakage current measurement setup for Potential Induced Degradation (PID) testing, (ii) Robustness of terminations test, (iii) Junction box pull tester, (iv) Cut susceptibility tester (v) Nominal Module Operating Temperature (NMOT) set up, (vi) Module breakage test, (vii) Screw connections tester, (viii) New solar simulator.

This year a total number of 266 modules have been tested as per International and BIS standards till December, 2020. The PVTF lab was identified by the Task Working Group 2 (WG2) of IEC TS 82 for testing and data analysis of Light and elevated temperature induced degradation (LeTID) testing of PV module. NISE has completed the test, and the data has already been shared with different labs of WG2. The Electroluminescence (EL) imaging at NISE is a non-destructive technique for conducting such an analysis of the degradation of PV Modules. The EL facility at NISE follows DIN IEC 60904-13:2016 standard. It enables in identifying the defects which are sensitive to the Solar PV Modules. Various test equipment used for testing of PV modules are shown in **Fig. 10.2**.

(a) (b)

Fig. 10.2: *Test equipment at Module Testing Lab*
(a) Module breakage tester and (b) Chord anchorage tester.

Upcoming activities in PV module test laboratory are:

1. Full testing set up for IS/IEC 61730-1,61730-2: Photovoltaic (PV) module safety qualification - Part 1: Requirements for construction; Photovoltaic (PV) module safety qualification - Part 2: Requirements for testing
2. IEC 62716: 2013: Photovoltaic (PV) modules - Ammonia corrosion testing
3. IEC TS 62782:2016: Photovoltaic (PV) modules - Cyclic (dynamic) mechanical load testing
4. IEC 61853-3:2018 Photovoltaic (PV) module performance testing and energy rating - Part 3: Energy rating of PV modules
5. IEC 61853-4:2018 Photovoltaic (PV) module performance testing and energy rating - Part 4: Standard reference climatic profiles.

10.1.6 Power Electronics Laboratory

NISE has established facilities for testing and evaluation of Solar Inverters/ power conditioning Units (PCU) of capacity ranging up to 100 KVA. All types of PCUs, hybrid, standalone, Grid-tied inverters (GI) pump controllers and Charge Controller can be tested. A total of 8 Nos inverters were tested this year as per International standards and MNRE specifications till December, 2020.

10.1.7 Battery Test & Characterization

The Battery Test & Characterization laboratory is in the process of obtaining the NABL accreditation for different tests under different standards. The battery test & characterization laboratory is engaged in different analysis, performance evaluation & research work as follows: (i) Development of Testing Profile/Test Methodologies for emerging battery technologies, (ii) Life Cycle Tests on different secondary battery, (iii) Exploring Battery health analysis technique, (iv) Degradation Analysis of secondary battery/Effect of different parameter on the degradation of battery. A total of 37 Nos batteries were tested as per different National/International Standards during this year, till December, 2020.

10.1.8 Advanced SPV system & lighting laboratory

The Solar Photovoltaic (SPV) system and Lighting laboratory is involved in performance testing and reliability of off-grid systems including solar lighting systems. The lab is well equipped with modern testing equipment like Integrating Sphere Photometer for Total Luminous Flux measurement, Digital Programmable AC/DC power supplies, and other Digital Auxiliary equipment for conformity/ type testing of wide range of products against latest standards and specifications adopted by BIS/MNRE. The tested products include all type of lighting in solar photovoltaic system such as Solar Lantern, Solar study lamp, Solar Home Lighting, Solar Street lighting system, etc. In the year 2020-21, a total of 51 industry samples on SPV lighting were tested. The solar PV lighting test facility at NISE is shown in **Fig. 10.3**.

Fig. 10.3: *Testing of Solar Street Lights with Integrating sphere system.*

10.1.9 Solar Cell Characterization and Outdoor Module Testing Facility

Solar cell characterization group at NISE has added a new spectro-radiometer facility for testing spectral content of light for different wavelength. The lab is now capable of estimating mismatch current factor of solar cell with known spectral response data. The spectral response system installation in solar cell is under process. NISE is undertaking a process to incorporate new advanced

testing facility for different solar cells. Presently, NISE has a 6 inch 6 bus bar. Customized solar zig is introduced in the design structure for the development solar cell testing for the proper collection of current and Fill factor and reduce a shading losses due to the bus bar. In the year 2020-21, a total of 4 solar cell samples were tested.

10.1.10 Solar Water Pump Test Facility

Solar Water Pump Testing Facility (**Fig. 10.4**) at NISE is a fully automated state of the art testing facility in India. The laboratory strictly adheres to MNRE Guidelines. It has a capacity of 0.5 HP to 10 HP. The capacity is being upgraded to 50 HP under the project titled Design and Development of High Efficiency Solar Water Pumping Systems (project supported by MNRE). The test facility is equipped with advanced tools such as Solar Array Simulators, Automatic Data loggers, Power Analysers, Power Meters, Flow Meters, Pressure Transmitters, Automatic gate valves, various sophisticated sensors and a dedicated software. All tests are performed against a suitable standard. The facility is also responsible for carrying out the analysis and R&D of solar water pumping systems. A total of 14 solar water pumps have been tested in the year 2020-21. It comprises of all major pumping technologies such as submersible, surface, AC and DC systems.

Fig. 10.4: *Solar PV Pump test facility at NISE*

10.1.11 Solar Thermal Technologies

Solar Dryer cum Space Heating System

NISE has indigenously designed and developed an innovative Solar Dryer cum Space Heating System with thermal storage system and filed an application for grant of Intellectual Property Rights (IPR) with Indian Provisional Patent Application No.: 201811013091. The system is ideally suited for drying of agricultural products such as crops, fruits, vegetables, spices, chips, fish, tea etc. NISE has successfully installed and commissioned 10 Nos. of solar dryer units (5 in Leh and 5 in Kargil) on trial basis **(Fig. 10.5)** to evaluate performance in actual field conditions in July, 2018. NISE carried out the design

improvements based on the feedback received from beneficiaries and Horticulture Department of J&K. These design improvements was done to enhance the performance of the system and for easy handling in terms of usage and installations. Based on the satisfactory performance of the system, Horticulture department of J&K requested NISE to supply and install 300 units of Solar Dryers cum Space Heating System in Ladakh, which are under installation.

Fig. 10.5: *Solar dryer units at Leh-Ladakh region*

National Institute of Solar Energy (NISE) has been carrying out research and analysis work for development of possible solution for space heating system in Ladakh and other Himalayan regions. NISE has carried out the designing of radiant floor heating system for Defence Institute of High Altitude Research (DIHAR), DRDO. Thermal analysis of the system was done on the Loop-CAD software.

Solar Cold Storage System

NISE has implemented 03 pilot installations of Solar Cold Storage for Horticulture Research Center Agartala, Agricultural Department Komalpur, Dhalai and Krishak Bandhu Center Gomti Udaipur in Tripura state. ANERT (Agency for Non-Conventional Energy and Rural Technology) has also installed 5 MT capacity Solar Cold Storage in Nochad, Kerala. NISE is regularly monitoring the performance of the pilot systems through online monitoring system. Based on the requirements of the pilot installations of various states, R&D work is being constantly carried out to meet the specific requirements apart from the standard product.

Fig. 10.6: *Solar Cold Storage System*

Bulk Milk Chiller System

NISE has also signed a Memorandum of Agreement (MoA) with industry partner for carrying out pilot installations and commercialization of the system and has successfully installed more than 15 Bulk Milk Chiller with thermal storage throughout India in the States of Punjab, Gujarat, Sikkim, Uttar Pradesh, Tamil Nadu, Karnataka and Maharashtra.

Fig. 10.7: *Bulk Milk Chiller System*

NISE has implemented an R&D project entitled "Modular Central Receiver Concentrated Solar Power Plant for Decentralized Power Generation" sanctioned by MNRE. The O&M activities were performed during the year 2019-20 to meet the objective of the R&D projects. The project has been concluded by MNRE on 31st March, 2020 and it was recommended that NISE shall utilize the existing facility for training and demonstration purpose.

NISE bags Platinum "QCI – D.L Shah Quality Award 2020" for Solar Dryer cum Space Heating Project in Ladakh

National Institute of Solar Energy (NISE) has won Platinum Award in 13th QCI – D.L Shah Quality Award 2020 on 17th December 2020, for the Solar Dryer Project implemented in Ladakh. The award is given by Quality Council of India as a recognition for successful projects of an organisation that have resulted in continuous improvement of processes, products and/or services, better/effective operations and increased customers and stake-holders satisfaction.

NISE has indigenously designed and developed an innovative Solar Dryer cum space heating system with thermal storage system. The technology can be used for a variety of agricultural process applications. The system is ideally suited for agricultural applications, such as crop, fruits, vegetables, spices, chips, fish, tea etc and other process drying. The system completely runs on the solar along with innovative thermal energy storage for continuous operation. System is designed for dual mode operation with plug and play connection: Drying Mode and Space Heating Mode.

Fig. 10.8: *NISE has won the Platinum QCI–D.L Shah Quality Award 2020*

National Institute of Solar Energy, Gurugram and Horticulture Department of Ladakh has jointly worked for supply of 300 units of Solar Dryer cum space heating system to the farmers of Ladakh under Prime Minister Development Programme (PMDP).

During summer the system is used by the farmers of Ladakh for drying apricots and other fruits and vegetables. During winters, the system is used by the farmers for space heating of their houses. Due to the use of solar dryer, drying time of apricots has been reduced to 3-5 days from 12-15 days taken by traditional open sun drying method. Apricot is now more hygienic and freer from insects, pathogens, dust and direct sun exposure. This has resulted in the improvement in product quality in terms of colour, taste, size and moisture level. Also the system has energy storage which helps the drying to operate round the clock. During winter season in Ladakh, the system is used by the farmers for heating their room which increases the capacity utilization of the system. This results in saving to farmers and reduction of indoor air pollution and the negative health impact from use of traditional bukharis.

The project is helping farmers of far flung areas in Ladakh to preserve their fruits and vegetables for longer duration by drying and increase their product quality. Additionally it helps them to keep warm during harsh winters months, bringing smiles to the farmers of Ladakh.

Fig. 10.9 *Solar Dryer cum Space Heating unit in Ladakh*

Fig. 10.10: *The Platinum QCI–D.L Shah Quality Award 2020 and Certificate won by NISE*

10.1.12 Solar Radiation Resource Assessment (SRRA)

The Solar Radiation Calibration Laboratory (SRCL) at NISE (**Fig. 10.11**) is operational since 2016 for calibration of solar radiation measuring sensors from National solar radiation network of MNRE (SRRA). The following activities carried out during the FY 2020-21.

- 8 SRRA stations equivalent to 24 solar radiometers and 6 in house facility pyranometers have been calibrated at the laboratory facility.
- Total 38 pyranometers have been calibrated at the facility from private organizations during this year under the commercial program.
- A comprehensive study is carried out on reference solar radiometer calibration methodology & analysis with establishing the traceability to the World Radiometric Reference using an absolute cavity radiometer.
- The periodical calibration data analysis is carrying out to develop the calibration protocols for improving the quality and reliability of measured solar radiation data.

Fig. 10.11. *Calibration of Radiometers at NISE (Project funded by MNRE)*

10.1.13 Skill Development And Capacity Building

NISE has taken several initiatives towards skill development and capacity building activities. During this year, across different states, a total of 2900 Suryamitras were trained in the field of installation and maintenance of the solar photovoltaic systems. NISE conducted 11 National programmes, imparting training to 319 professionals and 3 International training programs thereby provided training to 90 participants from various countries. NISE also successfully completed the advance professional program on solar energy for 20 participants, during February, 2020. **Fig. 10.12** shows the group photograph from 11th Renewable energy training programme for armed forces officials conducted in January, 2020.

Fig. 10.12. *Participants from 11th Renewable energy training program for officers from Armed forces.*

10.1.14 Hydrogen Energy

An R&D Project entitled Setting up of a Centre of Excellence on Hydrogen Energy at National Institute of Solar Energy (NISE), Gwal Pahari, Gurugram, supported by the Ministry of New and Renewable Energy is under implementation. The project was initiated with the objectives of (i) operating and maintaining the existing hydrogen production cum dispensing station, (ii) augmenting its hydrogen production capacity by installing another electrolyser, (iii) facilitating completion of field trials and demonstration of hydrogen fuelled vehicles at NISE, and (iv) organizing workshops, training and awareness programmes on different aspects of hydrogen energy. The following activities have been undertaken during 2020-21 (up to 31st December, 2020): (i) Work Order for Annual Maintenance Contract on the supplier of the existing hydrogen production cum dispensing facility was successfully placed, (ii) A Purchase Order was placed during the report period for supply of recommended spares for the facility based on an offer received from the supplier; (iii) After successful completion of an International Competitive Bidding Process NISE awarded a contract to an Indian supplier for procurement of an electrolyser of 10 Nm3/hr capacity for augmenting hydrogen production capacity of the existing facility; and (iv) NISE also conducted webinar a on 'Hydrogen: An Emerging Energy Carrier, Opportunities and Challenges for Production and Utilization in India' on 16th December, 2020. Hydrogen generation facility of NISE is shown in **Fig. 10.13**.

Fig. 10.13. *Hydrogen generation facility at NISE*

10.1.15 Out Reach Activities

NISE has continued its consultancy services and provided consultancy on field inspection, field testing **Fig. 10.14**, and services towards preparation of feasibility reports for solar projects. Work orders of the value Rs. 14.80 Lakhs has been realised in 2020-21 (upto 31.12.2020) from consultancy services.

Fig. 10.14. *Testing Services by NISE Technical Team at Solar PV Power Plant, Rohtak*

A collaborative project between NISE and Industry has been initiated funded by DST, titled "Supply of Clean Drinking Water through Solar-powered Station" at Faridpur. The project aims to provide 30,000 litres per day clean drinking water to people of village Faridpur district Gurgaon. NISE is also working along with German Development Cooperation (GIZ) to launch the first portable residential Solar Rooftop Photovoltaic System in India termed as PV Port and Store. **(Fig. 10.15).**

NISE has carried out short term assignments within this project such as overall coordination with manufacturers for manufacturing and deployment of PV Port system, quality inspection, field testing, coordination with DISCOM for consumer interaction and site selection, discovery of the cost of PV Port system according to the Indian Market scenario and policy and regulation for Solar Rooftop systems. NISE intends to further work on the performance evaluation of these deployed PV Port and Store system with aggregation of demand for PV Port system under Solar Rooftop program. The training of solar technicians Suryamitras for these system with digitised procurement of PV Port system for consumers through Portal Website or Application.

Fig. 10.15: *PV Port & Store System at NISE*

10.1.16 National and International Cooperation

NISE partners with government, academia, entrepreneurs and non-profit organisations for partnering and accelerate the growth of Renewable Energy technologies. In the year 2020-21, NISE has established its partnerships with esteemed organizations by signing 17 MoUs with National Organisations, and 1 with International institute.

10.1.17 Administration and Finance

The Government of India has sanctioned 41 regular posts including the post of Director General. The Institute has framed Recruitment Rules for the following sanctioned 41 regular scientific, technical and administrative posts. The Rules were approved by the Governing Council in its 3rd meeting held on 6th April, 2015. Efforts were made to fill up these posts through written test/interviews. Out of 40 sanctioned regular posts, the selection has been completed for 31 posts out of which 26 have joined and remaining are in the process of joining.

10.2 NATIONAL INSTITUTE OF WIND ENERGY (NIWE)

10.2.1 NIWE is one of the autonomous bodies of the Ministry whose main activities include wind & solar radiation resource assessment; testing and certification of wind turbine and associated systems and offer various consultancy services to customers. The major activities of NIWE during this period are given in succeeding paras.

10.2.2 Wind, Solar & Offshore Wind Resource Measurements

(i) Wind Resource Assessment (WRA) programme data is being used widely to establish wind farms in the country. Under this program of the Ministry, so far cumulatively 890 wind monitoring stations (WMS) have been established. As on date, 81 wind monitoring stations are under operation. In addition, Wind Resource Assessment studies were also carried out using telecom towers in the North Eastern region.

(ii) Further, during this year, 11 sites have been registered for wind measurement by private sector from various States in India. The wind data from four private wind monitoring stations have been analysed. Three consultancy projects relating to various wind farm developmental needs were undertaken.

(iii) As part of Solar Radiation Resource Assessment (SRRA) program of the Ministry cumulatively 125 stations have been set up so far **(Fig. 10.16).**

(iv) NIWE being the designated nodal agency for the development of offshore wind power projects in India is involved in executing the various pre-feasibility activities relating to resource assessment, survey and studies within EEZ (Exclusive Economic Zone), demarcation of offshore potential blocks and facilitating offshore wind energy project developers for setting up offshore wind energy farms.

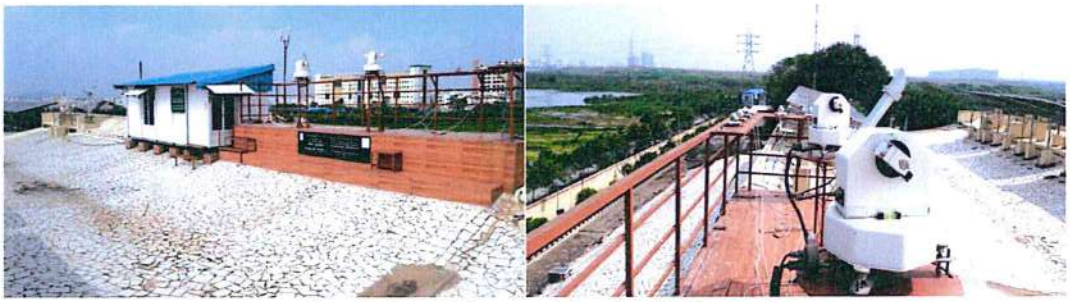

Fig. 10.16: *Calibration Lab at NIWE, Chennai*

10.2.3 Geo-Tagging of Wind Turbines Installed Across the Country

At present, the installed capacity of wind generation in India stands at about 38,400 MW with equivalent number of wind turbines. However, there is no centralized system for maintaining this vast database. Considering the requirements of the centralized system, under the directions of MNRE, NIWE has developed a geo-tagged data base and online registry web portal with the support of agencies of Central and State Governments. The web portal will have data base of wind turbines already installed and proposed to be installed across the country. NIWE has collated wind turbine details to the tune of 34 GW.

10.2.4 International Consultancy Project

During 2019-20, NIWE has taken first of its kind international project for preparation of a detailed project report for the establishment of a wind farm project from M/s Energoimport at Rio-Seco Cuba for a capacity of 50 MW power generation. During the year, NIWE had completed the analysis and submitted the technical and economic feasibility report using one-year real-time measurement from the 100m Met mast at Rio-Seco, Holguin province, CUBA.

10.2.5 Research & Development

Wind Turbine Research Station at Kayathar, has a cumulative installed capacity of 6.4 MW wind turbines for conducting various R&D related activities. The testing facilities are certified as per the requirements of ISO 9001:2015 and accredited as per the requirements of ISO / IEC 17025:2017. It is presently equipped to undertake Onshore Wind Turbine Type Testing and also special testing of wind turbines as per International standards IEC 61400-1, IEC 61400-11, IEC 61400-12-1, IEC 61400-13 and IEC 61400-21 in power performance measurement, Yaw efficiency test, Safety and functional test, Load measurements and User defined measurements in Mechanical Loads, Acoustics and Power Quality. During the year, Power curve measurements of two turbines of 2 MW, 2 power performance tests, type testing of a 750 kW was completed. Type testing of a 5.5 kW Small Wind Turbine was also carried out during this year.

Under the Quality assurance program of the National Lab policy, NIWE in the role of the Primary Lab in Wind Turbine Testing has coordinated and completed the first Indian Inter Laboratory Comparison (ILC) in the field of Power Performance Testing where in 4 reputed International Test Labs had participated and completed the work successful. The 2nd ILC on Load Measurements has been initiated. Further the Lab has participated in a similar activity conducted abroad in the area of Acoustics Measurements and has qualifying results at par with 15 other International Labs. In addition the Lab has inked an agreement with MEASNET, Europe for participating in its IECRE-PT (Proficiency Testing) programmes to benchmark its capabilities against other International Practicing Labs.

10.2.6 Wind and Solar Forecasting

NIWE has developed indigenous wind and solar power forecasting system consisting of Data management system, Monitoring System, Web portal, forecast simulation tools and security system. This operational forecast system with simulation tools predict the wind power upto 7 days ahead. In order to improve the forecasting model, NIWE has signed MoU with ISRO SAC for Development of Wind and Solar Power Forecasting using High Resolution Numerical Model. The Wind/Solar power forecasting services are being provided to Tamil Nadu, Gujarat, Karnataka, Andhra Pradesh, Maharashtra and SRLDC.

10.2.7 Certification and Standards

NIWE has obtained international accreditation for the certification services as per the ISO/IEC 17065 standard from National Accreditation Board for Certification Bodies (NABCB), Quality Council of India (QCI).

10.2.8 Skill Development and Training Division

NIWE has successfully conducted the following customized training courses;

a. Special Online Training Course on "Wind Turbine Technology" for the employees of M/s. Adani Green Energy Limited, Ahmedabad. The training course of 30 hours in 10 days during 17th to 28th August 2020 for 27 participants with a customized syllabus

b. Another customised online Training Course on "Wind Turbine Technology" was conducted for the employees of Gail India Limited, Noida. The training course of 12 hours in three days during 7th to 9th October, 2020 for 35 participants.

Further, in order to encourage better understanding on renewable energy and in particular wind generation, NIWE had organised thirteen webinars during June, 2020 to December 2020.

10.2.9 Infrastructure and Other Activities

During the COVID-19 Pandemic, NIWE staff has been provided with Secured Virtual Private Network (VPN) facility to connect to their respective endpoints in order to Work from Home (WFH) as per the approved IT policy. All Engineering software have been centralized and installed in server for speedy computing. Seamless access to these software is enabled to Scientists and Engineers of various divisions based on requirements and information received.

The Fourth Edition of IREDA-NIWE Annual Awards for Wind Energy 2021 is scheduled on March 21, 2021 on the Foundation Day of NIWE. The award is to promote innovation, research & development, manufacturing, developing & harnessing wind energy at the State and National levels and to motivate individuals, stakeholders to strive for the best in the field.

10.2.10 Global Wind Day Celebrations 2020

NIWE organized the Global Wind Day celebration, on 15th June of every year. As part of 2020 Global Wind Day celebration, e-Poster contest on Sustainable Energy and Wind Generation was organized for school students.

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

10.3.1 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 for research and developmental activities, biomass resource assessment, testing, validation and training for promotion of bioenergy in the country. During the year 2020-21, R&D activities were taken up in the areas of biogas production from agro-residue, biomass cookstove performance, waste biomass conversion to activated carbon, biomass gasification, and solar-biomass hybrid systems. The research carried out was published in reputed journals of the frontier bioenergy area. The Institute prepared necessary technical documents related to bioenergy as entrusted by MNRE time to time. The Institute participated in technical programs and meetings of the Ministry of New and Renewable Energy, particularly related to bioenergy sector, for discussion on R&D, strategy and policy, progress and dissemination of knowledge and technology in the area. Several projects on different R&D processes for biofuels and bioenergy are going on under different divisions:

10.3.2 Thermochemical Conversion Division

During the FY 2020-21, research on improved biomass cookstove was carried to improve the performance of in-house developed biomass cookstoves. The research was published in reputed peer reviewed journals. During the same year, the division also explored the scope of biomass gasification and developed the following projects to cater the ongoing energy requirement of the country.

» **Densification of agro-waste and its assessment for Power Generation through Gasification**

It is essential to identify and characterize alternative renewable fuels (like agricultural waste, organic matter and forest waste, or municipal solar waste etc. which is available bounteously) for clean and

sustainable energy production. It is also important to identify and assess the major issues (like gas emission, ash behaviour, and moisture content etc.) related to unexplored fuels for their potential use in gasifier. Moreover, loose biomass like rice straw and baggase, requires proper processing for combustion in thermal power plants. Their densification and briquette formation would help to utilize such agro-waste efficiently for various purposes.

In the current project, it is proposed to investigate the potential of agro-waste briquettes and its impact on fuel efficiency in gasifiers. For the same, different biomass like paddy straw, corn stover, sweet sorghum, millet, cotton stick, and mustard crop residue based on seasonal availability will be characterized for its application in briquetting. Further, the impact of size of milled biomass and binders will be investigated on briquettes characteristics. The fuel efficiency of briquettes will be tested in downdraft gasifier and techno-economic feasibility of the technology will be analysed. The potential biomass briquettes from agro-waste would help to identify the optimum composition of biomass for power generation through gasification mode.

» **Design and development of a lab scale solar reactor for biomass torrefaction under high concentration**

The biomass torrefaction, pyrolysis, carbonization etc are energy intensive processes, which requires external energy source to heat up the biomass to generate gases, tar and charcoal, depending upon the process used. The project aims to utilize concentrating solar technology as external heating source, thus making solar reactor for biocoal production. With recent policies of the Govt of India, the biocoal are being promoted to use instead of fossil-based coal. The high density biocoal generates less carbon emission and are renewable in nature, as it can easily be obtained from waste biomass. In the project, the final product would be biocoal which can be used as replacement of traditional coal. The viability of solar reactor for biomass torrefaction would mainly reduce the pollution level and enhance the overall energy density of biocoal.

» **Improved Biomass Cookstove**

SSS NIBE is working on the development of Improved Biomass Cookstove (IBC) with higher efficiency and low emissions as per BIS specifications. The R&D focuses on the designing of cookstove with efficient air supply to reduce the thermal losses and efficient burning of biomass. The new designs of IBCs are developed with varying insulating material. The first design included Plaster of Paris (POP), while the other had glass wool (GW) as insulating material. The experimentation was carried out to identify the performance of both IBCs. The physical and chemical characteristics of new design of IBC were assessed in terms of thermal efficiency, power output, and emission rate in the National Cookstove Test Centre, situated in the Institute.

» **Solar Biomass Hybrid Air Drier**

SSS NIBE is working on development of Solar Biomass Hybrid Air drier for drying of agro waste and vegetables in collaboration with Bharat Heavy Electricals Ltd. The R&D focuses on the design of solar thermal system along with biomass combustion chamber which can be used to provide heating for drying of agro-waste and vegetables. This will help in offering sustainable solutions for energy demand, specifically in colder regions.

10.3.3 Biochemical Conversion Division

Biochemical Conversion Division has basic facilities of Analytical, Bioprocess, Microbiology and Molecular Biology Laboratories. Various research project funded by the Department of Biotechnology are going on.

Biorefining of Sugarcane Bagasse for Production of Bioethanol and Value-added Products

A project entitled Biorefining of sugarcane bagasse for production of bioethanol and value-added products under Indo-Brazil bilateral collaboration with IFSC/USP, Brazil and GNDU, Amritsar, funded by the Department of Biotechnology (DBT), Ministry of Science and Technology has been completed on October 31, 2020. The project cost from Indian side is Rs. 129.264 lakhs.

The objectives of the project included development of a process for Xylitol production from Hydrolysate of acid (H_2SO_4) and pre-treated sugarcane bagasse containing dissolved xylose. For enhanced Ethanol production as the main product of biomass refinery, fed-batch simultaneous saccharification and co-fermentation (SSF) process was developed for alkali pre-treated sugarcane bagasse using in-house isolated and developed yeast strain.

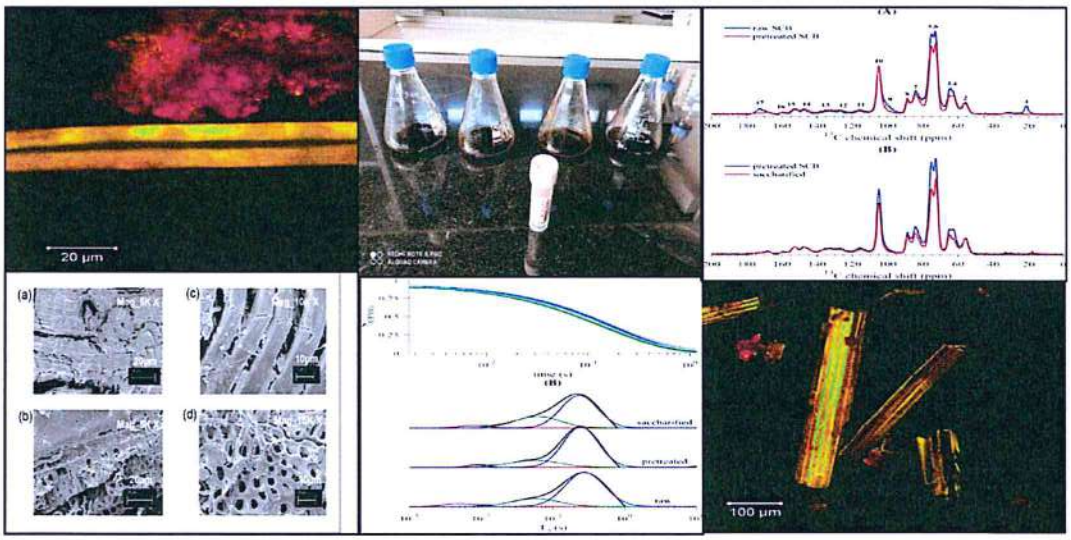

Fig. 10.17: *Lignin Characterization and its Valorization*

Biorefinery approach for Generation of Platform Chemicals and Bioethanol from Indigenous Lignocellulosic Agro waste Bioresources

A project entitled *Biorefinery approach for generation of platform chemicals and bioethanol from indigenous lignocellulosic agrowaste bioresources'* has been sanctioned by DBT. The project cost is Rs.69.60 lakhs. The project was taken up with effect from October 26, 2017.

The objective of project is to process lignocellulosic waste specially grown in North East region i.e. *Saccharumspontaneum* (Kans) grass and banana pseudostem for bioethanol and platform chemicals. This project is to be performed in collaboration with Tezpur University, Assam. SSS NIBE has to take

care of bioethanol production from lignocellulosic wastes and characterization of end products. Kans grass was characterized with raw biomass (7-10)% Moisture, (93-90) % solid content, (94.8) % volatile solid and (5.2) % ash content. The pretreated biomass under optimized conditions has been used for ethanol production by simultaneous saccharification and fermentation (SSF) method using in-house thermotolerant yeast and commercial cellulases enzymes. **(Fig. 10.18).**

Fig. 10.18 *A) Raw Kans Grass Biomass B) NaOH Pre-treatment C) Acid Pre-treatment D) Ammonia Pre-treatment*

10.3.4 Chemical Conversion Division

During this period agro-waste (like corncob and elephant grass)conversion to activated carbon and their applications for chemical conversion of waste stream of biodiesel Industry have been carried out. The division, also proposed two new projects for pilot scale demonstration, which includes (a) MSW to power generation via gasification, and (b) Activated carbon production from corncob. The latter project was formulated in collaboration with a start-up Industry and submitted to DST for funding.

The institute prepared rib shaped activated carbon catalyst (AC-CC) from *Zea mays L. cob* (an agricultural waste, commonly known as corncob) by an activation method using sodium hydroxide as an activating agent for the first time ever. The prepared AC-CC have been characterized by using equipment thermogravimetric analyser (TGA), Fourier transform infrared spectroscope (FTIR), Scanning electron microscope (SEM), X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS) and temperature programmed desorption (TPD). It has been found that such product can be promising renewable catalyst for the glycerol conversion into solketal.

10.3.5 Publications

During 2020-21, a total of 15 publications across various journals, conferences, books were brought out by scientists working in the Institute.

10.3.6 Masters Programme in Renewable Energy

The institute has started an academic course of Masters in Technology in Renewable Energy, in joint collaboration with National Institute of Technology (NIT) Jalandhar since September, 2020. The program and NRE fellowship for the students were approved by Hon'ble Minister, NRE. The course is floated in the 'Centre for Energy and Environment', NIT Jalandhar. The intake capacity under the program is for 20 students, which include 5 sponsored candidates. The Academic Session 2020-21 was commenced from 21st Sept 2020 onwards with intake of 13 students through centralized admission process of NIT Jalandhar.

10.3.7 Skill Development Programmes

SSS NIBE have been organizing various skill development programmes in the field of Bioenergy in association with partner institutes across India. During March 2 - 6, 2020, one-week National Training Programme on Renewable Energy: Special Focus on Bioenergy was organized. Thirteen participants participated in the program from various sectors/institutions. The inaugural session was chaired by Dr. Rajesh Grover, Director, Pushpa Gujral Science City, Kapurthala, Punjab, as Chief Guest of the programm. The training programme was arranged in key note lectures on the relevant topics delivered by the invited experts from R&D/academic/financing institutions, ministry, industries and scientists of the institutes. The programme concluded on 6th March, 2020 at 03:00 PM after the Valedictory Function. The certificates were distributed to the all the participants after the successful completion of the training.

During October 7-8, 2020, SSS NIBE worked as Knowledge Partner for Virtual Training Tour on Biogas, jointly organized by Indian Biogas Association (IBA).

10.3.8 Collaboration Activities

SSS NIBE has signed Memorandum of Understanding (MoU) with different organizations to operate a collaborative venture for the development and dissemination of bio-energy through academic and research. The list of MoUs signed are given in **Table 10.2**

Table 10.2 MOUs Signed by SSS-NIBE

Sl. No.	MOU	Date of MoU	MoU valid up to
1.	SSS NIBE & Punjab Public Works Department (B&R), Kapurthala	12th March, 2020	11th March, 2025
2.	SSS NIBE & National Institute of Technology, Jalandhar	4th November, 2020	3rd November, 2025
3.	SSS NIBE & Indian Biogas Association, Gurgaon	4th November, 2020	3rd November 2023
4.	SSS NIBE & National Institute of Solar Energy	8th January, 2021	7th January, 2026
5.	SSS NIBE & National Institute of Wind Energy	8th February, 2021	7th February, 2026

10.4 SOLAR ENERGY CORPORATION OF INDIA LIMITED (SECI)

10.4.1 Solar Energy Corporation of India Ltd. (SECI) is a Section- 3 Company under the Companies Act, 2013, with 100 percent Government ownership, under the administrative control of the Ministry of New and Renewable Energy (MNRE).

10.4.2 The company was set up as an implementing and executing arm of the Jawaharlal Nehru National Solar Mission (JNNSM) for development, promotion and commercialization of solar energy technologies in the country. In 2015, the mandate of the company has been broadened to cover all segments of renewable energy, pursuant to the approval of the Government of India.

10.4.3 During FY 2019-20, it registered a total revenue of Rs.4657.73 crore and profit after tax (PAT) of Rs.178.94 crore.

10.4.4 Business Activities

10.4.5 Implementation of Solar Tenders Under National Solar Mission

- SECI is the implementing agency of MNRE for promotion of solar projects under the National Solar Mission (NSM). SECI floats tenders on pan-India or 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. SECI signs long term Power Purchase Agreements (PPA) with the selected developers and long-term Power Sale Agreements (PSA) with Power Distribution companies (DISCOMs), as a power trading intermediary.
- As on 31.12.2020, SECI has cumulatively awarded 32546 MW of solar projects, of which 5705 MW capacity has been commissioned. During FY 2020-21, SECI has awarded solar projects amounting to 12270 MW capacity and projects totalling 200 MW have been commissioned (till 31.12.2020).

Fig. 10.19: *50 MW solar project in Rajasthan under ISTS I*

10.4.6 Rooftop Solar: SECI is implementing MNRE's schemes for setting up of grid-connected rooftop solar projects in the country. the company's initiatives in this segment have resulted in competitive procurement mechanisms and widespread deployment of rooftop solar projects.

During FY 2020-21, SECI's tender for setting up of 97.5 MW grid connected rooftop solar projects on Government buildings, under Achievement Linked Incentive Scheme (awarded on 15.01.2020) is under implementation.

10.4.7 Floating Solar: The company is promoting floating solar technology as an alternative to land-based solar projects in areas with constraints on land availability/usage. 150 MW floating solar projects are under development in Uttar Pradesh.

During FY 2020-21, contract for setting up of 4 MW floating solar project with 2MW/1MWh energy storage in Andaman & Nicobar has been awarded. Floating solar projects are being planned in several other states.

10.4.8 Manufacturing Linked Solar: With the objective to strengthen India's domestic manufacturing base in solar photovoltaic (PV) technology, SECI has brought out tender for selection of developers for setting up of solar projects linked with solar PV manufacturing facilities. Under this tender, cumulative 12,000 MW of solar power generation capacity has been awarded, linked with 3,000 MW of manufacturing facilities, of which 8,000 MW of solar power generation capacity linked with 2,000 MW of manufacturing facilities have been awarded during FY 2020-21.

10.4.9 Implementation of ISTS Connected Wind Power Tenders

- As MNRE's implementation agency, SECI is promoting large-scale wind power projects in the country. Through selection of developers on competitive procurement basis, projects are set up through third-party investments in build-own-operate mode. SECI signs long term PPA with the selected developers and long term PSA with DISCOMs as a power trading intermediary.
- Cumulatively till 31.12.2020, SECI has awarded 10,330.70 MW of wind projects in nine tendering tranches, of which 2,598.9 MW have been commissioned. During the FY 2020-21, 970 MW capacity has been awarded and 637.5 MW of projects have been commissioned (till 31.12.2020).

10.4.10 Implementation of Tenders For Hybrid Projects

SECI is promoting innovative projects, viz. solar-wind hybrid projects, RE with assured supply during peak hours and Round-the-Clock (RTC) RE power, with the objectives of resource optimization, better grid integration and reduced intermittency. For these projects, SECI selects developers on competitive procurement basis, and projects are set up in build-own-operate mode. SECI signs long term PPA with the selected developers and long term PSA with DISCOMs as a power trading intermediary.

Cumulatively till 31.12.2020, SECI has awarded 4240 MW capacity under solar-wind hybrid, RE with assured peak hours supply and RTC configurations. Of these, 1600 MW (400 MW RTC and 1200 MW solar-wind hybrid) capacity has been awarded during FY 2020-21 (till 31.12.2020).

10.4.11 Solar Parks Scheme

SECI is the implementation agency for the scheme for development of solar parks, for providing infrastructural support, such as developing the land and power evacuation facilities, to solar project developers. Under the scheme, 42 Solar Parks have been sanctioned by MNRE in 15 states with total capacity of 26541 MW till 31.12.2020.

10.4.12 CPSU Scheme

SECI has been implementing CPSU scheme of MNRE. Under Phase I of the scheme, solar projects totalling 881.76 MW have been set up. Under phase-II of the scheme, 2,026 MW of solar project capacities (awarded in FY 2019-20) are under implementation.

10.4.13 Scheme for Defence Establishments

Under the scheme for setting up of over 300 MW of grid connected and off grid solar PV projects by Defence establishments, 139 MW capacity of projects have been commissioned and 102.95 MW of projects are under implementation (as on 31.12.2020).

10.4.14 Project Development

Apart from catalysing the creation of large scale solar and wind capacities in the country on build-own-operate basis through power aggregation, SECI is also developing RE projects through its own investment, and offers project management consultancy services to other agencies. Some of the major projects undertaken by SECI during FY 2020-21 are listed below:

(i) Projects under PMC-

- **300 MW solar projects for SCCL-** 300 MW aggregate capacity of solar projects are being set up in spare land of coal mines at different locations in Telangana by Singareni Collieries Company Ltd. (SCCL) for captive use. 55 MW capacity has been commissioned, 245 MW is under execution, and 81 MW capacity is under DPR preparation stage.
- **50 MW solar project for THDC**- 50 MW solar power project of THDC in Kasargod, Kerala, has been successfully commissioned in December, 2020.
- **15 MW floating solar project for BBMB**- 15 MW floating solar project is being set up under developer mode (Build-own-operate basis) for power off-take by the Bhakra Beas Management Board (BBMB) at Nangal pond, Himachal Pradesh. Tender for selection of developer has been floated on 02.07.2020 and bids are being called (as on 31.12.2020).
- **4 MW floating solar project in Andaman & Nicobar Islands:** 4 MW floating solar project with Battery storage is being set up under developer mode (Build-own-operate basis) for power off-take by the Union Territory. Project developer has been selected through a competitive bidding process and the contract has been awarded in October, 2020.
- **6 MW Solar projects for Military Engineer Services (MES)** - Three projects of 2 MW each are being developed for MES Meerut, Roorkee and Dehradun. These projects are under execution and are expected to be commissioned shortly.
- **5 MW project at VOCPT:** SECI is developing a 5 MW project V.O. Chidambaranar Port Trust at Tuticorin. The project was awarded on 20th Nov 2020 and the project is under execution.

(ii) Own Projects-

- **10 MW Solar project at Badi Sid, Rajasthan**- This solar PV project of 10 MW capacity is located at Badi Sid, Jodhpur district of Rajasthan. Commissioned in FY 2015-16, the project is operational and has generated 12.88 MU of solar energy in FY 2020-21 (till 30.11.2020)
- **1 MW rooftop solar projects in Andaman & Nicobar**- SECI has installed 1 MW rooftop solar power projects in Andaman & Nicobar Islands. It was commissioned in FY 2017-18 and is presently operational.

» **10 MW Solar project in Karnataka**– SECI's 10 MW solar PV project for supply of power to the Defence Research and Development Organization (DRDO) has been successfully commissioned in October, 2020.

Fig. 10.20: *10 MW solar project in DRDO Karnataka*

» **20 MW Solar projects with battery storage in Lakshadweep islands:** SECI is working on development of solar projects in Lakshadweep as an alternative to use of diesel for power generation. . Under Phase I, EPC contract for solar projects of 1.95 MW of projects with 2.15 MWh Energy Storage at four islands of Agati, Kavaratti, Bangaram, Thinakara islands was awarded in July 2020 and is under execution. Balance capacities are under technical and environmental due-diligence.

» **100 MW Solar project with battery storage in Chhattisgarh**- SECI is under discussions with the state of Chhattisgarh for development of 100 MW solar plant with battery storage for meeting the Discom's demand, through World Bank funding. Land acquisition is under progress and PPA has been signed. Tender for selection of EPC contractor has been issued in September, 2020 and bidding is in progress (as on 31.12.2020).

» **50 MW (DC) Solar project with battery storage in Leh:** SECI is developing 50 MW (DC) Solar PV project with battery storage in Leh for supply of solar power to the UT. Tender for selection of EPC contractor has been issued in December, 2020 and bidding is in progress (as on 31.12.2020).

» **Solar-wind hybrid project in Andhra Pradesh**- SECI is planning to set up solar-wind hybrid project in Andhra Pradesh through World Bank funding. Land acquisition is under progress (as on 31.12.2020).

» **50 MW solar PV projects at Agricultural feeders in Tamil Nadu & promotion of Agro PV projects:** SECI is developing 50 MW of projects in around 11 segregated agriculture feeders in Tamil Nadu. Out of these 50 MW projects, a 10 MW project is being developed as agro PV project with four different orientations of mounting structures for solar projects. The tender for the same is released on 6.01.2021 and the land for the same will be arranged by the EPC contractor.

10.4.15 Power Trading

» SECI is mandated to purchase power from projects set up under RE tenders issued by the company,

as a power trading intermediary, and in-turn supplying it to various DISCOMs through long term Power Purchase or Power Sale Agreements (PPAs or PSAs).

» For this role, SECI has a Category-I interstate power trading license from Central Electricity Regulatory Commission (CERC) and is actively trading RE power on both intra-state and inter-state levels.

» In FY 2020-21, 10,721.43 million units (MU) of electricity have been traded across states and union territories (till 31.12.2020).

10.5 INDIAN RENEWABLE ENERGY DEVELOPMENT AGENCY LIMITED (IREDA)

10.5.1 Indian Renewable Energy Development Agency Limited (IREDA) is a Mini Ratna (Category-I) Government of India Enterprise 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 and conservation with the motto: ENERGY FOR EVER.

10.5.2 Lending Operations

(i) During the Financial Year 2019-20, IREDA has sanctioned loans to the tune of ₹ 12696.11 crore (corresponding previous year ₹ 11941.87 crore) and disbursed ₹ 8785.31 crore (corresponding previous year ₹ 9385.37 crore) against the annual target of ₹ 15,000 crore and ₹ 10,700 crore for sanction and disbursements respectively. The sanctioned loan (includes co-financed projects and takeover loans) would support capacity addition of 5673.48 MW. The sector wise breakup of sanctions and disbursements for the period and the calendar year 2020 are given below in **Table 10.3.**

Table 10.3: IREDA – Sector-Wise Break-up of Loan Sanctions and Disbursements During FY 2019-20

IREDA – Sector-Wise Break-up of Loan Sanctions and Disbursements During FY 2019-20			Sector-Wise Break-up of Loan Sanctions and Disbursements from 01.01.2020 to 31.12.2020	
				(Rs. in crore)
Sector	**Sanction**	**Disbursement**	**Sanction**	**Disbursement**
Wind Power	1610.55	1057.11	962.78	887.62
Hydro Power	295.28	295.97	392.32	534.82
Biomass and Cogeneration	44.12	118.11	87.26	33.06
Energy Efficiency & Conservation	5.00	-	5.00	4.75
Solar Energy	4042.09	2666.10	2518.49	1723.73
Waste to Energy	118.38	78.12	93.01	135.18
Biomethanation from Industrial Effluents	-	-	-	-
Biomass Briquetting	-	-	-	-
Biomass Gasification	-	-	-	-
National Clean Energy Fund (NCEF)	-	-	-	-

Bill Discounting	-	10.10	-	-
Bridge Loan	85.50	5.82	10.81	4.00
Short Term Loan	5060.00	4507.97	1438.82	2899.55
Miscellaneous (Guarantee Scheme + Energy Access + Manufacturing +Ethanol +LoC)	1435.19	46.00	1309.08	328.86
TOTAL	**12696.11**	**8785.31**	**6817.57**	**6551.57**

(ii) The sector-wise break-up of cumulative sanctions and disbursements up to 31.12.2020 and projected sanctions and disbursements for the period from 01.01.2021 to 31.03.2021 are given in **Table 10.4**

Table 10.4: IREDA Sector-Wise Break-up of Cumulative Loan Sanctions and Disbursements up to 31.12.2020

IREDA – Sector-Wise Break-up of Cumulative Loan Sanctions and Disbursements up to 31.12.2020			**Projected Sanctions and disbursements from 01.01.2021 to 31.03.2021**	
				(Rs.in crore)
Sector	**Cumulative Sanction**	**Cumulative Disbursement**	**Sanction**	**Disbursement**
Wind Power	26460.00	18137.98	877.22	320.04
Hydro Power	8824.51	5342.15	120.98	69.76
Biomass Power and Cogeneration	5428.14	3523.06	12.74	30.01
Energy Efficiency & Conservation	1276.10	347.25		
Solar Energy	27212.13	14919.70	1481.48	1929.07
Waste to Energy	961.29	393.14	6.99	43.06
Biomethanation from Industrial Effluents	19.47	57.60	50	50
Biomass Briquetting	12.43	9.99	50	20
Biomass Gasification	72.47	5.12	-	-
National Clean Energy Fund (NCEF)	156.57	127.14	-	-
Bill Discounting	181.97	161.76	-	-
Short Term Loan	15955.21	14085.06	1461.18	1180.45
Bridge Loan	223.86	156.14	-	-
Miscellaneous ((Guarantee Scheme + Energy Access + Manufacturing +Ethanol +LoC +Transmission + Factoring)	2862.04	338.85	1347.39	1595.10
TOTAL	**89646.19**	**57604.94**	**5407.98**	**5237.49**

10.5.3 MOU with MNRE

Based on the audited accounts of financial year 2019-20, the Memorandum of Understanding (MoU) rating is expected to be "Fair". IREDA has also signed MoU with the MNRE for the year 2020-21.

10.5.4 Resource Mobilization

Paid up capital of IREDA is Rs.784.60 crore with a net worth of Rs.2521.32 crore based on the financial results for the year ended March 31, 2020. During 2019-20, IREDA has raised Rs.334.60 crore through various International lines of credit apart from Rs.1803 crore through Bonds.

10.5.5 Dissemination of Information

IREDA has continued to create awareness of Renewable Energy Technologies, Energy Efficiency & Conservation (EEC) and also its financial assistance schemes by hosting all its publications on its website.

10.5.6 Human Resource Development

(i) IREDA considers its employees as its most valuable assets and aims to align its human assets to achieve the business goal. IREDA has taken several measures to improve performance culture in the Company through policy interventions and improvement of systems and processes. During the year, IREDA has achieved 300 training man-days, which includes one-week training programme at premier institutes for more than 15% employees. "Monthly Lecture Series" with eminent personalities of different walks of life, to harness the knowledge and to create awareness on concepts for development has become regular feature in IREDA. Trainings and workshops directed towards spiritual, health and attitudinal development of employees are also regularly conducted. 47 personnel have been elevated to higher posts during this year. IREDA has also incorporated periodical review of employees under FR-56 (j) under clause No. 34 of Service Rules.

(ii) IREDA strictly observe the reservation policy of the Government of India as applicable in the categories belonging to Scheduled Castes/ Scheduled Tribes/ Other Backward Communities/ Person with Disabilities & EWS. IREDA is following the reservation rosters prescribed by the Government.

(iii) IREDA adopted digitization process by implementing e-office and 'Work from Home' to improve efficiency and productivity. This has facilitated operating functions of office during the pandemic situation and lockdown due to COVID-19. Standard Operating Procedures was notified, and 'Work from Home' was initiated as the lockdown was announced in March, 2020.

(iv) IREDA celebrated International Yoga Day, Vigilance Awareness Week and Hindi Fortnight during the year. IREDA also observed all protocol related to Swachhata and organized dedicated cleanliness and awareness drive in office including all protocol related to COVID -19 pandemic. IREDA constituted a "IREDA Covid Care Team" to give necessary care and support to IREDA employees and their families during COVID-19 pandemic. Further, IREDA hosted Health Talk by Doctors from Max, Apollo and other hospitals from health & awareness point of view to address the queries on health issues.

(v) Employee relations continued to be very cordial and harmonious during the financial year. There were no man-days lost during the period under review.

(vi) In addition to the above, total number of employees, as on 31.12.2020 is 158 excluding Board Level Executives, comprising 38 female and 120 male employees.

10.5.7 Corporate Social Responsibility Sustainable Development and R&D Activities

(i) The Company spent ₹ 11.16 crore during the FY 2020-21 (till 31.12.2020) on CSR activities for the project which were completed/ongoing during the year (including ₹ 8.29 Crore paid for the projects which were sanctioned during the year 2020-21). Projects aggregating to ₹ 9.02 Crore were sanctioned during the year and were in progress and few completed at the end of the year. The unspent amount on CSR initiative shall be spent upon the completion of the project. As a socially responsible corporate, IREDA is committed to increase its CSR impact and spend over the coming years, with its aim of playing a large role in India's sustainable development by embedding wider economic, social and environmental objectives.

(ii) During the period April 2020 – December 2020, following activities and projects were undertaken by the Company under its CSR initiatives as shown in **Table 10.5**.

Table 10.5: CSR Initiatives undertaken by IREDA during 2020-21

S. No.	Description	Rs. (Lakhs)
1.	Contribution to PM-CARES Fund	750.00
2.	Provision for 1500 PPE Kits and 40000 Three Layered Masks for Medical Staff engaged in Hospitals at Balrampur and Chandauli Aspirational Districts	20.55
3.	Provision for Mobile Medical Van for running Therapy on Wheels Program of Samphia Foundation in Kullu, Himachal Pradesh.	35.2
4.	Provision for SCADA System in India International Center, New Delhi	30.0
5.	Provision for installation of 2 Nos 5 kWp Solar PV Systems and 20 Nos. Solar PV Lighting Systems at Jeevodaya Foundation Itarasi, Madhya Pradesh	13.86
6.	Supply of 5000 IREDA Branded Cloth Masks in Aspirational Districts of Balrampur & Chandauli and IREDA Stakeholder in Delhi	6.29
7.	Provision for 4000 PPE Kits and 40000 Three Layered Masks for Medical Staff engaged in Hospitals and Material for Campaign of COVID-19 appropriate Behaviour at Balrampur and Chandauli Aspirational Districts	46.12
Total Sanctioned Amount in FY 2020-21		**902.02**

Projected Sanction for CSR from 01.01.2021 to 31.03.2021 : IREDA has sanctioned 100% of the provision for FY 2020-21.

Projected Disbursement for CSR from 01.01.2021 to 31.03.2021 : ₹ 2.50 Crores.