



POWER FROM OTHER RENEWABLES

POWER FROM OTHER RENEWABLES

4.1 GRID INTERACTIVE AND OFF-GRID RENEWABLE POWER

- (i) India has large renewable energy potential from sources such as wind, solar, biomass, small hydro, etc. As per estimates, India has a wind potential of more than 300 GW at a hub height of 100 metre, solar potential of ~750 GW, assuming 3% wasteland is made available, small hydro potential of ~ 20 GW, and bio-energy potential of 25 GW. Further, there exists significant potential from decentralized distributed applications for meeting the hot water requirement for residential, commercial and industrial sector through solar energy and also meeting cooking energy needs in the rural areas through biogas. Renewable energy also has the potential to usher in universal energy access. In a decentralized or standalone way renewable energy is appropriate, scalable and a viable solution for providing power to un-electrified or power deficient villages and hamlets.
- (ii) In December 2019, the cumulative renewable power installed capacity was 84.84 GW. Capacity addition of 7.59 GW has been achieved during the current year 2019-20 (upto 31.12.2019)

4.2 GRID INTERACTIVE RENEWABLE POWER

4.2.1 WIND ENERGY PROGRAMME

India's wind energy sector is led by indigenous wind power industry and has shown consistent progress. The expansion of the wind industry has resulted in a strong ecosystem, project operation capabilities and manufacturing base of about 10,000 MW per annum. The country currently has the fourth highest wind installed capacity in the world with total installed capacity of 37.50 GW (as on 31st December, 2019) and 62.036 Billion Units were generated from wind power during 2018-19.

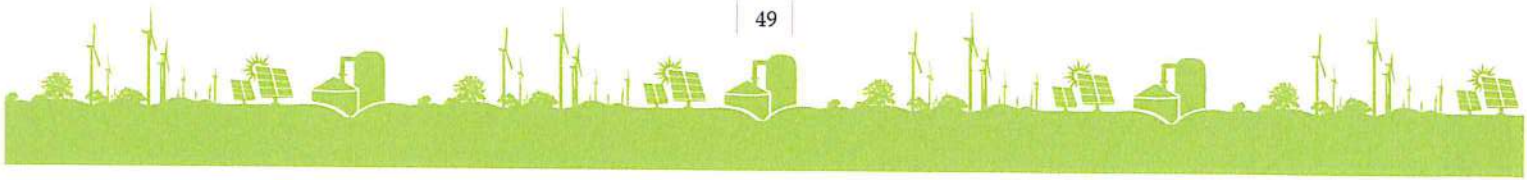
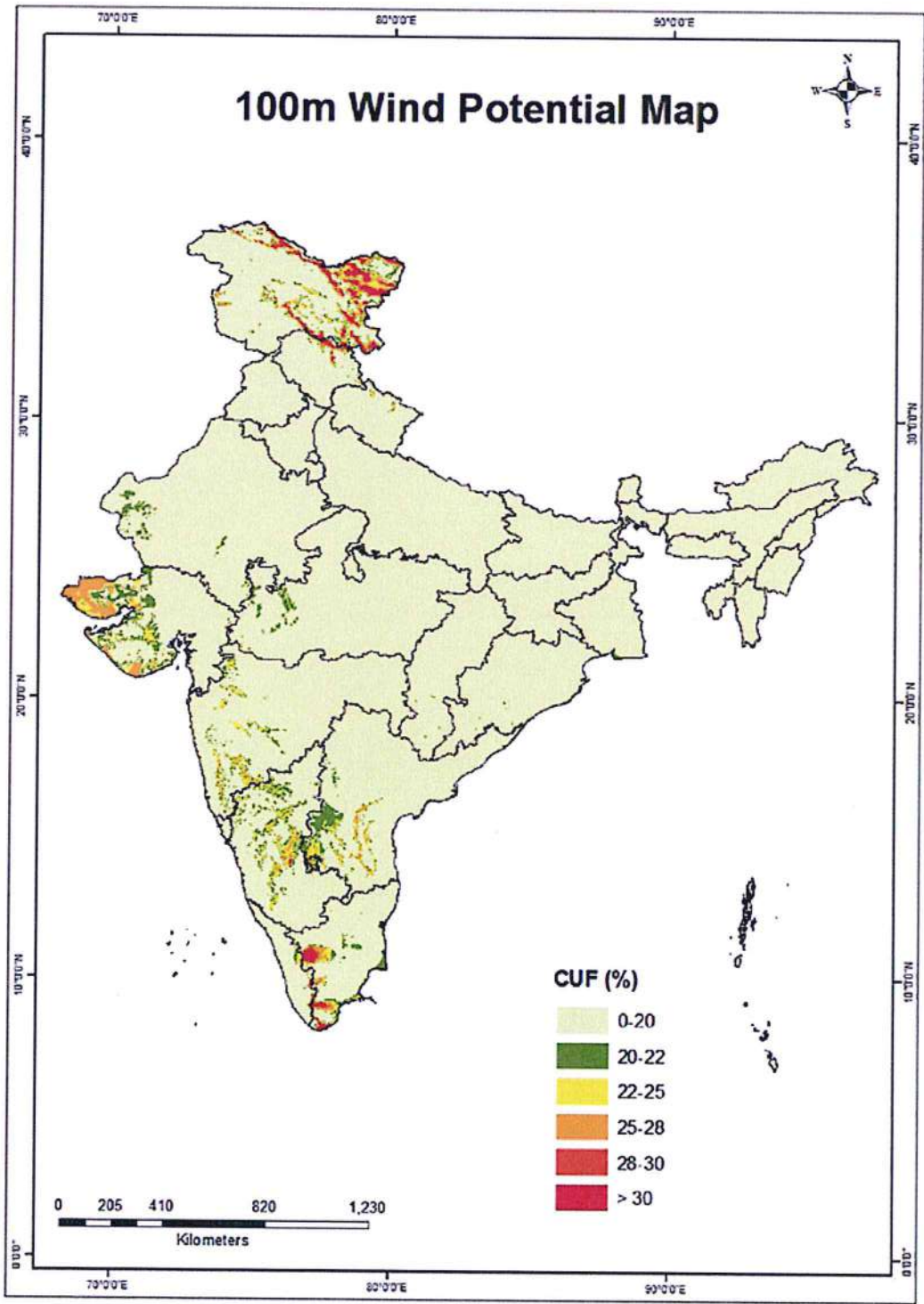
4.2.2 POTENTIAL OF WIND ENERGY IN INDIA

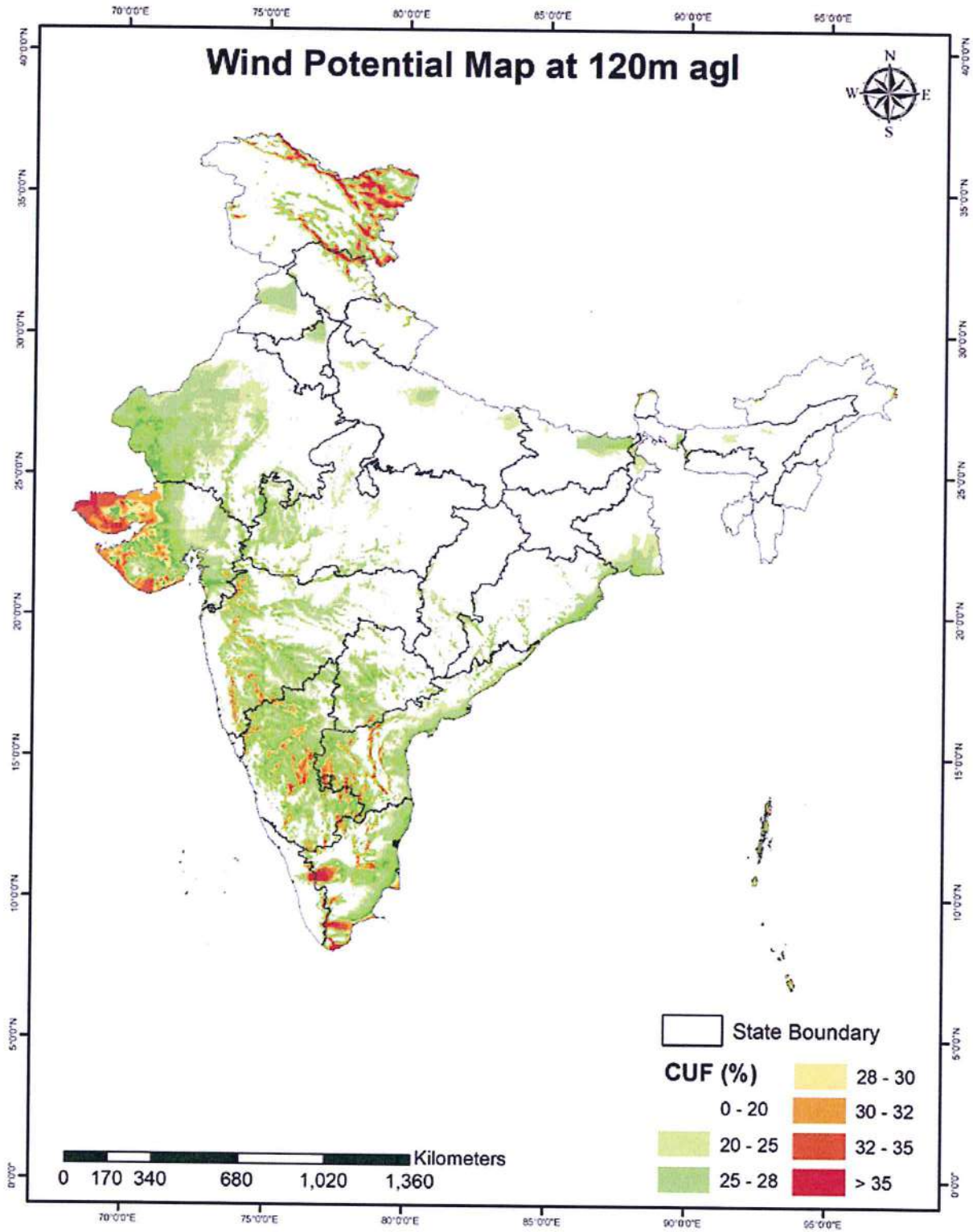
- (i) Wind is an intermittent and site-specific source of energy and therefore, an extensive Wind Resource Assessment is essential for the selection of potential sites. The Government, through National Institute of Wind Energy (NIWE), has installed over 800 wind-monitoring stations all over the country and issued wind potential maps at 50 m, 80 m, 100 m and 120 m above ground level. The latest assessment indicates gross wind power potential of 302.25 GW and 695.50 in the country at 100 meter and 120 meter respectively, above ground level. Most of this potential exists in seven windy States is given in **Table 4.1**.

S. No.	State	Wind Power Potential at 100 mtr agl in GW	Wind Power Potential at 120 mtr agl (GW)
1	Andhra Pradesh	44.23	74.90
2	Gujarat	84.43	142.56
3	Karnataka	55.86	124.15
4	Madhya Pradesh	10.48	15.40
5	Maharashtra	45.39	98.21
6	Rajasthan	18.77	127.75
7	Tamil Nadu	33.80	68.75
	Total (7 windy States)	292.97	651.72
	Other States	9.28	43.78
	All India Total	302.25	695.50



(ii) The wind atlas is available on the NIWE website www.niwe.res.in and wind potential map at 100 m and 120 m above ground level is given below:





4.2.3 INSTALLED CAPACITY OF WIND POWER IN THE COUNTRY

- (i) The installed capacity of grid-interactive wind power in the country as on 31.12.2019 is 37.50 GW and state-wise installed capacity (in MW) is shown in **Table 4.2**.

Table 4.2: State wise Wind Power installed as on 31.12.2019

S. No.	STATE	Wind Power (MW)
1	Andhra Pradesh	4092.450
2	Gujarat	7359.220
3	Karnataka	4753.400
9	Kerala	62.500
4	Madhya Pradesh	2519.890
5	Maharashtra	5000.330
6	Rajasthan	4299.720
7	Tamil Nadu	9285.265
9	Telangana	128.100
10	Others	4.300
	Total (MW)	37505.175



Installation site of 300MW wind turbine with blades at Mulanur site Tirupur Distt. Tamil Nadu of wind power project under SECI Tranche IV bid





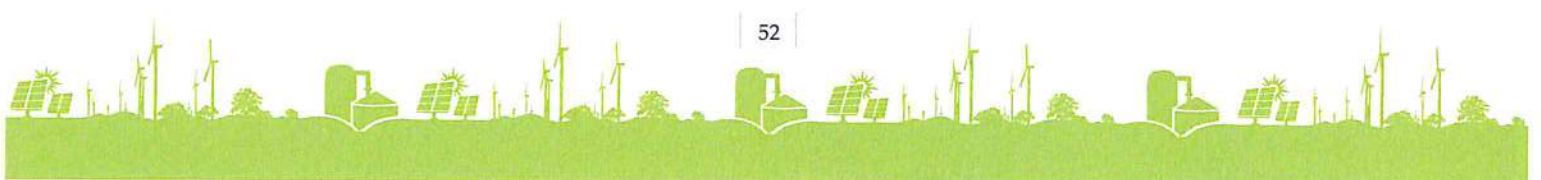
A wind mill of 2.1MW capacity established at a 250 MW wind farm at Chandragiri in Tamil Nadu, India under SECI Tranche-I

(ii) The year-wise electricity generation from wind energy source is shown in **Table 4.3**.

Sr. No.	Year	Wind (MU)
1	2014-15	33768
2	2015-16	33029
3	2016-17	46004
4	2017-18	52666
5	2018-19	62036
6.	2019-20 (upto 31.10.2019)	47729

4.2.4 TECHNOLOGY DEVELOPMENT AND MANUFACTURING BASE FOR WIND POWER

The Wind Turbine Generator technology has evolved and state-of-the-art technologies are available in the country for the manufacture of wind turbines. Around 70-80% indigenisation has been achieved with strong domestic manufacturing in the wind sector. All the major global players in this field have their presence in the country and over 31 different models of wind turbines are being manufactured by more than 15 different companies, through (i) joint ventures under licensed production (ii) subsidiaries of foreign companies, and (iii) Indian companies with their own technology. The unit size of machines has gone up to 3.00 MW. The current annual production capacity of wind turbines in the country is about 8000 MW to 10000 MW.





4.2.5 TENDER/BIDDING IN WIND ENERGY SECTOR

- (i) Government issued Guidelines for Tariff Based Competitive Bidding Process for Procurement of Power from Grid Connected Wind Power Projects vide resolution notified on 8th December, 2017. This was done with an objective to provide a framework for procurement of wind power through a transparent process of bidding including standardization of the process and defining of roles and responsibilities of various stakeholders. These Guidelines aim to enable the Distribution Licensees to procure wind power at competitive rates in a cost effective manner.
- (ii) Based on experience of bidding and after consultation with stakeholders, the standard bidding guidelines for wind power projects were amended on 16th July, 2019 to reduce the investment risks related to the land acquisition and CUF and to provide incentives for early part commissioning of project. The subjectivity in penalty provisions has been removed and the penalty rate has been fixed. The risk of wind power developers in case of delay in signing of PSA has been mitigated by starting timeline of execution of project from date of signing of PPA or PSA, whichever is later.

4.2.6 STATUS OF TENDERS FOR WIND POWER PROJECTS

To enable Discoms of the non-windy States to fulfil their non-solar Renewable Purchase Obligation (RPO), through purchase of wind power at a tariff determined by transparent bidding process, MNRE through SECI has auctioned wind power capacity in 8 tranches. Further, NTPC and the states of Gujarat, Maharashtra and Tamil Nadu have also auctioned wind power capacities.

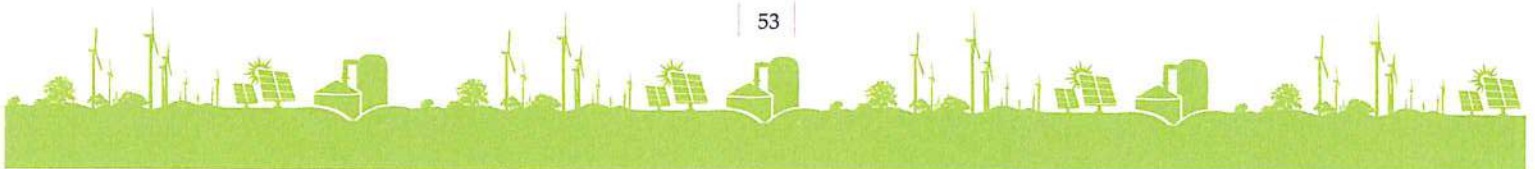
(1) Cumulative commissioned capacity till 31/12/19: 37.505 GW

(2) Capacity under implementation: 9.355 GW

Total (1+2): 46.86 GW

The Minimum Tariffs discovered from tenders auctioned for Wind Power are shown in **Table 4.4**.

Table 4.4: Minimum Tariffs discovered from tenders auctioned for Wind Power				
Sl. No.	Bid	Capacity Awarded (MW)	Type	Min. Tariff (Rs./kwh)
1.	SECI-I	1049.9	Central	3.46
2.	SECI-II	1000	Central	2.64
3.	SECI-III	2000	Central	2.44
4.	SECI-IV	2000	Central	2.51
5.	Tamil Nadu	450	State	3.42
6.	Gujarat (GUVNL)	500	State	2.43
7.	Maharashtra (MSEDCL)	500	State	2.85
8.	SECI-V	1190	Central	2.76
9.	NTPC	850	Central	2.77
10.	SECI-VI	1200	Central	2.82
11.	SECI-VII	480	Central	2.79
12.	SECI-VIII	440	Central	2.83
13.	Gujarat (GUVNL)	202.6	State	2.80
	Sub Total	11862.5		



4.2.7 INCENTIVES AVAILABLE FOR WIND SECTOR

- (i) The Government is promoting wind power projects in entire country through private sector investment by providing various fiscal and financial incentives such as Accelerated Depreciation benefit; concessional custom duty exemption on certain components of wind electric generators. Besides, Generation Based Incentive (GBI) Scheme was available for the wind projects commissioned up to 31st March 2017.
- (ii) In addition to fiscal and other incentives as stated above, following steps also have been taken to promote installation of wind capacity in the country:
 - Technical support including wind resource assessment and identification of potential sites through the National Institute of Wind Energy, Chennai.
 - In order to facilitate inter-state sale of wind power, the inter-state transmission charges and losses have been waived off for wind and solar projects to be commissioned by March, 2022.

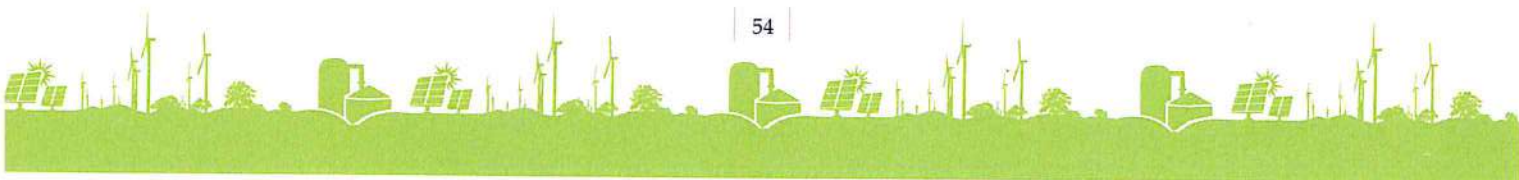
4.2.8 NATIONAL WIND-SOLAR HYBRID POLICY

The Ministry issued National Wind-Solar Hybrid Policy on 14th May, 2018. The main objective of the policy is to provide a framework for promotion of large grid connected wind-solar PV hybrid system for optimal and efficient utilization of wind and solar resources, transmission infrastructure and land. The wind - solar PV hybrid systems will help in reducing the variability in renewable power generation and achieving better grid stability. The policy also aims to encourage new technologies, methods and way-outs involving combined operation of wind and solar PV plants. The major highlights of this policy are as under:

- i. A wind-solar plant will be recognized as hybrid plant if the rated power capacity of one resource is at least 25% of the rated power capacity of other resource.
- ii. Both AC and DC integration of wind solar hybrid project are allowed.
- iii. The power procured from the hybrid project may be used for fulfilment of solar RPO and non-solar RPO in the proportion of rated capacity of solar and wind power in the hybrid plant respectively.
- iv. Existing wind or solar power projects, willing to install solar PV plant or WTGs respectively to avail benefit of hybrid project, may be allowed.
- v. All fiscal and financial incentives available to wind and solar power projects will also be made available to hybrid projects.
- vi. The Central Electricity Authority (CEA) and Central Electricity Regulatory Commission (CERC) shall formulate necessary standards and regulations including metering methodology and standards, forecasting and scheduling regulations, REC mechanism, grant of connectivity and sharing of transmission lines, etc., for wind-solar hybrid systems.
- vii. Storage may be added to the hybrid project to ensure availability of firm power for a particular period.

4.2.9 WIND SOLAR HYBRID PROJECTS

- (i) In order to implement the National Wind Solar Hybrid Policy, a scheme for setting up of 2500 MW Inter State Transmission System (ISTS) connected wind-solar hybrid projects was sanctioned on 25.05.2018. The Solar Energy Corporation of India (SECI) was nodal agency for implementation of the scheme through tariff based transparent competitive bidding process.



- (ii) Under this scheme, SECI has awarded 1440 MW capacity of wind solar hybrid projects after e- reverse auction, as shown in Table 4.5.

Table 4.4: Minimum Tariffs discovered from tenders auctioned for Wind Power					
Sr. No.	Bidder's Name	Project Capacity (MW)	Tariff (INR/kWh)	Project Location	Scheduled Commissioning Date
1	Mahoba Solar (UP) Private Limited	390	2.69	Rajasthan	03.12.2020
2	SBE Renewables Ten Private Limited	450	2.67	Tamil Nadu	03.12.2020
3	Adani Renewable Energy (Park) Gujarat Limited	600	2.69	Rajasthan	17.02.2021
	Total	1440			

4.2.10 ISSUANCE OF DUTY EXEMPTION CERTIFICATES FOR MANUFACTURING OF WIND TURBINES

Ministry is issuing concessional custom duty exemption certificates (CCDC) to the manufacturers of wind operated electricity generators as per Ministry of Finance tariff notification no. 50/2017-customs dated 30.06.2017. For this purpose the eligible turbine and component manufacturers need to get the bill of material for RLMM listed turbine models approved and then apply in prescribed formats to Ministry for a CCDC certificate for their import consignments. In order to make the entire process fast and transparent, an online portal has been developed and launched from Dec, 2019 which is running successfully.

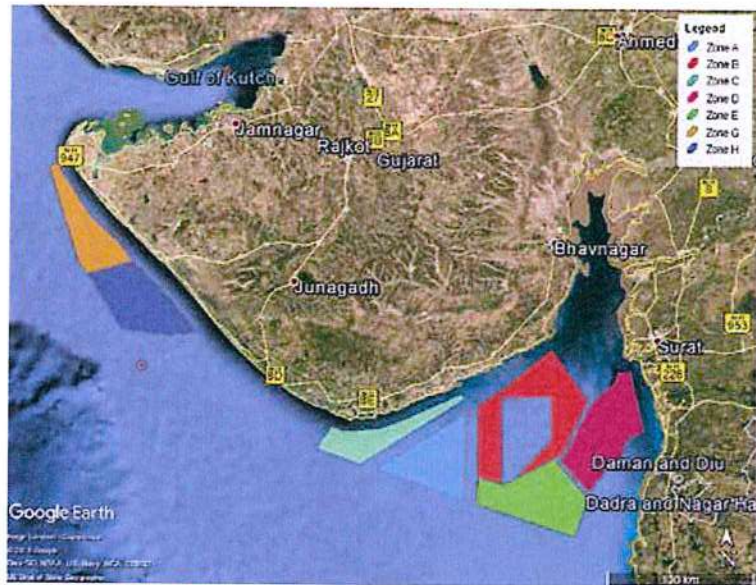
4.2.11 OFFSHORE WIND DEVELOPMENT IN INDIA

India is blessed with a coastline of about 7600 km surrounded by seawater on three sides and has tremendous power generation potential from offshore wind energy. Considering this, the Government had notified the National Offshore Wind Energy Policy as per the Gazette Notification dated 6th October 2015. As per the policy, Ministry of New and Renewable Energy will act as the nodal ministry for development of Offshore Wind Energy in India and work in close coordination with other government entities for Development and Use of Maritime Space within the Exclusive Economic Zone (EEZ) of the country in an effective manner for production of enormous quantity grid quality electrical power for national consumption. National Institute of Wind Energy (NIWE), Chennai has been designated as the nodal agency to execute various pre-feasibility activities relating to resource assessment, surveys 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.

4.2.12 PRESENT STATUS

- (i) Based on the preliminary assessment from satellite data and data available from other sources, 8 (eight) zones each in Gujarat and Tamil Nadu have been identified as potential offshore zones for exploitation of offshore wind energy potential. Initial assessment of offshore wind energy potential within the identified zones has been estimated to be about 70 GW off the coast of Gujarat & Tamil Nadu only.
- (ii) Offshore wind energy development is a very capital intensive project and the initial investment is very high. In order to attract the large investment for development of the sector in India, Government of India has already announced its intention of developing 5 GW of offshore wind energy project by 2022 and 30 GW by 2030.





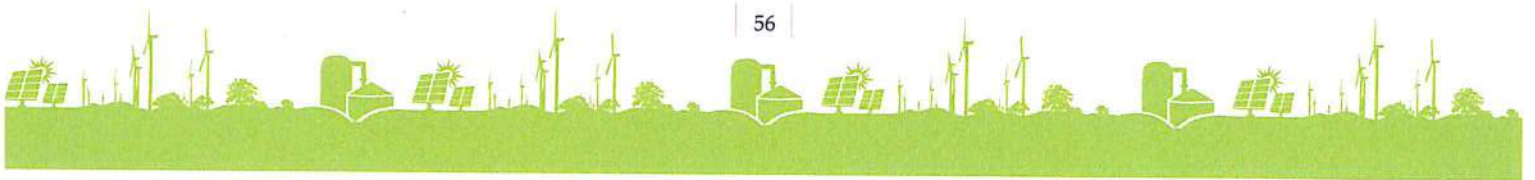
Gujarat Offshore Wind Potential Zone

a. Offshore measurements off Gujarat coast

LiDAR based offshore wind potential measurements for 2 years have been completed at Gulf of Khambhat off Gujarat coast. The offshore LiDAR wind data measurement report for the first year has been published for benefit of stakeholder and the second year LiDAR wind data measurement report is under examination before its publication. Raw data files (time series) of two years of LiDAR measurement carried out at Gulf of Khambhat has also been uploaded at NIWE website.



Tamil Nadu Offshore Wind Potential Zone





b. Geophysical investigation at Gulf of Khambhat off Gujarat coast

In order to ascertain the nature of sub sea surface and soil profile available at recommended depths for the design of foundation of offshore structures, a detailed geophysical survey is required to be carried out. Onsite Geo-physical investigation (single beam bathymetry survey, side scan sonar, sub-bottom profiling, and magnetometer survey and sediment samples) covering an area of 365 sq. km for 1GW offshore project in Gulf of Khambhat off Gujarat Coast has been completed.

c. Geotechnical Investigation at Gulf of Khambhat off Gujarat coast

Based on the Geo-physical results, five bore-hole locations for geotechnical studies were identified in zone- B and zone –A off the cost of Gujarat. The Geotechnical work will cover Cone Penetration Test / Borehole studies for proposed 1GW offshore wind farm area and two LiDAR locations depth of 60 meters. The Geo-technical work and the field data collection has been completed by NIWE and the draft geotechnical report is under examination.

d. Rapid Environmental Impact Assessment for 1 GW offshore wind farm project at Gulf of Khambhat off Gujarat coast

(i) The Rapid EIA work has been completed by National Institute of Oceanography (NIO) covering the following aspects:

- Air modelling and wind wake studies,
- Baseline data collection & noise and vibration study.
- Hydrodynamic modelling studies.
- Physiochemical characteristic of seawater and sediment,
- Assess the fish diversity zone, Abundance and biomass,
- Status and occurrence of mangroves, corals, seaweeds, sea grasses, sea turtles & marine mammals (kg/haul) in the study area,
- Socio-economic studies pertaining to the fisheries.
- Assessment of impacts due to the proposed 1GW offshore wind farm project.

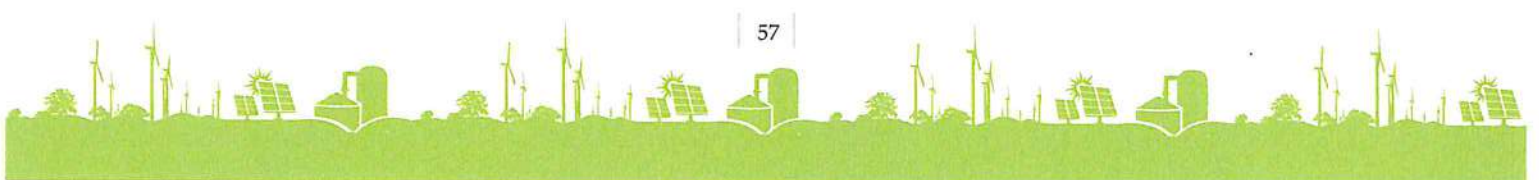
(ii) NIO has completed the field studies and investigations in July 2019 and draft report was submitted. Stakeholders' consultation on the said report has been completed. The views and opinions expressed by various stake holders have been communicated to the NIO for incorporation in the final report.

e. Offshore wind energy Lease Rules

In order to formulate the required framework for regulating the lease of offshore areas within the EEZ of India for offshore wind energy development, Ministry is framing Lease Rules under the 'Territorial Waters, Continental Shelf, Exclusive Economic Zone and Other Maritime Zones Act, 1976'. The draft offshore wind energy lease rules have already been circulated to stakeholders Ministries and Departments and their comments have been received.

f. Offshore Wind Turbine Research cum Test Centre at Dhanushkodi, Tamil Nadu

In order to strengthen the domestic capacity for design and development of new offshore wind energy turbines, a testing cum research facility was necessary and the Ministry has already identified the suitable site at Dhanushkodi, Tamil Nadu for establishment of the testing cum research centre. The required land for the purpose has been allotted by Govt. of Tamilnadu. NIWE is in the process for preparing a detailed project report for the centre.



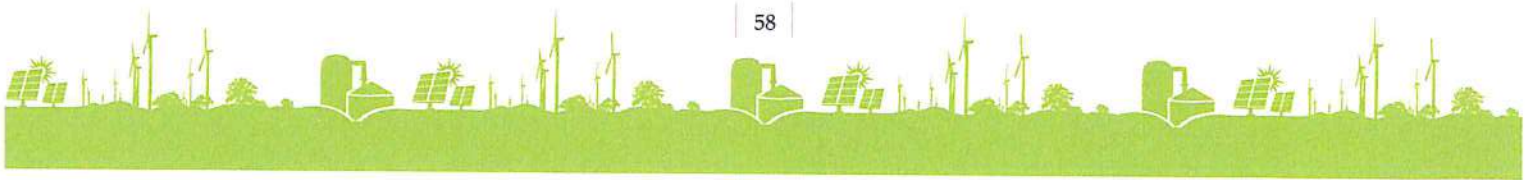


4.2.13 BIOMASS POWER / BAGASSE BASED CO-GENERATION (UPTO MARCH 2020) GRID - CONNECTED

- 4.2.14 Ministry has been promoting Biomass Power and Bagasse Co-generation Programme with the aim to recover energy from biomass including bagasse, agricultural residues such as shells, husks, de-oiled cakes and wood from dedicated energy plantations for power generation. A new scheme to support promotion of biomass based cogeneration in sugar mills and other industries (up to March 2020) has been notified on 11.05.2018. The potential for power generation from agricultural and agro-industrial residues is estimated at about 18,000 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 8,000 MW. Thus the total estimated potential for biomass power is about 26,000 MW.
- 4.2.15 Over 500 biomass power and cogeneration projects with aggregate capacity of 9186.50 MW have been installed in the country up to December 2019.
- 4.2.16 Sugar industry has been traditionally practicing incidental cogeneration by using bagasse as a fuel for meeting the steam and power requirements of sugar processing and sugar mill complex. With the advancement in the boiler and turbine technologies for generation and utilization of steam at high temperature and pressure, sugar industry has been producing electricity and steam for their own requirements and selling surplus electricity to the grid by optimally utilizing the bagasse. The sale of surplus power generated through optimum cogeneration is helping a sugar mill to improve its viability and profitability, apart from crating additional power generation capacity in the country.
- 4.2.17 The Programme has the following component:
- Bagasse based cogeneration in sugar mills for export of surplus power to grid



28 MW Grid Connected Bagasse Cogeneration Plant of Rajarambapu Patil SSKL, Sangli, Maharashtra





4.2.18 The programme has the following objectives:

- i. To promote efficient and economic use of surplus biomass for power generation.
- ii. To maximize surplus power generation from sugar mills using improved technologies.
- iii. To promote technologies of co-generation for supplementing conventional power.

4.2.19 For the purpose of biomass based cogeneration programme following nomenclature are broadly adopted

a. Biomass Resources

The programme will provide CFA for projects utilizing biomass like bagasse, agro-based industrial residue, crop residues, wood produced through energy plantations, weeds, wood waste produced in industrial operations, etc. Municipal Solid Waste is not covered under the programme.

b. Financing Institutions

All registered financial Institutions development / investment corporations; all nationalized bank, private banks, Central & State Cooperative Banks, State/Public Sector Leasing and Financing corporations.

c. Promoters

Promoters include individual / independent registered companies, Joint Sector / public sector companies / state agencies and private and public sector investors having technical and managerial capabilities for implementing Bagasse cogeneration projects.

d. Central Financial Assistance (CFA)

As per new scheme to support biomass based cogeneration in sugar mills and other industries (up to March 2020) notified on 11.05.2018, Central Financial Assistance (CFA) will be provided at the rate of Rs.25 Lakh / MW for bagasse cogeneration projects on surplus exportable capacity under the scheme. CFA will be calculated on surplus exportable power as mentioned in Power Purchase Agreement (PPA) / Appraisal Report. The CFA will be back-ended and will be released in one installment after successful commissioning and commencement of commercial generation and performance testing of the plant. The CFA will be released to the term loan account to reduce the loan component of the promoter. No advance CFA will be released under the scheme. CFA will be provided only for projects which will be installing new boiler and turbines.

e. Achievements

A cumulative capacity of 9186.50 MW has been commissioned so far mainly in the states of Tamil Nadu, Uttar Pradesh, Karnataka, Andhra Pradesh, Maharashtra, Chhattisgarh, West Bengal and Punjab.

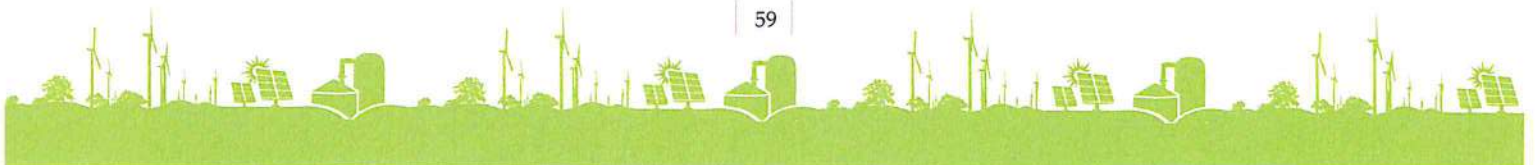
4.2.20 SMALL HYDRO POWER

4.2.21 The Ministry of New and Renewable Energy (MNRE) is vested with the responsibility of developing hydro power projects of capacity up to 25MW, categorized as Small Hydro Power (SHP) Projects. These projects have 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



- 4.2.22 The estimated potential of small/mini/micro hydel projects in the country is 21133.65 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. The national target for SHP is to achieve a cumulative capacity of 5000 MW by 2022, under overall targets of achieving a cumulative grid connected Renewable Energy Power Projects of 175,000 MW. Against this target of achieving an aggregate capacity of 5000 MW by the year 2022, an aggregate capacity of 4671.557 MW been achieved by 31st December 2019 through 1127 small hydropower projects. In addition, 109 projects of about 529.24 MW are in various stages of implementation. **Table 4.6** provides state-wise details of identified potential, projects completed and those under execution.
- 4.2.23 For the year 2019-20, a target of commissioning of 100 MW small hydro projects was set. Against this target, 12 projects of aggregate capacity of 78.402 MW have been synchronized to the grid by 31st December 2019 (**Table 4.7**). In addition to commissioning of these 12 projects, two old projects (**Table 4.8**) have been renovated by introducing more efficient electrical and mechanical equipment in the State of Mizoram. Actual physical achievement from 01.01.2019 to 31.12.2019 and estimated physical achievement from 01.01.2020 to 31.03.2020 is given in **Table 4.9**.
- 4.2.24 Under the 'Ladakh Renewable Energy Initiative (LREI)', one mini hydel project namely, Chamsen MHP (450 kW) in village Chamsen in Leh was commissioned during current financial year. In addition, two Mini Hydro Power Projects in Kargil district, namely, Matayeen (550 kW) and Khandi MHP (1000 kW) are currently under testing stage.
- 4.2.25 Ministry also supported setting up of 259 watermills in Karnataka and 40 water mills in Nagaland. These watermills are used for electrical and mechanical applications in remote and far flung areas of the country. These watermills are being operated by the individuals or local community to meet the power requirements of local community in decentralized manner.

Table 4.7: List of SHP projects commissioned during 2019-20 (till 31.12.2019)

S.No.	State	Name of the project	Capacity (MW)	Name of the Agency/Developer
1	Gujarat	SHP -1 on Vadodara Branch canal	1.052	SSNNL Gujarat
2	Himachal	Jeori	9.600	Technology House Pvt Ltd.
3	Himachal Pradesh	Salun	9.000	Swadeshi Distributors LLP
4	Himachal Pradesh	Kuwarnsi	15.000	Jagdambey Hydro Projects LLP
5	Himachal Pradesh	Kinur	5.000	Snowdew Hydroelectric Power Projects (P) Ltd.
6	Himachal Pradesh	Hysrund	3.300	Vardaan Cottage
7	Himachal Pradesh	Balh Padhar	4.000	USP Hydro Enrgy Limited
8	Karnataka	Anthargange	2.000	Antharagange Power Pvt. Ltd.
9	Karnataka	Aniyur SHP	24.000	SLV Power Pvt. Ltd.
10	Ladakh	Chamsen	0.450	Ladakh Renewable Energy Development Agency
11	Ladakh	Chilong	1.000	Kargil Renewable Energy Development Agency
12	Maharashtra	Temghar	4.000	Laxmi Organic Industries Ltd
Aggregate capacity			78.402	



Table 4.6: State wise list of potential sites, installed projects and on-going projects in SHP sector (as on 31.12.2019)

State	Total Potential		Projects Installed						Projects under Implementation	
	Nos.	Total Capacity (MW)	Upto 2018-19		2019-20		Total		Nos.	Capacity (MW)
			Nos.	Capacity (MW)	Nos.	Capacity (MW)	Nos.	Capacity (MW)		
Andhra Pradesh	359	409.32	44	162.110	0	0	44	162.110	0	0
Arunachal Pradesh	800	2064.92	156	131.105	0	0	156	131.105	10	7.05
Assam	106	201.99	6	34.110	0	0	6	34.110	1	2
Bihar	139	526.98	29	70.7	0	0	29	70.700	0	0
Chhattisgarh	199	1098.2	10	76	0	0	10	76.000	0	0
Goa	7	4.7	1	0.05	0	0	1	0.050	0	0
Gujarat	292	201.97	12	61.3	1	1.052	13	62.352	9	48.81
Haryana	33	107.4	9	73.5	0	0	9	73.500	0	0
Himachal Pradesh	1049	3460.34	189	860.61	6	45.9	195	906.510	18	179.60
Jammu & Kashmir	302	1707.45	44	179.03	2	1.45	46	180.480	16	47.10
Jharkhand	121	227.96	6	4.05	0	0	6	4.050	0	0
Karnataka	618	3726.49	168	1254.73	2	26	170	1280.73	3	13.000
Kerala	238	647.15	34	222.02	0	0	34	222.02	8	80.500
Madhya Pradesh	299	820.44	12	95.91	0	0	12	95.91	2	7.600
Maharashtra	270	786.46	69	375.575	1	4	70	379.575	9	10.400
Manipur	110	99.95	8	5.45	0	0	8	5.45	0	0.000
Meghalaya	97	230.05	5	32.53	0	0	5	32.53	2	25.500
Mizoram	72	168.9	18	36.47	0	0	18	36.47	4	8.700
Nagaland	98	182.18	12	30.67	0	0	12	30.67	1	1.000
Odisha	220	286.22	10	64.625	0	0	10	64.625	3	57.000
Punjab	375	578.28	56	173.55	0	0	56	173.55	7	4.900
Rajasthan	64	51.67	10	23.85	0	0	10	23.85	0	0
Sikkim	88	266.64	17	52.11	0	0	17	52.11	1	3.000
Tamil Nadu	191	604.46	21	123.05	0	0	21	123.05	0	0
Telangana	94	102.25	30	90.87	0	0	30	90.87	0	0
Tripura	13	46.86	3	16.01	0	0	3	16.01	0	0
A&N Islands	7	7.27	1	5.25	0	0	1	5.25	0	0
Uttar Pradesh	251	460.75	9	25.1	0	0	9	25.1	2	25.500
Uttarakhand	442	1664.31	102	214.32	0	0	102	214.32	13	7.580
West Bengal	179	392.06	24	98.5	0	0	24	98.5	0	0
Total	7133	21133.62	1115	4593.155	12	78.402	1127	4671.557	109	529.240

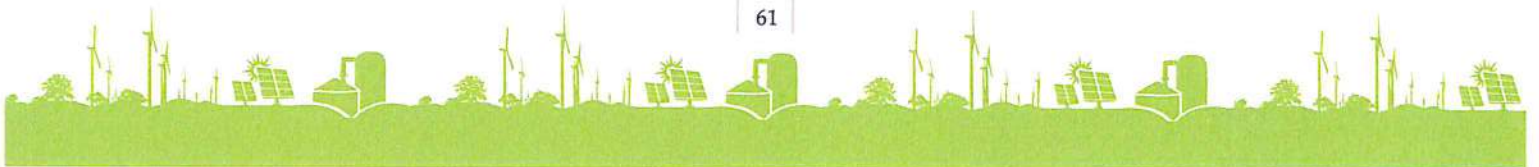


Table 4.8: List of R&M projects completed during 2019-20

Sr.No.	Name of the project	Capacity (MW)	Name of the Agency	State
1	Tuirivang SHP	0.3	Power & Electricity Dept., Mizoram	Mizoram
2	Teirei SHP	3.0	Power & Electricity Dept., Mizoram	Mizoram

Table 4.9: Actual physical achievement from 01.01.2019 to 31.12.2019 and estimated physical achievement from 01.01.2020 to 31.03.2020.

Actual physical achievement from 01.01.2019 to 31.12.2019	Estimated physical achievement from 01.01.2020 to 31.03.2020
154.10 MW	25 MW

SUCCESS STORY

Dikshi Small Hydro Power Project (SHP) of 24 MW capacity is the first SHP to be commissioned in the private sector in the State of Arunachal Pradesh. It is located in Dikshi Village in West Kameng District of Arunachal Pradesh. It is a Run-of-River project constructed on the river Phudung, a tributary of Kameng River by M/s Devi Energies Private Limited, Hyderabad. Power needs of West and East Kameng districts and also the power requirements of Defence establishments in the area would be addressed with the green power generated from this project. The project was inaugurated by Shri Pema Kandu, Hon'ble Chief Minister of Arunachal Pradesh on 13.09.2019 heralding a new era in harnessing the huge hydro power potential of Arunachal Pradesh.



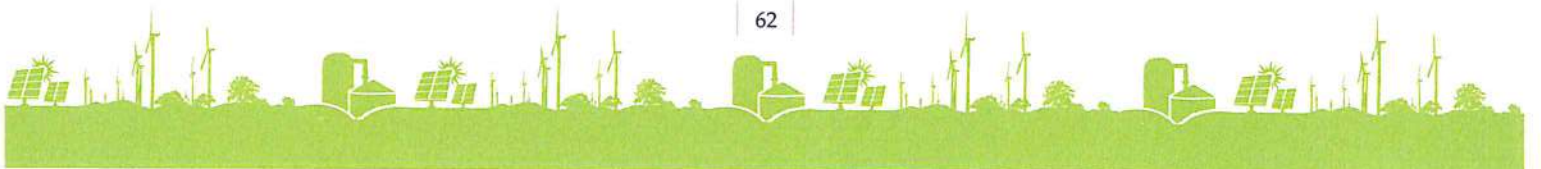
Control Panels



DIKSHI 24 MW SHP-Power House



Inauguration of the project by Sri Pema Khandu, Hon'ble Chief Minister of Arunachal Pradesh



4.2.25 WASTE TO ENERGY

4.2.26 PROGRAMME ON ENERGY FROM URBAN, INDUSTRIAL & AGRICULTURAL WASTES/RESIDUES

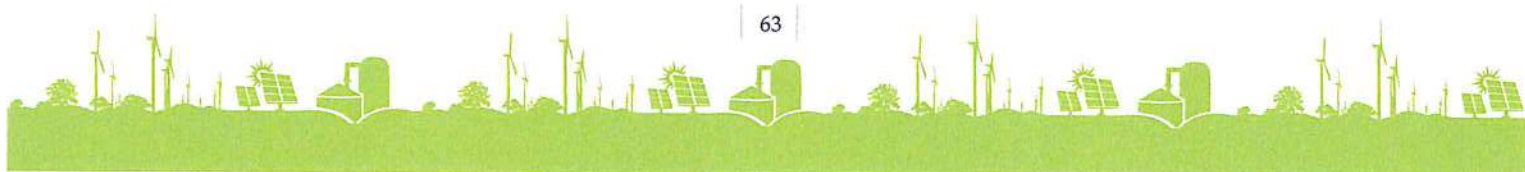
- i. The Programme on Energy from Urban, Industrial and Agricultural Waste/Residues aimed at generation of biogas, BioCNG and Power from different wastes, such as vegetable and other market wastes, slaughterhouse waste, agricultural residues and industrial wastes & effluents continued during the year 2019-2020. About 100 tons/day of cow dung can generate about 1600 kgs of Bio-CNG per day. In addition to Bio-CNG/Biogas, biogas plants generate organic fertilizer as a by-product which is valuable for agricultural fields.
- ii. Such projects are being set up in a number of industry sectors namely distillery, paper and pulp solvent extraction, dairy, starch industries, sugar mills, pharmaceutical industries, etc., and sewage treatment plants.

4.2.27 OBJECTIVES OF THE SCHEME

- a. To promote setting up of projects for recovery of energy in the form of Biogas / BioCNG/Enriched Biogas/ Power from urban, industrial and agricultural wastes; and captive power and thermal use through gasification in industries.
- b. To promote Biomass Gasifier based power plants for producing electricity to meet the unmet demand of captive power and thermal needs of rice mills and other industries and villages for lighting, water pumping and micro-enterprises.
- c. To create conducive conditions and environment, with fiscal and financial regime, to develop, demonstrate and disseminate information on recovery of energy from waste and residues.

4.2.28 SUBSIDY/GRANT/INCENTIVE PROVIDED UNDER THE SCHEME

- (i) Central Financial Assistance (CFA) for projects of different categories is given in the form of capital subsidy to the promoters and in the form of Grants-in-Aid for other activities, as given below:
 - a. Biogas generation : Rs 1.0 crore per 12000 cum/day (Max. Rs 10 Crore/project) ;
 - b. BioCNG generation (including setting of Biogas plant): Rs 4.0 Crore per 4800Kg/day (Max. Rs 10 Crore/project) ;
 - c. Power generation based on Biogas (including setting of Biogas plant): Rs.3.0 Crore per MW (Max. Rs.10 Crore/project).
 - d. Biomass Gasifier:
 - Rs. 2,500 per kWe with dual fuel engines for electrical application
 - Rs. 15,000 per kWe with 100% gas engines for electrical application
 - Rs. 2 lakh per 300 kWth for thermal applications.
- (ii) Other Incentives and Support Measures available to Waste to Energy the sector are –
 - a. Concessional Customs Duty and GST at rate of 5% for initial setting up of grid connected projects for power generation or production of Bio-CNG from wastes;
 - b. Preferential Tariff announced by the CERC /SERC;



- c. Incentives to State Nodal Agencies - Service Charge @ 1% of the Subsidy restricted to Rs.5.00 lakh per project;
- d. According to the amended Tariff Policy, Distribution Licensee(s) shall compulsorily procure 100% power produced from all the Waste-to-Energy plants in the State, in the ratio of their procurement of power from all sources including their own, at the tariff determined by the Appropriate Commission under Section 62 of the Act.

4.2.29 PROGRESS DURING THE YEAR 2019-20

- (i) During the year 2019-20, 4 Biogas generation projects with cumulative installed capacity of 37900 m³ per day in states of Andhra Pradesh, Madhya Pradesh, Uttar Pradesh and Telangana, 4 MW of power projects in states of Punjab, Karnataka and Maharashtra and 6 BioCNG generation projects with cumulative installed capacity of 25731 kg/day were installed as on 30.12.2019.
- (ii) 139.80 MW capacity Grid interactive power projects, 114.93 MW capacity Off-grid power projects, 7,02,508 m³ per day of Biogas generation capacity and 84759 kg per day generation capacity of BioCNG have been set up in the country as on 30.12.2019.

4.3 OFF-GRID RENEWABLE POWER

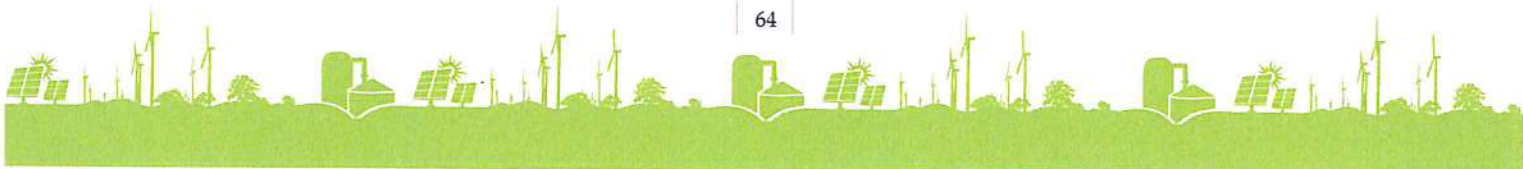
4.3.1 BIOGAS POWER

4.3.2 BIOGAS POWER (OFF-GRID) GENERATION AND THERMAL APPLICATION PROGRAMME (BPGTP)

- (i) The Ministry is implementing biogas based scheme/ Programme for promoting biogas generation for Off-grid/ distributed and decentralized Renewable Power applications in the capacity range of 3 kW to 250 kW and also for thermal energy applications having biogas generation capacity in the corresponding matching size range of 30 m³ to 2500 m³ per day. The organic bio-degradable wastes from various sources such as cattle dung/ animal wastes, food & kitchen waste, poultry dropping waste, agro-industry waste etc., are the feed stock for Biogas plants.



Biogas plant of 650 m³ / 75 kW Biogas Power (Off-Grid) project at M/s. Bhagya Laxmi Dairy Farm, Village Sultanpur, Post-Manchar, Taluka- Ambegaon, District - Pune (Maharashtra)





Biogas Power Generation (Off-grid) Project at site of beneficiary Sri Ramji Gupta, Vill- Bhatauli, Post- Rura, Dist- Kanpur Dihat (Biogas Capacity 140 m³ / 16 KW)

4.3.4 IMPLEMENTATION OF BPGTP

- (i) The Biogas based Power Generation and Thermal Application Programme (BPGTP) is implemented through the Agriculture and Rural Development Departments of the States, Dairy Co-operatives, State Nodal Agencies (SNAs), Biogas Development and Training Centres (BDTCs), Khadi and Village Industries Commission (KVIC) and National Dairy Development Board (NDDB) from the year, 2018-19.

4.3.5 CENTRAL FINANCIAL ASSISTANCE (CFA) FOR BPGTP

- (i) The CFA under the programme is provided varying from Rs.25,000 /- per kW to Rs.40,000 /- per kW for power generation as per the generation capacity slab and Rs.12,500 /- per kW to Rs.20,000 /- per kW for thermal applications respectively. The CFA rates also vary depending upon the category of beneficiaries and regions/ States such as SC and ST categories and North Eastern Region States.

4.3.6 ACHIEVEMENTS

During the year 2019-20, 12 projects have been commissioned with power generation capacity of 212 kW and corresponding biogas generation capacity of 1810 m³ per day. With this, the cumulative total of 316 biogas based projects with a total power generation capacity of 7.207 MW with a cumulative total biogas generation of 69,381 m³ per day have been set up in the country, up to 31.12.2019. Further against a target of sanction for setting up 50 new projects, 12 projects have been sanctioned for installation / implementation up to 31.12.2019.

4.3.7 SCHEME TO SUPPORT PROMOTION OF BIOMASS BASED COGENERATION IN SUGAR MILLS AND OTHER INDUSTRIES OTHER THAN SUGAR MILLS (UPTO MARCH 2020) OFF-GRID

- (i) Industrial sector consumes approximately 35% of total electricity generated in the country. In the absence of quality and reliable power from the grid, the sector is increasing its own power generation capacity





mainly through captive power plants based on fossil fuels such as coal, oil or natural gas. Several industries require electrical as well as thermal energy for their operations, which can either be met through different energy sources or through co-generation. The power and steam generated from such co-generation plants can be used for meeting the captive requirements and the surplus power produced can be exported to the grid. Such projects are being set up in a number of industries like distillery, paper and pulp industry, solvent extraction units, rice mills, textiles, pharmaceutical industries, etc.

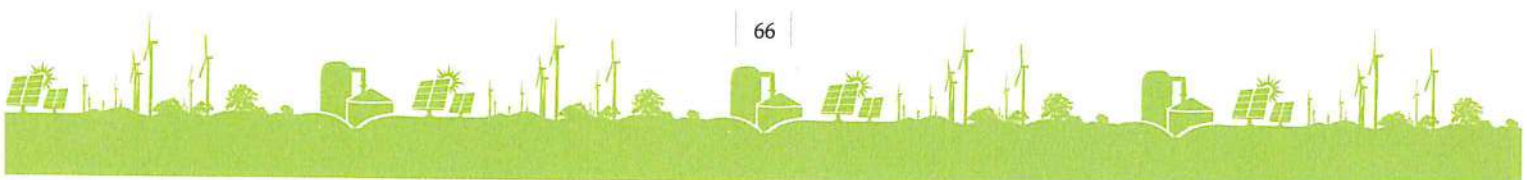
- (ii) A new scheme to support promotion of biomass based co-generation in sugar mills and other industries (effective up to March 2020) has been notified on 11.05.2018 for exploiting the vast potential of biomass power in the form of thermal energy and power for captive use in industry.
- (iii) Under the scheme a Central Financial Assistance (CFA) @ Rs. 50 Lakhs per MW on installed capacity will be provided. CFA in both cases will be on reimbursement basis. Availing loan from any financial institution is mandatory for promoters to avail CFA.

4.3.8 ACHIEVEMENTS

A cumulative capacity of 675 MW has been commissioned so far mainly in the states of Tamil Nadu, Uttar Pradesh, Haryana, Karnataka, Andhra Pradesh, Uttarakhand, Punjab and Rajasthan.

4.4 RENEWABLE PURCHASE OBLIGATION (RPO)

- (i) The Ministry continued to make concerted efforts for ensuring RPO compliance. The RPO Cell followed up with states on regular basis. Further, State Electricity Regulatory Commissions (SERCs) were requested for ensuring RPO compliance and enforcing penal provisions against defaulting Obligated Entities. Ministry has also requested for APTEL's intervention to direct defaulting SERCs to ensure RPO compliance through timely monitoring and invoking penal provisions for non-compliance; aligning RPO trajectory notified by Ministry of Power (MoP) up to the year 2021-22; and not to permit carry forward or waiver of RPO.
- (ii) Further, in view of the increasing quantum of inter-state renewable power transactions, the Ministry requested all State Load Dispatch Centres (SLDCs) to collate the information on energy consumed at the state level. SLDCs were also requested to designate nodal officers for coordination of the activity. In response, 15 SLDCs have designated officers for coordinating the activity, and 13 SLDCs have already provided the information in the prescribed format.
- (iii) RPO Portal, a centralized online platform for RPO compliance monitoring developed under a MNRE project by TERI, is now operational (www.rpo.gov.in). Following National workshop of State Nodal Officers for RPO Compliance held on 18 September 2018, three regional workshops, one each at Bangalore, Ahmedabad and New Delhi were organised to provide hands-on training to the Obligated Entities for the RPO provisions, and populating the RPO portal on a regular basis. As an outcome, user IDs and passwords have been created for state nodal officers. Details of major Obligated Entities have been compiled and data for 5 States have been updated on RPO portal.





**RENEWABLE ENERGY FOR RURAL
APPLICATIONS**

RENEWABLE ENERGY FOR RURAL APPLICATIONS

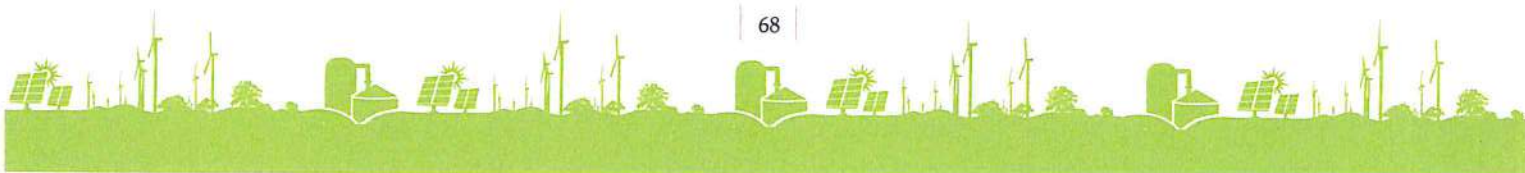
5.1 The MNRE is implementing and supporting Biogas Schemes for dissemination and deployment of biogas plants in remote, rural and semi-urban areas of the country. Biogas production is based on the anaerobic digestion of organic wastes/materials. Biogas is cheap, clean and environment friendly gaseous fuel for cooking, lighting and running biogas engines for motive power & electricity generation on farms. The biogas plant digested slurry contains enriched organic Nitrogen, Phosphorus and Potash (NPK) and also other major plant micronutrients free from weed seeds, smell and pathogens. The application of recommended dose of biogas slurry increase the yield by 12% to 35% of all types of crops fruits and vegetables. The Biogas slurry can be used in any form viz. liquid, semi-solid or dried and in any type of soils for any crop.

5.2 NEW NATIONAL BIOGAS AND ORGANIC MANURE PROGRAMME (NNBOMP)

The NNBOMP scheme, a central sector scheme aims for setting up small Biogas Plants in the size range varying from 1 m³ to 25 m³. The objectives of the scheme are to provide green and clean renewable gaseous fuel for cooking, lighting and small power needs of the potential farmers, cattle farmers/ users including individual households and to facilitate management and utilization of biogas plant produced slurry as an organic enriched Solid Biogas Fertilizer (SBF) / Biogas Liquid Fertilizer (BLF). The potential of the generation of Biogas and biogas slurry in the country is immense, when considered a large number of organic decomposable wastes through the Anaerobic Digestion (A.D.). In India, Biogas plants have generally used cattle dung with the option of linking with sanitary toilets. The estimated potential production of biogas based on combined population of cattle and buffaloes which stands at about 302.23 million heads (Cattle census-2019) comes to about 33000 million M³/year, considering 75% collection recovery of the cattle dung wastes alone.

5.2.1 PROGRAMME IMPLEMENTING AGENCIES (PIAS) OF NNBOMP 2019-20

- (i) The NNBOMP is being implemented through multi-agency approach by designating the following as the Programme Implementing Agencies (PIAs) of the Scheme in the States/ UTs –
 - a) State Rural Development Departments (SRDDs)
 - b) State Renewable Energy Agencies/Departments.
 - c) Khadi and Village Industries Commission (KVIC).
 - d) Biogas Development and Training Centres (BDTCs).
 - e) National Dairy Development Board (NDDB).
- (ii) The new scheme Guidelines have been made effective since 01.04.2018, to make it reachable to all states/ UTs making life style changing for remote, rural and semi-urban households/dairy farmers/Agriculture farmers etc., as far as the supply of clean and renewable gaseous fuel for cooking/lighting and biogas digested slurry is concerned. The biogas plant digested slurry is an excellent organic fertilizer /manure offering alternatives to replace costly chemical fertilizers such as Urea & DAP and have sustainable agriculture with good soil health.
- (iii) Biogas being a clean cooking fuel, produced from the wastes available at the doorsteps of the potential beneficiaries along with simultaneous production of organic nutrients enriched slurry provide opportunity to have reduction in cost/saving on an average by Rs.9000/- to Rs. 12,000/- per year, considering the



plant size of 1 to 4 M³. Higher the size of biogas plant higher the income generation for the beneficiary and livelihood opportunities. The efforts of setting up biogas plants across the country are contributing towards doubling the income of Farmers.

5.2.2. SUBSIDY AND OTHER CENTRAL FINANCIAL ASSISTANCE FOR SETTING BIOGAS PLANTS UNDER NEW NATIONAL BIOGAS AND ORGANIC MANURE PROGRAMME (NNBOMP)-

Under the NNBOMP, the Central Subsidy is being provided for installing biogas plants of size 1 M³ to 25 M³, which varies from Rs. 7500/- per plant of 1 M³ to Rs. 35,000/- per plant of size 20-25 M³. The subsidy amount depends upon the size of a biogas plant installed, States or Regions, beneficiary category and North Eastern Region States. Separate CFA is provided as Biogas Turn Key Job Fee for construction & commissioning supervision and also providing 5 year's free warranty for trouble free operation and maintenance of the biogas plants. In addition, the States/UTs implementing the scheme are also provided Administrative charges as well as trainings and publicity & technical supports through Biogas Development and Training centres (BDTCs). The component- wise details of the CFA are given in the **Table 5.1**.



biogas plants (size 3 M³) at village Amlighat, Jagiroad, district Morigaon, (Assam) installed by Forest Development Agency, Assam for beneficiary Shri Lilanath Bajgain

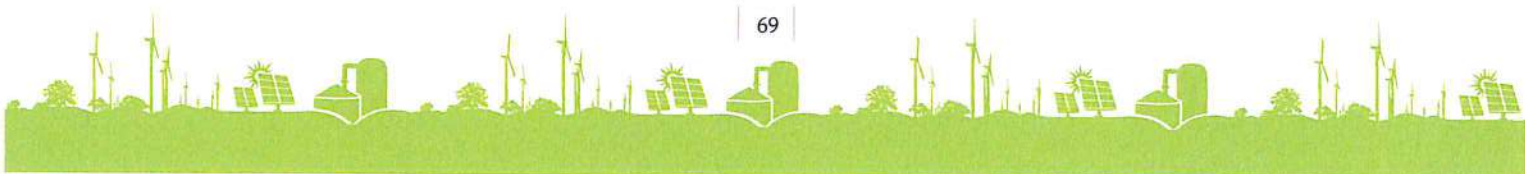
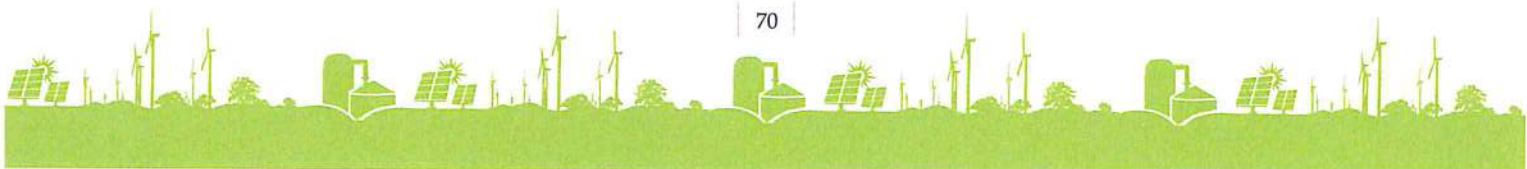


Table 5.1:- Central Financial Assistance under the New National Biogas and Organic Manure Programme, (NNBOMP) w.e.f. 01.04.2018 for the Medium Term Plan of 14th Finance Commission up to March, 2020 for Biogas Plant size from 1 cu.m. to 25 cu.m. per day.						
Sl. No.	Particulars of Central Financial Assistance (CFA) and States / UTs, Regions & Categories of beneficiaries	Biogas Plants under NNB OMP (size 1 to 25 cubic metre biogas per day) (In Rupees per plant)				
A	Central Subsidy Rates Applicable (In Rs. per plant)	1 Cubic Metre	2-6 Cubic Metre	8-10 Cubic Metre	15 Cubic Metre	20 - 25 Cubic Metre
1	NER States, including Sikkim and including SC and ST Categories of NER.	17,000	22,000	24,000	25,000	35,000
2	Special Category States (Jammu & Kashmir, Himachal Pradesh, Uttarakhand, and Andaman & Nicobar Islands) and Scheduled Castes / Scheduled Tribes of all other States.	10,000	13,000	18,000	21,000	28,000
3	All other States (General Category)	7,500	12,000	16,000	20,000	25,000
B	Additional Subsidy for cattle dung based biogas plants if linked with sanitary toilets, only for individual households (Rs. Per Biogas Plant) fixed amount.	1,600	1,600	1,600	Nil	Nil
C	Turn-Key Job Fee for construction, supervision, commissioning, and free O&M warranty for five years trouble free operations of plant including quality control at all levels.	<p>Rs. 2500/- per biogas plant for fixed dome design construction based plants such as Deenbandhu and floating gasholder KVIC type brick masonry models from 1 to 10 M³ and Rs. 4500/- per plant for 15 to 25 M³ plant size. Turn Key Job Fee will also be provided for eligible biogas plants for pre-fabricated plants as per above mentioned models involving part construction work either for digester or dome.</p> <p>Turn Key Job Fee at the flat rate of Rs. 1000/- per plant will be also eligible for biogas plants of size ranging from 1 to 25 M³ which are completely pre-fabricated / manufactured biogas plants and made up of standard quality material FRP / HDPE / PVC etc. as already approved or as and when approved by MNRE. However, no Turn Key Job Fee will be payable for bag type digesters made of rubberized nylon fabric (flexi model) plants as it does not involve higher construction techniques and any supervision of construction. The manufacturers and developers of such biogas plants for implementation under this scheme will have to provide a free warranty and guarantee of five years for all plants for post installation trouble free operations under the terms and conditions of Turn –Key Job Work Scheme applicable including for all those who are implementing the scheme on bidding basis.</p>				
D.	Administrative Charges– for physical target achievement range of biogas plants (Amount in Rs.)					
1	100-3,000 nos. of Biogas Plants	1,00,000 [^]				
2	3,001-7,000 nos. of Biogas plants	10,50,000 ^{^^}				
3	Above 7,000 nos. of Biogas plants	24,50,000 *				
E	Support for Training courses including skill development Programme for Biogas Mitras					
1	Users Course	4,000				





2	Staff Course	10,000
3	Construction-cum Maintenance / Refresher Course	50,000
4	Turn-key Workers & Management Course/ Skill Development for TKWs / RETs / SHGs/ Officials of SND and KVIC	75,000
F	Biogas Development & Training Centres. Financial support for set functions and roles of BDTCs would be provided towards staff, conducting training courses, skill development courses, pilot plant demonstration, TA/DA, consumables and contingencies as per allocated targets.	As per the pattern of CFA and staff strength / positions conveyed vide Ministry's sanction letter No. 19- 3/2011-BE (Pt.) dated 16th November, 2011, dated 2nd March, 2012 and continued vide sanction No 19-4/2017-BG/ R&D/Biogas dated 14th July, 2017. The annual outlay allocated year-wise shall be based on the yearly Plan of work & targets as approved activities by the MNRE.
G	Support for Communication & Publicity as per the physical achievement range of Biogas Plants (Amount in Rs.)	The financial support would be provided on lump - sum basis which is linked with the physical achievements as per the range/slab of biogas plants achievements. The publicity and information charges would be limited to the actual expenditure claimed and supported by copies of vouchers which would be subject to the maximum limits as given below.
1	Up to 1,000 plants	Rs. 2,00,000/-
2	1,001- 10,000 plants	Rs. 4,00,000/-
3	More than 10,000 plants	Rs. 6,00,000/-
H	Incentive for saving fossil fuels (diesel, petrol, kerosene, electricity etc.) to farmers by using biogas in 100% Biogas engines.	Incentive is eligible for purchase of 100% biogas engines and transportation of biogas from the site of the biogas plant to the site of biogas engine. The fixed CFA of Rs. 3000/- per 100% Biogas based Generator set / Biogas engine water Pumping System (BPS) for water pumping and meeting other small farm power needs from biogas, subject to a maximum of Rs. 4000/- per plant for plants of 15 to 25 Cubic Metre would be provided. The annual target for this will be approved by the Ministry based on the proposals received from the States and targets allocated by the MNRE.

Additional incentive to PIAs for implementation of NNBOMP , biogas plants size 1 to 25 M3 (under the component 2.2 D above)

[^] Extra Rs.400 per plant in excess of 100 biogas plants installed.

^{^^} Extra Rs.350 per plant in excess of 3000 biogas plants.

^{*} Extra Rs.300 per plant in excess of 7,000 biogas plants subject to maximum of Rs.60.00 lakh (Rupees Sixty Lakhs only).

5.2.3 CENTRAL FINANCE ASSISTANCE FOR BIOGAS PLANTS UNDER NEW NATIONAL BIOGAS AND ORGANIC MANURE PROGRAMME (NNBOMP).

- (i) Under the programme the CFA is being provided for setting up of biogas plants of size from 1 m³ to 25 m³. The CFA being provided is in the range of Rs.7,500/- per plant of 1 m³ to Rs.35,000/- per plant of 20-25 m³ depending upon the size of plants, location States or regions, category etc. Besides this, financial support is also provided for turnkey job fee for construction, supervision etc. It also provides support for skill development programme for Biogas Mitras and to BDTCs for conducting training courses. The details of the CFA are given in **Table 5.1**.



5.2.4 BIOGAS DEVELOPMENT AND TRAINING CENTERS (BDTCs)

Under the National Biogas and Organic Manure Programme, eight Biogas Development and Training Centers (BDTCs) have been established with the objective to set up good quality biogas plants as per established technical criteria and to generate sustained trained manpower in the sector of Biogas Technology. Their main functions are to extend Technical, Training and Publicity support required by the States/ UTs for the beneficiaries, including training and skill development in Biogas sector, dissemination of knowledge and publicity of biogas schemes in close co-ordination with the State Programme Implementing Agencies of NNBMOP.

5.2.5 ACHIEVEMENTS UNDER THE NATIONAL BIOGAS PROGRAMME

A target of setting up 76000 small Biogas Plants has been allocated to the States/ UTs for the year 2019-20. The progress under the New National Biogas and Organic Manure Programme (NNBOMP); the State/ UT-wise estimated potential and cumulative achievements of small biogas plants under the NNBOMP up to 31.12.2019 and cumulative achievements under both NBMMP & NNBOMP as on 31.12.2019 are given in **Table 5.2**.



MNRE Officers inspecting a biogas plants (size 3 M3) at village Amlighat, Jagiroad, district Morigaon, (Assam) installed by Forest Development Agency, Assam

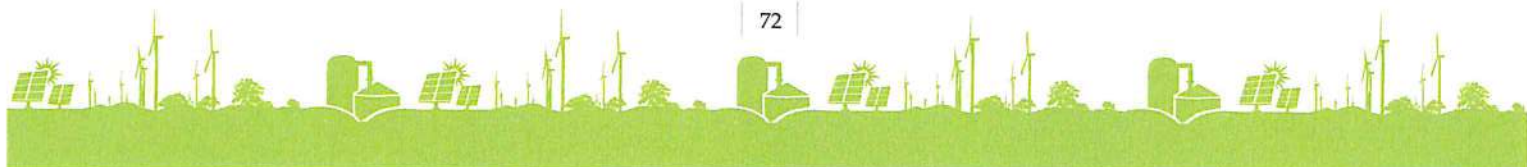




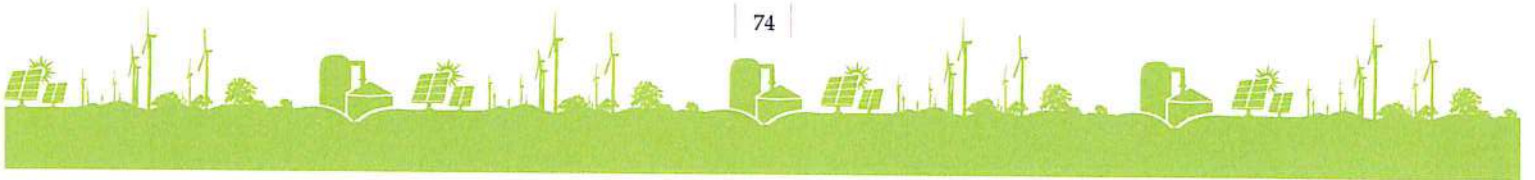
Table 5.2: State-wise estimated potential and State/ UT wise achievements for family type/ small biogas plants, from 1981-82 to 2017-18 under the National Biogas and Manure Management Programme (NBMMP) and Targets and achievements under NNBOMP during the year 2018-19 and 2019-20 (up to 31st December, 2019).

State/ Union Territories	Estimated potential	Cumulative total achievement up to 31/03/2019 (2018-19)	Targets and achievements under national Biogas Programme (Nos. of Biogas Plants)	
			Target (2019-20)	Total achievements of 2019-20 as on 31.12.2019
1	2	3	4	5
Andhra Pradesh	1065000	555294	4000	2556
Arunachal Pradesh	7500	3591	200	18
Assam	307000	138423	5000	0
Bihar	733000	129905	1000	0
Chhattisgarh	400000	58908	5500	411
Goa	8000	4235	300	0
Gujarat	554000	434995	2600	0
Haryana	300000	62825	3200	117
Himachal Pradesh	125000	47680	400	0
Jammu & Kashmir	128000	3195	400	0
Jharkhand	100000	7823	700	0
Karnataka	680000	503935	7000	3106
Kerala	150000	152019	2500	417
Madhya Pradesh	1491000	372929	5800	1061
Maharashtra	897000	918201	8500	1765
Manipur	38000	2128	200	0
Meghalaya	24000	10659	500	0
Mizoram	5000	5838	400	18
Nagaland	6700	7953	300	0
Odisha	605000	271691	1500	30
Punjab	411000	183931	4500	912
Rajasthan	915000	72132	3300	198
Sikkim	7300	9044	300	0
Tamil Nadu	615000	223618	1000	126
Telangana	0	19694	1000	0
Tripura	28000	3663	500	20
Uttar Pradesh	1938000	440385	1500	301
Uttarakhand	83000	363615	1300	407
West Bengal	695000	972	800	0
A&N Islands	2200	97	200	0
Chandigarh	1400	169	0	0
Dadra & Nagar Haveli	2000	681	200	0
Daman and Diu		0	0	
Lakshadweep		0	0	
Delhi/ New Delhi	12900	578	0	0
Puducherry	4300	17541	200	0
KVIC	-		7200	651
NDDB, Anand	-	-	4000	0
TOTAL :	12339300	5028347	76000	12019





- 5.2.6 The Progress of implementation and review at National Level was done in 3 meetings of the States/UTs held in the Ministry. One Regional Review meeting for North Eastern States including Sikkim and also for West Bengal was held in IIT-Guwahati (Assam).





**RENEWABLE ENERGY FOR URBAN,
INDUSTRIAL AND COMMERCIAL
APPLICATIONS**

RENEWABLE ENERGY FOR URBAN, INDUSTRIAL AND COMMERCIAL APPLICATIONS

6.1 The programmes being implemented during the year include: i) Energy Efficient Solar /Green Building Programme.

6.2 ENERGY EFFICIENT SOLAR/GREEN BUILDINGS PROGRAMME

Ministry had implemented a Scheme on 'Energy Efficient Solar/Green Buildings' since 2009 with the aim to promote energy efficient solar/ green buildings in the country through a combination of financial and promotional incentives mainly for capacity building, awareness, seminar and workshops and other promotional activities, etc. Though, the scheme got over in March, 2017 with the end of 12th Plan period, the balance payments/ settlements for already sanctioned projects have been taken up during the year. The details of the buildings which were awarded GRIHA rating under this program during this financial year are in **Table 6.1**.

6.3 DEVELOPMENT OF SOLAR CITIES PROGRAMME

- (i) 'Development of Solar Cities' programme was launched with the aim to reduce the energy demand of the city through a combination of energy efficiency measures and enhancing use of renewable energy. Urban Local Bodies and Municipal Corporations were given financial assistance of upto Rs.50 lakh for the Preparation of the Master Plan along with DPRs (up to Rs.10 lakh), Oversight of its implementation (up to Rs.10 lakh), setting up of Solar City Cell and its functioning in the city (up to Rs.10 lakh) and organizing promotional activities (up to Rs.20 lakh).
- (ii) Ministry sanctioned 60 cities/towns to development as 'Solar/ Green Cities'. Of which, 5 cities were identified as Model Solar City and an additional CFA upto Rs.9.50 crore were allotted for renewable energy projects to each Model Solar City. Similarly 13 cities identified as Pilot Solar Cities and an additional financial support upto Rs.2.50 crore were allotted for them. As per this, Ministry had sanctioned various renewable energy projects comprising of about 9.03 MWp SPV projects and 7894.5 m2 Solar Water Heating systems.
- (iii) Under this programme, Ministry also sanctioned financial assistance of Rs.5.00 lakh each to 52 institutions (technical/educational institution) for preparation of Master Plan/DPR for developing their campuses as green campuses.
- (iv) The scheme was not continued beyond the 12th Five Year Plan. In this Financial Year, Shimla, a Pilot Solar City, has completed 35 kWp SPV project and also supplied 1300 Nos. of Solar Home Lighting systems for slum areas around Shimla with a financial assistance of Rs.1,46,87,337/- from the ministry. Rs.21,81,462/- was released in this Financial Year.

Table 6.1: Details of the buildings which were awarded GRIHA rating during this F.Y.

Sl. No.	Name of the Building	Rating awarded
1	Power Grid Regional Headquarter Office Building, Bangalore	4 stars
2	Madanjeet School of Renewable Energy, Pondicherry University, Puducherry	3 stars
3	New Girls Hostel, IIT Madras	4 stars
4	New Boys Hostel, IIT Madras	4 stars
5	Punjab National Bank Head Quarters, Dwarka	5 stars
6	EI Complex, Gurugram	5 stars





**RESEARCH, DEVELOPMENT AND
DEMONSTRATION (RD&D) IN NEW AND
RENEWABLE ENERGY**

RESEARCH, DEVELOPMENT AND DEMONSTRATION (RD&D) IN NEW AND RENEWABLE ENERGY

- 7.1 Research, design, development and technology demonstration for its validation are one of the core requirements for the growth of New & Renewable Energy. Ministry of New & Renewable Energy (MNRE) supports Research, Development and Demonstration (RD&D) to develop new and renewable energy technologies, processes, materials, components, sub-systems, products & services, standards and resource assessment so as to indigenously manufacture new and renewable energy systems and devices. The objective of the programme is to make the industry globally competitive and renewable energy generation and supply, self-sustainable/profitable and thereby contribute to increased share in total energy mix in the country.
- 7.2 RD&D Projects received from R&D institutions /universities, industries and NGO's etc. in the field of solar, wind, solar-wind hybrid, storage, small hydro power, biogas, hydrogen and fuel cells, geothermal, etc. are considered by the Ministry for financial support.

7.3 POLICY AND GUIDELINES

- (i) A comprehensive policy framework on RD&D is in place to support RD&D in new and renewable energy sector, including associating and supporting RD&D earned out by industry for market development. Ministry provides up to 100% financial support to Government/non-profit research organizations/NGOs and up to 50% to industry.
- (ii) The policy framework provides guidelines for project identification, formulation, monitoring, its appraisal, approval and financial support. The RD&D projects received from R&D/academic institutions, industries, etc. are evaluated through subject experts. The qualifying projects are appraised by R&D Project Appraisal Committees. The projects recommended by the committees are sanctioned to prospective implementing agencies. The projects are monitored by Monitoring Committees. Projects on completion are reviewed in Project Appraisal Committee Meetings for their achievements.

7.4 RD&D FOCUS

The RD&D efforts are continued with emphasis on cost reduction, reliability and efficiency improvement of renewable energy systems, components and BOS. Projects in accordance with the R&D thrust areas of the ministry in solar thermal, SPV, biogas, wind, wind-hybrid, storage, small Hydro Power, hydrogen and fuel cells, geothermal, etc. are supported for RD&D Activity. 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.

7.5 INSTITUTIONAL MECHANISM

The Ministry is supporting creation of enabling conditions for institutional mechanisms to enhance collaboration for faster development and demonstration of technology for commercialization. The Ministry has taken initiatives for strengthening its institutions, namely, National Institute of Solar Energy (NISE), Gurgaon, National Institute of Bio-Energy (NIBE), Kapurthala and National Institute of Wind Energy (NIWE), Chennai with their functions for pursuing RD&D, testing, standardization and certification in solar, bioenergy and wind energy systems, respectively. In addition, the MNRE is also partnering with MHRD for implementation of research projects in NRE under IMPRINT and UAY initiatives. These initiatives envisage supporting projects in consortia including industry for technology development on cost sharing basis by partner ministries/departments/industries.



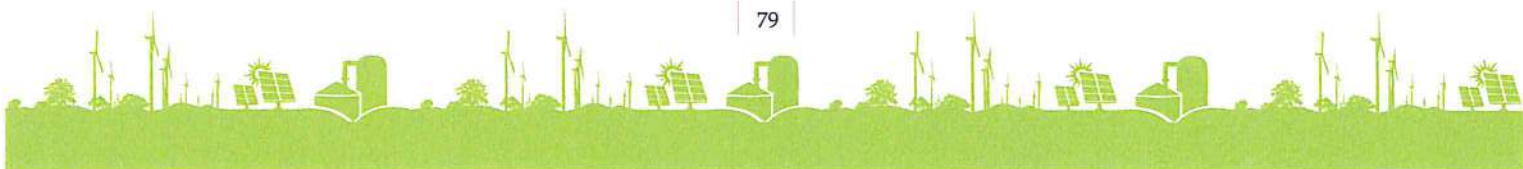


7.6 SOLAR R & D

7.6.1 SOLAR PHOTOVOLTAICS

(i) The Ministry's flagship project in solar photovoltaics being implemented at IIT Bombay and christened National Centre for Photovoltaic Research and Education (NCPRE) Phase II, had several major areas. The progress made in each of these areas is briefly described below.

- **Education and Training:** Various courses, workshops and training sessions have been organized to extend the knowledge gathered at NCPRE to people from academia and industry. Four familiarization workshops and two Hands-on training sessions were organized to familiarize other academia and promote their interaction with NCPRE investigators through the PUMP initiative which also saw submission of 67 new project proposals on PV.
- **Crystalline Si Solar Cells:** LIP set up established for 6 in x 6 in solar cells. Ni plating to be used as a barrier for Cu diffusion into Si. With all processes carried out at NCPRE, the champion cell on mono-Si wafers had an efficiency of 19.4% (VOC = 634 mV, ISC = 37.11 mA/cm², FF = 81.2%). For mc-Si wafers, efforts are directed at reducing surface reflections through metal assisted chemical etching and additive-less alkaline texturing. PERC cell development saw further optimisation of sprayed Al₂O₃ and joint development with industry a laser ablation process for dielectric films. For IBC solar cells, co-diffusion of B and P into silicon was studied with screen-printed diffusion source. For carrier selective contacts, an improved MoO₃/n-Si solar cell with efficiency of 13.6% (active area efficiency of 15.24%) was demonstrated.
- **Thin Film Materials and Devices:** Multi-cation perovskite solar cells in n-i-p and p-i-n configurations have been fabricated with efficiencies 14.3% and ~17% respectively. Screen printed carbon based perovskite solar cells in order to reduce the cost and easiness in scaling up have been fabricated by two step drop cast method with efficiencies ~13.36% on 0.09cm² and 5.9% over 4cm² device area. A mini module of 10cm² with ~4V open circuit voltage has been fabricated by interconnecting 2cm² solar cells in series.
- **Energy Storage:** 20 Li-ion cells of 2.5 Ah capacity with LCO-graphite chemistry, having cycle life of more than 100 cycles has been successfully demonstrated. Along with this, a new chemistry C-LTO/LFP have been under investigation for long cycle life (10K). Also, a Prototype-Battery fabrication facility for demonstration of 7 Ah, 10 Ah stacked pouch cells, 2.5 Ah jelly rolled pouch cell and cylindrical cells has been established. The team has been also able to demonstrate an ultrahigh specific Na-ion full cell with a doped ammonium vanadium oxide (NVO) cathode against hydrogenated sodium titanium oxide (NTO) The cell is capable of retaining 94% capacity after 400 cycles, having a high energy density of 467 Wh/kg at a very high rate of 0.2 A/g
- **Power Electronics:** The power supply part of the high power inverter test setup has been completed. Five prototype, standalone 500 VA inverters for rural off-grid application have been fabricated and testing is carried out upto 125W power level. A 1 kVA inverter which can be operated in the presence or absence of grid is implemented and the detailed report along with BOM submitted to MNRE. A 2 HP BLDC motor which is driven from solar PV, and is used for surface mounted pumping application has been designed in-house. A 5 kVA solar PV based inverter with integrated 2.5 kW battery storage has been fabricated that can be operated in grid connected as well as in standalone mode.
- **Module Reliability:** Field Assessment of Reliability of PV Modules of Various Technologies in Different Climatic Zones of India in 2016, 2018 and 2020 covering 500-1200 modules is under





process and report upto 2018 has been completed. IIT Bombay trying to develop the new test standards for PV modules, BOS and components based on the findings during the survey.

- (ii) The MNRE sponsored project on perovskite based thin film solar cells being implemented at IIT Bombay and showed 18% efficiency and sustained 1000 bending cycles. In another phase in the area of Flexible Perovskite Solar Cells and Intermediate Module with an target of Laminated Roll to Roll devices with >18% efficiency with T80>10000 hrs.
- (iii) In the on-going project on development of high efficiency solar cells using n-type Si wafers at the Meghnad Saha Institute of Technology (MSIT), Kolkata, base line solar cells have been fabricated on small (76 mm x 76 mm), n-type mono-Si wafers with champion efficiency of 16.8 %. The project has been continued to achieve 20-22% efficiency on 6 inch x 6 inch wafer.
- (iv) NISE has completed a R&D project with Surya Enertec, a Gurugram-based private company in developing Solar-powered Clean Drinking Water Systems suitable for various locations in the country. Five machines have been designed and fabricated. The controller and remote monitoring system have been developed and fabricated in-house. Third water purification machine of 500 LPH capacity is installed in a village: Khurampur, Distt Gurgaon. Fourth water purification machine of 200 LPH capacity is installed at Safdarjung Hospital Delhi. Fifth machine of 200 LPH capacity is installed at Civil Hospital, Gurgaon.
- (v) The MNRE has sponsored the PERC cell project is being implemented jointly by BHEL-ASSCP and NISE and the facility for primary reference is coming up at NPL, Delhi. In the PERC cell project, BHEL has the responsibility of cell processing while NISE has the responsibility of device simulation as well as complete characterization of solar cells. The process and the test equipment has been identified, the specification finalized and is under procurement.
- (vi) The MNRE has sanctioned new R&D projects entitled Design and Development of 'High Efficiency Solar Water Pumping Systems implemented by NISE, Gurugram and Flexible Perovskite Solar Cells and Intermediate Module by IIT Bombay.

7.6.2 SOLAR THERMAL

- (i) The MNRE has also sponsored for Development of Supercritical CO₂ Turbomachinery for Solar Thermal Power Plants to IISc Bangalore. Under this project, turbomachinery of different design configurations suitable for testing and analysis on the existing test loop at IISc have been designed.
- (ii) The Ministry has sanctioned a R&D project entitled System Design, Erection, Testing & Commissioning of 40 kWth and 10 kWe pilot plant aiming at the Feasibility Study of MWe Scale Concentrated Solar Thermal Plant integrated with 24 x 7 Thermal Energy Storage by Dr. V K Sethi, Ram Krishna Dharmarth Foundation University, Bhopal and RPI USA. The project is aimed to develop the high energy density solar thermal storage and its integration with solar thermal technologies.

7.6.3 SOLAR RADIATION RESOURCE ASSESSMENT (SRRA) STATIONS

In order to strengthen the solar resource assessment and to meet the requirement of availability of Solar Radiation data, In Phase- I program, 51 SRRA stations and in Phase- II, 60 SRRA stations and 4 Advanced Measurement Stations are installed at selected locations spread all over the country. This exercise has been coordinated by National Institute of Wind Energy (NIWE), Chennai an autonomous institution of the Ministry. A central server facility for data collection from all these stations has been set up at NIWE. The data so collected will be useful in developing a solar atlas for the country. In addition, all the solar power projects selected under the Mission have also set up radiation monitoring equipment at their project sites.





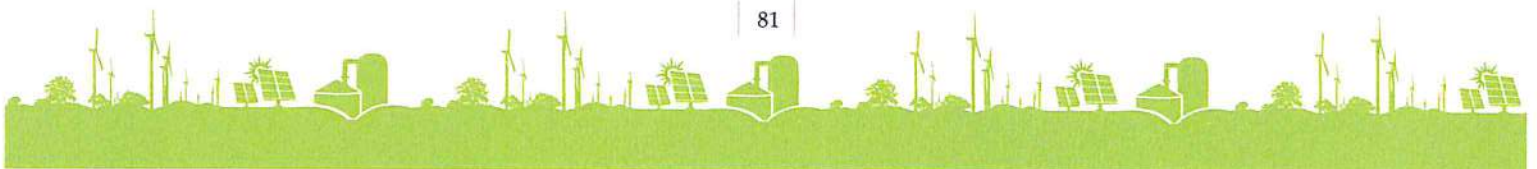
Round robin testing of Primary Standard Reference sensor from Calibration laboratory at NISE, NIWE & IMD Pune March 2018

Data collection from all the 111 SRRR stations and 4 AMS stations and its quality control has been going on and Operation and maintenance along Online monitoring with of the 111 SRRR stations is continued. Calibration of 38 pyranometers and 19 pyrhemometers from Karnataka, Kerala, Andhra Pradesh, Assam, Madhya Pradesh, Odisha, Gujarat, Punjab, Haryana, Himachal, Jharkhand, Goa and Chandigarh states/ UT under Phase-II program has been completed. Calibration of 12 pyranometers and 1 pyrhemometer under commercial has also been completed.

7.7 BIOGAS RESEARCH, DESIGN AND DEVELOPMENT

7.7.1 RD&D project on Biogas sector continued during the year. The work on the following projects was continued during the year:-

- i) **Development & Performance evaluation of a 3 KW biogas based power generation system utilizing Lignocellular Biomass**, at IIT-Guwahati. Under this project, the 4 objectives of the project have been completed with the optimization of operating parameters of a 5 hp gasoline engine along with the performance study by a performance study by a 16 m³ of biogas produced per day from lignocellulosic



feed stock materials mainly cow dung, rice straw, duck weed and switch grass and to produce 3 kWe biogas power generation has been successfully installed and maintained by IIT Guwahati at Auaniati Satara, North Guwahati, Assam under this project. All the objectives, of the assigned project have been achieved including performance studies with the modified engine and comparative results with 100 % Gas engine. The project completion report has been received and comments of experts on the same have been received for finalization and acceptance.

- ii) **Development of Hybrid-High rate bio-methanation reactor using locally available media for treating waste water and solid waste** at Tamil Nadu Agricultural University, Coimbatore (Tamil Nadu). Under this project, three lab scale hybrid reactors with acrylic sheet one of which served as control and the other two reactors with different packed media were fabricated. The stability of the reactors attained with affluent pH of 7 to 7.5 and the biogas production observed 250-300 ml in each reactor. The performance evaluation of high rate reactor and hybrid high rate reactor with community wastewater was completed and HRT was optimized. The efficient waste water treatment system through high rate and hybrid high rate biomethanation reactor was developed, which is economic over adopting aerobic waste water treatment systems, which generates biogas and is being utilized for power generation and thermal energy applications. The R&D project incorporated the scrubber design and for upgrading the biogas produced from waste water of TNAU hostel premises. In 4 different combinations, the molecular sieve 100 % showed the best results in terms of both high CO₂ adsorption percent and high performance index for two design of scrubbers columns. Maximum Methane content of 96.8% has been obtained in 2 metre scrubbing column with molecular sieve (100 %) material in the pressure of 7 bar. It has been concluded that molecular sieve is the best material for Biogas purification and height of the scrubbing column should not be less than 2 metre. A low cost activated charcoal CO₂ scrubber has been developed under this project for biogas purification and upgradation.

Comparative results of HRR and HHRR: As per the norms of Central Pollution Control Board the permissible discharge limit for waste water is 250 mg/l. The comparison of High Rate Reactor (HRR) and Hybrid High Rate Reactor (HHRR) designed, installed for the project and comparative studies were done. By comparing the removal efficiencies of both the reactors, the HHRR with lower HRT showed the higher removal efficiencies of TS, VS, BOD and COD in the order of 81.46 %, 83.44%, 84.33% and 86.41% respectively. The UASB reactor comparatively worked at low organic loadings, while the hybrid reactor could work on higher organic loadings and hence works very efficiently with good removals of COD/BOD. The overall efficiencies of HRR and HHRR showed that the performance of HHRR was higher than the performance of HRR. The project has been completed by TNAU and the Project Completion Report has been received.

- iii) **Development of suitable pre-treatment system for paddy straw disintegration for biogas generation leading towards commercialization of technology**

A research project was awarded by MNRE entitled Development of suitable pre-treatment system for paddy straw disintegration for biogas generation leading towards commercialization of technology to the Indian Institute of Technology, Delhi, to address the issue in-field burning of paddy straw stubble in northern Indian states and provide a sustainable solution for the same. In the project a laboratory scale hydrothermal reactor has been developed for pre-treatment of paddy straw at different temperature and reactor loading rates. Further, a field scale hydrothermal reactor having 50 L capacity has also been fabricated for performing field scale experiment for performance evaluation of the model. Two of the 3 major objectives of the project have been completed. A Project Monitoring Committee (PMC) has visited the project site in IIT, Delhi on 02.12.2019. The report of the PMC has been received and continuation of the project will achieve the remaining one major objective.





7.8 HYDROGEN ENERGY AND FUEL CELLS

- (i) The Ministry has been supporting a broad based Research, Development and Demonstration (RD&D) Programme on different aspects of hydrogen energy technologies that includes production of hydrogen, its storage and utilisation for stationary, motive and portable power generation applications using internal combustion engine and fuel cells and also for other applications. As on 31.12.2019, a total of 12 RD&D projects on different aspects of hydrogen energy and fuel cells are under implementation.
- (ii) Two new projects were sanctioned during the year, these are 'Design and development of 20kW Low Temperature Polymer Electrolyte Membrane (LT-PEM) fuel cell with high indigenous content' to Centre for Fuel Cell Technology, International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI-CFCT); and 'Setting Up of a Centre of Excellence on Hydrogen Energy' at National Institute of Solar Energy (NISE), Gwal Pahari, Haryana.
- (iii) MNRE had invited preliminary proposal for 'Demonstration of fuel cell powered buses in Delhi-NCR region'. The proposals received are currently under evaluation.
- (iv) IISc Bangalore conducted a two-day 'National Workshop on Hydrogen Production Technologies' on 19-20 December 2019. Leading researchers and industry participated in the event and elucidated cutting edge technologies and cost trends for hydrogen production in the country.
- (v) A Committee has been constituted under the Chairmanship of Secretary MNRE to examine relative advantages of hydrogen fuel cells and batteries for energy storage and transport applications. The first meeting of the Committee was held on 12 September 2019. Further, on 19 December 2019, major automobile sector OEMs were invited to discuss the prospects and challenges for commercialization of hydrogen fuel cells technology for transportation.

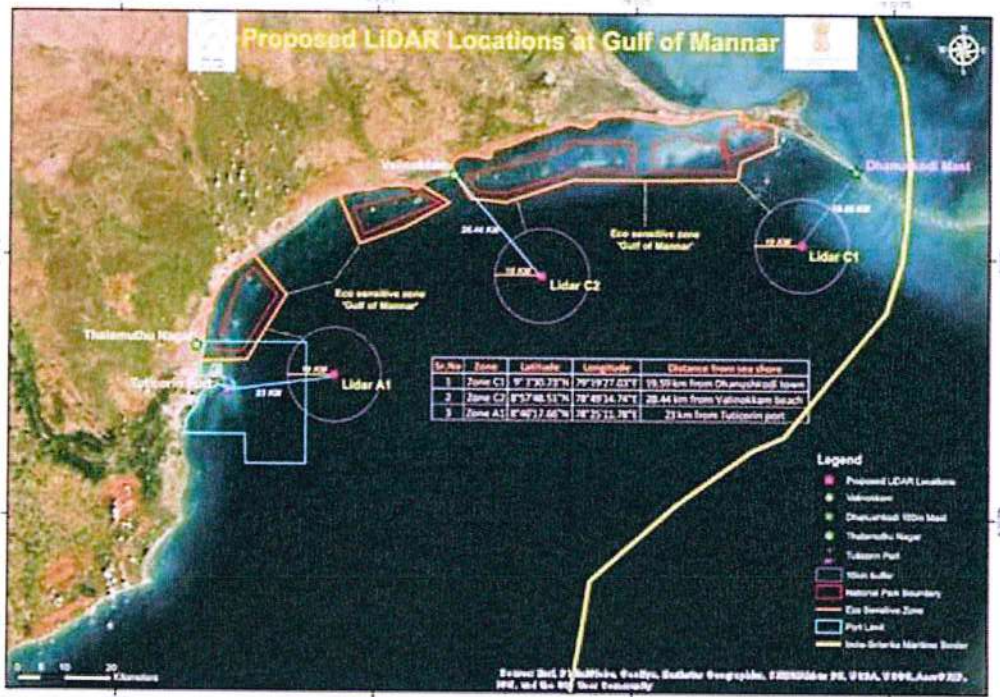
7.9 ENERGY STORAGE

- (i) Ministry continued to provide inputs to NITI Aayog on Mission on Transformative Mobility and Battery Storage that focusses on promotion of electric mobility and phased manufacturing programme for battery storage. Ministry has undertaken initiatives for energy storage demand aggregation for grid connected renewables; for diesel replacement in islands, remote locations; and for commercial and industrial applications. Tenders for solar power deployment coupled with storage (SECI tender), and a plan for fossil fuel free Lakshadweep are already under implementation.
- (ii) Ministry solicited the proposal for technology developments in energy storage and a meeting of the R&D Project Appraisal Committee (RDPAC) to consider R&D proposals on Energy Storage was held on 26 November 2019. Two project proposals were considered and are currently under approval process.
- (iii) In addition, Ministry as a Inter-Ministerial steering committee member for scheme Faster Adoption and Manufacturing of Electric Vehicles in India (FAME-II) continued to provide inputs on different aspects of electric mobility. Ministry also requested Ministry of Power to amend the guidelines dated 1st October 2019 or issue a supplementary guidelines stating that no permission is required for setting up of renewable energy based charging stations that are operating in off-grid and decentralized mode.

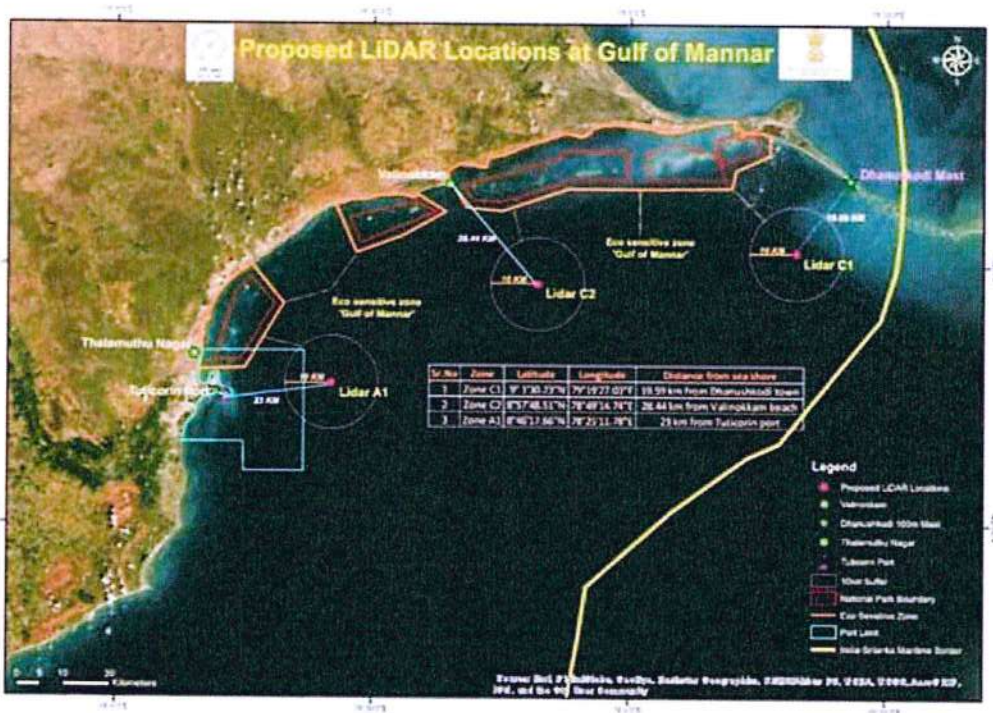
7.10 WIND R & D

- (i) Ministry has sanctioned 20 R & D projects from 2014-15 onwards in wind energy related projects. The closure reports for seven R & D projects have been reviewed by the PMC and recommended for formal closure.

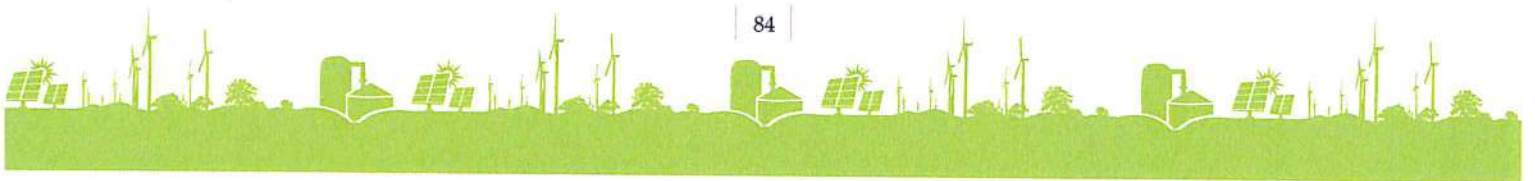




Proposed met-ocean locations in Gulf of Khambhat, Gujarat



Proposed met-ocean locations in Gulf of Mannar, Tamil Nadu





- (ii) The activities carried out on the two R & D projects sanctioned to NIWE in 2017-18 are given as under;
- a. Met-Ocean measurements (Wind, Wave, Tide, Current, Water level, etc) at Gulf of Khambhat and Gulf of Mannar for fostering the growth of offshore wind in the country**
- (i) With an objective to identify the potential subzones / blocks for promotion of offshore wind farm development in the country, NIWE has entrusted with carrying out a detailed offshore wind resource measurement along with geophysical, geotechnical and oceanographic studies under this project. For the purpose, NIWE is going to install & commission Four LiDARs (two for Gujarat and two for Tamil Nadu) to carry out extensive wind resource assessment both off the coast of Gujarat & Tamil Nadu. In addition to this, NIWE will carry out the Oceanographic / Hydrographic measurements, which include Water level, Wave Height and period, Current speed and direction and other derived parameters such as Significant Wave Height, Wave period, etc., in and around the wind LiDAR platforms or suitable locations off the Gujarat coast and Tamil Nadu coast to understand the sea-state conditions, which are necessary to design the foundation of the Offshore wind turbines.
- (ii) Based on the multi-criteria analysis the locations for installation of LiDARs have been finalized. The geotechnical studies for designing the LiDAR structure off Gujarat coast have been completed. NIWE is in the process of initiating the geophysical and geotechnical studies off the coast of Tamil Nadu for this purpose.
- b. Integrated wind & solar resource assessment through mapping and measurements**
- (i) Mapping and measurements envisages the deployment of dedicated 100 m integrated wind-solar monitoring stations at carefully chosen sites in different parts of the country. Under this project, 50 numbers 100 m tall integrated wind-solar monitoring stations (in two phases) with 5 levels of instrumentation are to be installed in the country over a period of three years.
- Wind resource measurements will also be carried out using SODAR along with measurements from integrated wind-solar monitoring stations concurrently for the period of approximately 3 months for the vertical extrapolation of the mast data. The measurements carried out using integrated wind-solar measurements and the SODAR will be used to estimate the wind solar power potential of the country at 150 m level and for the preparation of 150 m wind-solar hybrid map.
- (ii) Multi criteria suitability analysis based on the available data sets has been completed to identify 25 Nos. of suitable locations for the installation of integrated measurement stations. The details of identified locations for measurement through installation & commissioning of mast is given in **Table 7.1**.
- (iii) Map showing the proposed Wind Solar Monitoring stations
- (iv) Under this project the wind energy potential assessment at 120 m high is carried out at a spatial resolution of 500 m, using the advanced meso-micro coupled numerical wind flow model with the corroboration from 406 actual measurement sites spread across the country. Based on the analysis, the indicative wind potential of India is estimated as 695 GW at 120 m agl.

7.11 STANDARDS & QUALITY CONTROL IN RENEWABLE ENERGY SECTOR

As part of R&D Programme of MNRE increased interaction was made with experts, test labs and industry for quality control of the renewable energy systems/components. Active interaction was made with the Bureau of Indian Standards(BIS) through various committee's meetings for updating standards matching Indian climatic conditions. Interactions were also made with National Accreditation Board for Testing

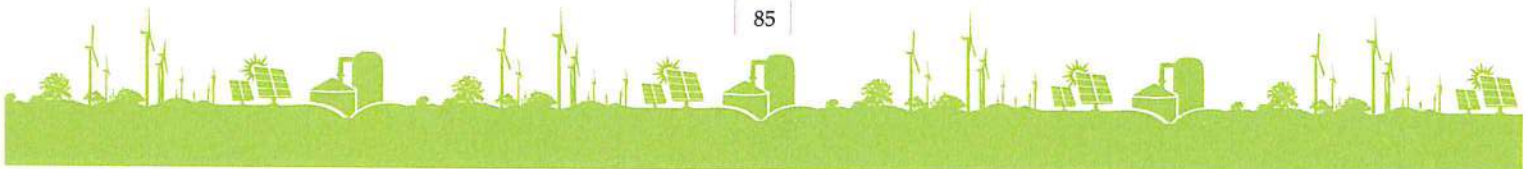
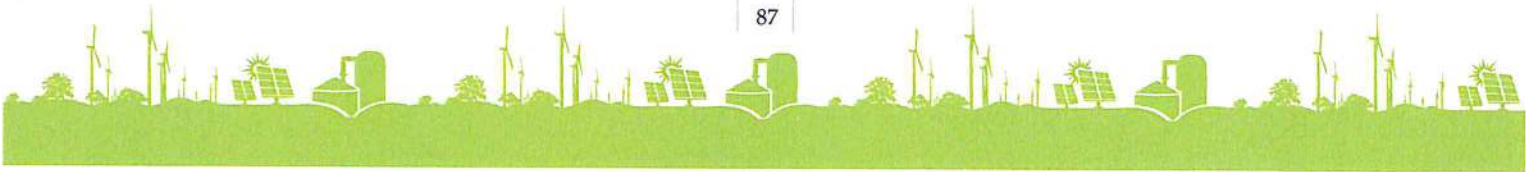
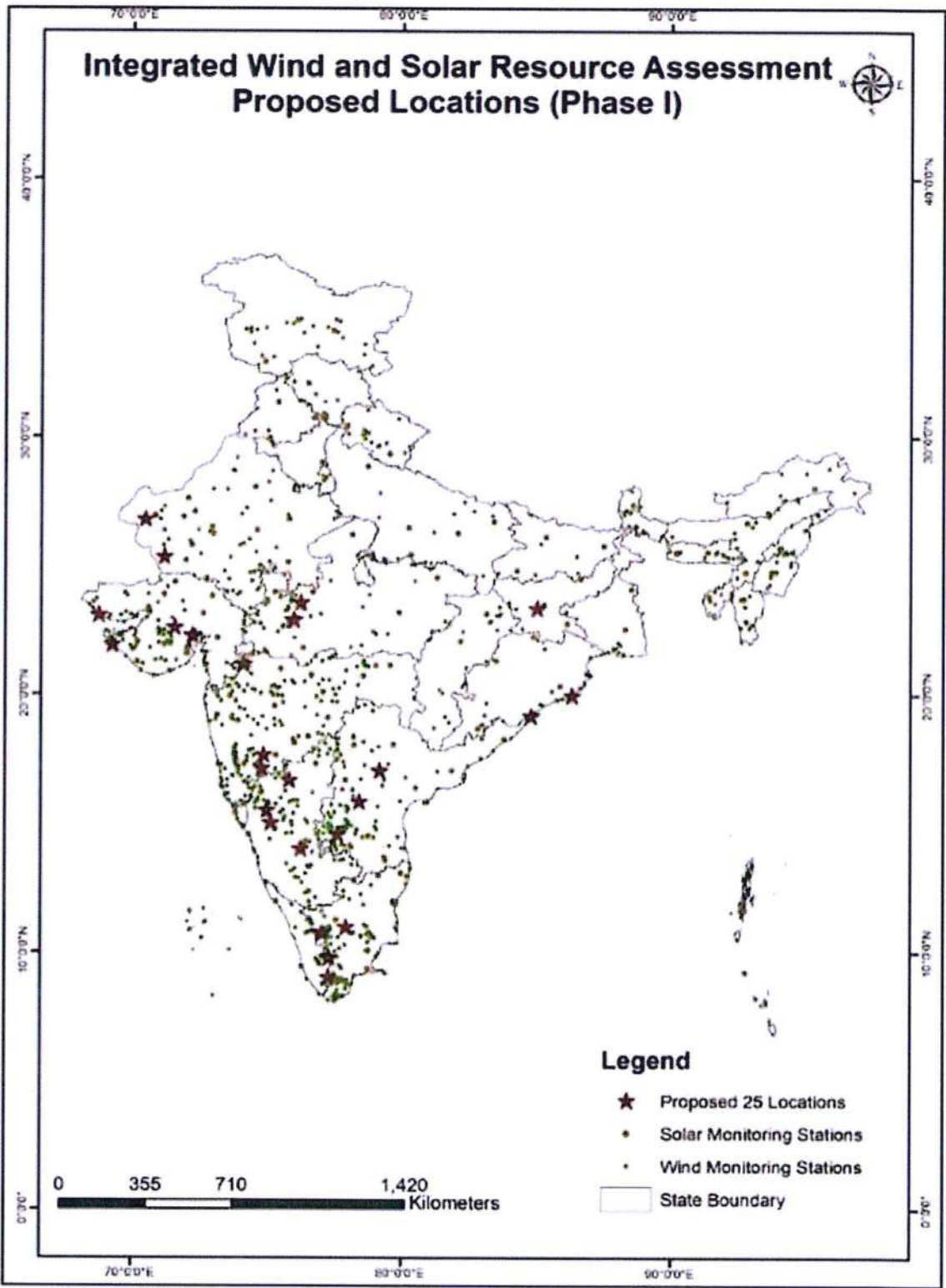


Table 7.1: Identified Locations for Measurement Through Installation & Commissioning of Mast

Sl. No	Site Id	Latitude °N	Longitude °E	State
1	IWS OD1	19.16	84.79	ODISHA
2	IWS TN 2	9.02	77.30	TAMIL NADU
3	IWS TN3	9.78	77.33	TAMIL NADU
4	IWS TN 4	10.73	77.06	TAMIL NADU
5	IWS TN 5	10.97	77.94	TAMIL NADU
6	IWSF KA6	14.01	76.26	KARNATAKA
7	IWS KA7	15.01	75.16	KARNATAKA
8	IWS KA8	15.50	75.01	KARNATAKA
9	IWS KA9	16.68	75.84	KARNATAKA
10	IWS JH10	23.35	85.01	JHARKHAND
11	IWS AP 11	15.83	78.44	ANDHRA PRADESH
12	IWS TE12	17.04	79.17	TELANGANA
13	IWS MH13	17.14	74.81	MAHARASHTRA
14	IWS OD14	19.96	86.32	ODISHA
15	IWF AP15	14.57	77.63	ANDHRA PRADESH
16	IWS MH16	17.66	74.89	MAHARASHTRA
17	IWS MP17	22.88	76.01	MADHYA PRADESH
18	IWS MH18	21.17	74.14	MAHARASHTRA
19	IWS GJ19	22.29	72.24	GUJARAT
20	IWS GJ20	21.91	69.27	GUJARAT
21	IWS GJ21	23.08	68.78	GUJARAT
22	IWS GJ22	22.60	71.59	GUJARAT
23	IWS RJ23	26.79	70.49	RAJASTHAN
24	IWS RJ24	25.34	71.20	RAJASTHAN
25	IWS MP25	23.56	76.26	MADHYA PRADESH





& Calibration Laboratories(NABL) for proper assessment of technical competence for accreditation of test labs for specified standards. A meeting was held on 27th November 2019 in MNRE under the chairmanship of Shri Anand Kumar, Secretary, MNRE regarding discussion on various issues pertaining to standards development, standards implementation, lab accreditation and implementation of Quality Control Order on SPV (Compulsory Registration Scheme). The meeting was attended by the concerned MNRE officers, test labs, BIS officers and SPV module industry associations. In the meeting, various actions points were decided for streamlining standard development and implementation in renewable energy sector in the country.

7.11.1 QUALITY CONTROL OF SPV SYSTEMS/COMPONENTS

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 preparing 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 aid order should conform to specified Indian Standard/corresponding IEC, and products qualifying the standards tested in BIS recognized test labs are required to be registered by the respective manufacturers with BIS. Only products registered with BIS are allowed for deployment in projects. The Quality Control Order involves preparation of guidelines for series approval of samples for submitting to test labs for testing for granting registration by BIS as the products have different sizes, ratings, varieties, etc. The products are subjected to field surveillance to ensure the quality of products in field as per performance certification done by test labs.

7.11.2 TEST LABS FOR PERFORMANCE TESTING

- (i) The preparedness of test labs was reviewed periodically under the chairmanship of Shri Anand Kumar, Secretary, MNRE for fulfilling the requirements of performance testing of identified products as per Quality Control Order. Test labs are key requirement for performance testing as per standard for quality assurance. The labs are required to get their technical competence validated by laboratory accreditation bodies which use ISO/IEC 17025 as tool for the purpose. Once the labs are accredited by NABL, the BIS grants lab recognition.
- (ii) Active interaction was made with test labs and BIS for streamlining the process of testing with quality and reliability, issuing test reports and registration of products by BIS. Interaction with NABL and BIS was also made to ensure the labs are properly assessed for their technical competence for delivering testing services efficiently with reliable test results. In this regard, Dr. B. S. Negi, Adviser (Quality Control), MNRE chaired a meeting with concerned representatives of BIS, NABL and Department of Promotion of Industry and Internal Trade(DPIIT) on 3rd January 2010 at 3PM in MNRE. In the meeting, a transparent and robust process of assessment of technical competence of test labs and efficient actions on the proposals by NABL and BIS was discussed. The updated list of test labs actively engaged in testing of products is given in **Table 7.2**.

7.11.3 IMPLEMENTATION OF QUALITY CONTROL ORDER

SERIES GUIDELINES FOR TESTING PRODUCTS

- (i) A Technical Advisory Committee set up to oversee the implementation of the Quality Control Order in its meetings discussed various issues including finalizing series guidelines for SPV Modules, Inverters and Battery Storage. Guidelines for series approval of SPV Modules (both types crystalline and thin film)



Table 7.2: Updated List of Test Labs				
Sl. No.	Product	Indian Standard Number	Title of India Standard	Test Labs Recognized by BIS
1.	Crystalline Silicon Terrestrial Photovoltaic (PV) Modules (Si Wafer based)	IS-14286	Crystalline Silicon Terrestrial Photovoltaic (PV) Modules - Design Qualification and type Approval	1. Hi Physix Laboratory India Pvt. Ltd., Pune 2. UL India Pvt. Ltd., Bangalore 3. TUV Rheinland, Bangalore
2.	Thin-Film Terrestrial Photovoltaic (PV) Modules (a-Si, CIGs and CdTe)	IS-16077	Thin-Film Terrestrial Photovoltaic (PV) Modules - Design Qualification and Type Approval	1. Hi Physix Laboratory India Pvt. Ltd., Pune 2. UL India Pvt. Ltd., Bangalore
3.	PV Module (Si Wafer and Thin Film)	IS/IEC 61730 (Part-1) IS/IEC 61730 (Part-2)	Photovoltaic (PV) Module Safety Qualification Part-1 Requirements for Construction Photovoltaic (PV) Module Safety Qualification Part-2 Requirements for Testing	1. Hi Physix Laboratory India Pvt. Ltd., Pune 2. UL India Pvt. Ltd., Bangalore. 3. TUV Rheinland, Bangalore
4.	Power Inverters for use in Photovoltaic Power System	IS 16221 (Part-2)	Safety of Power Converters for use in Photovoltaic Power Systems Part-2 – Particular Requirements for Inverters	1. CPRI, Bangalore 2. Hi-Physix Laboratory India Pvt. Ltd., Pune
5.	Utility – Interconnected Photovoltaic Inverters	IS-16169	Test Procedures of Islanding Prevention Measures for Utility-Interconnected Photovoltaic Inverters	1. CPRI, Bangalore 2. Hi-Physix Laboratory India Pvt. Ltd., Pune 3. UL India Pvt. Ltd., Bangalore
6.	Storage Battery	IS-16270	Secondary Cells and Batteries for Solar Photovoltaic Application General - Requirements and Methods of Test	1. CPRI, Bangalore 2. CECRI, Karaikudi, Tamil Nadu 3. Hi Physix Laboratory India Pvt. Ltd., Pune

for testing in test labs were notified on 9th July 2018. Active interaction was made with industry and test labs for quality assurance and for delivering efficient testing services by test labs. The guidelines were monitored for improvement in implementation. The revised series guidelines for SPV Modules developed in consultation with test labs, industry and BIS were notified on 16th April 2019 for implementation.

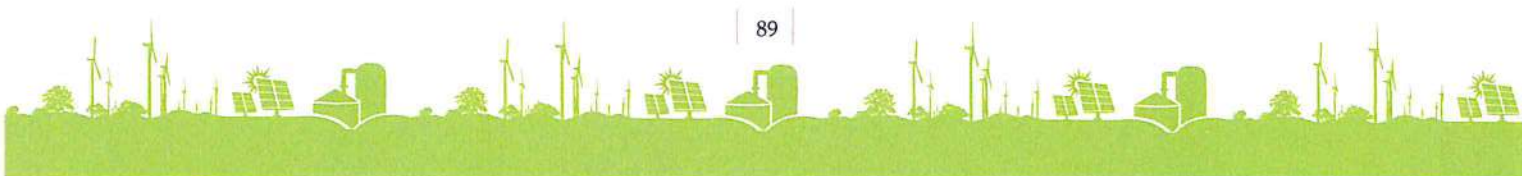
- (ii) The series guidelines for battery storage were notified by MNRE on 27/6/2019 for implementation. The series guidelines for inverters were notified by MNRE on 26/9/2019 for implementation.

7.11.4 SURVEILLANCE

The Quality Control Order has a provision for inspection and surveillance of products in field for quality check on products manufactured by industry and deployed in field after performance certification by test labs. The sample of goods of the registered user shall be drawn from the manufacturing unit or from the market by the appropriate authority for ascertaining whether they conform to the specified standard. A surveillance system was developed and the same is being worked out by the National Institute of Solar Energy(NISE), Gurugram for implementation.

7.11.5 BIS REGISTRATION

The technical regulation has given boost to not only quality control of SPV Modules but also domestic manufacture of SPV Modules. Bureau of Indian Standards (BIS) has accorded approval and registration



for 250 manufacturers for their products based on performance testing reports issued by three test labs, which include 167 manufacturers from India and 83 from China and other countries. Thus, the regulation has brought a major breakthrough in domestic production of SPV Modules. It has been decided that only SPV Modules with BIS Mark will be used in SPV Power Projects in the country.

7.11.6 NEW INITIATIVE ON STANDARD ON GRID TIE INVERTER

At present two standards on inverters have been specified for quality control. These standards cover safety requirements as per IS-1622-Part II and for islanding prevention measures for utility inter-connected photovoltaic inverter as per IS 16169. It was felt standards on efficiency, grid integration and environmental tests also need to be followed for complete performance testing of inverters. A meeting was held on 21.08.2019 at CPRI, Bangalore with experts for test labs and select inverter industries for discussion on IEC Standards on efficiency (IEC 61683), grid interaction (IEC 61727) and environmental tests (IEC 60068). In the meeting, which was chaired by Dr. B. S. Negi, Adviser (Quality Control), MNRE, it was discussed that these standards need to be perused for developing an inclusive standard on Grid Tie Inverter for Indian climatic conditions. A draft document prepared in consultation with test labs and industry was discussed in the subsequent meeting held on 26th September, 2019 in MNRE, which was attended by concerned officers from MNRE, BIS and CEA. Further interaction is going on the subject.

7.11.7 NEW INITIATIVE FOR QUALITY CONTROL ORDER ON SOLAR THERMAL COLLECTORS

Looking at considerable potential for solar water heating in the country, interactions were initiated with solar thermal industries engaged in manufacture of solar flat plate collectors, evacuated tube collectors and concentrating collectors and BIS to review the Indian standards available on these products for bringing out technical regulation for quality control. A draft Quality control order was prepared in consultation with BIS and the related stakeholders. A view was taken to adopt the latest international standards for quality control of solar flat plate collectors and solar evacuated tube collectors. In the BIS Meeting on the subject held on 17th December 2019 in BIS, the latest ISO Standards on solar thermal collectors and ETC were perused for modification for Indian conditions. Once the standards are revised and notified, the same will be considered for implementation for quality control of these products.

7.11.8 STAR LABELLING BY BEE

BEE initiated a scheme for star-labelling on Solar Water Heating Systems and SPV Modules in order to encourage industry for producing efficient solar thermal collectors and SPV Modules. The MNRE participated in Technical Committee meetings of BEE for finalising the scheme framework including deciding Star Labelling of these systems. The Star Labelling has been classified in five categories with Five Star rating for solar/thermal collector given for system efficiency more than 65%. The Star rating for SPV Module is under consideration. A rigorous process has been stipulated for star rating. The testing will be conducted in NABL accredited test labs approved by BIS. Only products fulfilling the MNRE Quality Control Orders will be eligible for participation in Star Labelling Programme of BEE.

