

Recent Development in Renewable Energy of India

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Abstract— India have a huge supply of Renewable resources, it is the only country who have an exclusive ministry for Renewable energy, the Ministry of Non-conventional Energy Sources (MNES). In year 2006 MNES was renamed by Ministry of New and Renewable Energy (MNRE). India have four renewable Sources which are available in India Hydro Power, Solar Power, Wind Power and Biomass Power. The Government of India and it state Government had released many Policy for Promotion and development of Renewable energy.

I. INTRODUCTION

THE World Energy Forum have expected that fossil-based oil, coal and gas reserves will be shattered in less than another 10 decades. Fossil fuels account for over 79% of the prime energy consumed in the world, and 57.7% of that quantity is used in the transport sector and are shrinking rapidly.[1] The energy strategy of a India purposes at efficiency and security and to provide access which being environment friendly and achievement of an optimum mix of primary resources for energy generation. Fossil fuels will continue to play a leading role in the energy scenario in our country in the next few decades. However, conventional or fossil fuel resources are limited, non-renewable, polluting and, therefore, need to be used prudently. On the other hand, renewable energy resources are indigenous, non-polluting and virtually unlimited. India is gifted with abundant renewable energy resources. Therefore, their use should be promote in every doable way. In biofuels, the country have a ray of hope in providing energy security. Biofuels are environment friendly fuels and their use would address global concerns about prevention of carbon emissions. The transportation sector has been known as a most polluting sector. Use of biofuels have, therefore, become compelling in view of the tightening automotive vehicle emission standards to curb air pollution.[2] Jawaharlal Nehru National Solar Mission (JNNSM) targets total capacity of 20 GW grid-connected solar powers by 2022 which is changed to 100GW in 2015 by PM of India. Power sector plays a important role in the growth of Indian economy and it is growing at rapid motion. The total installed capacity have reached to 310 GW with generation mix of Thermal (69.4%), Hydro (13.9%), Renewable (14.8%) and Nuclear (1.9%). It is evident that the renewable power has secured 2nd position and is spreading its wings rapidly in India.[3]

II. RENEWABLE ENERGY

Renewable energy sector in India have emerged as a significant player in the grid connected power generation capacity. It supports the government schedule of maintainable growth, while, developing as an integral part

of the solution to meet the nation's energy needs and an vital player for energy access.[4] India have an estimated renewable energy potential of about 900 GW from commercially consumable sources viz. Wind – 102 GW (at 80 meter mast height); Small Hydro – 20 GW; Bioenergy – 25 GW; and 750 GW solar power, assuming 3% wasteland is made available. Renewable energy have a great potential to usher in universal energy access.[5]

The Government have Target of renewable energy capacity to 175 GW by the year 2022 which includes 100 GW from solar Power, 60 GW from wind power, 10 GW from bio-power and 5 GW from small hydro-power. The target of 100 GW capacity set under the National Solar Mission (NSM) will primarily comprise of 40 GW Rooftop and 60 GW through Large and Medium Scale Grid Connected Solar Power Projects. With this target India will achieve 40% of cumulative Electric power capacity from non-fossil fuel based energy resources by 2030. A target of wind 4000 MW, solar 12000 MW, small hydro power 250 MW, bio-power 400 MW and waste to power 10 MW total 16660 MW Has been set for 2016-2017. [6]

III. SOLAR ENERGY

India is a tropical country, where sunshine is available for longer hours per day with great intensity. Solar energy, therefore, have great potential as future energy source. It also have the advantage of permitting the decentralized distribution of energy, thereby empowering people at the grassroots level. In year 2009 the India Government "Jawaharlal Nehru National Solar Mission Phase I". and In year 2012 the India Government had released the policy "Jawaharlal Nehru National Solar Mission Phase II". India is gifted with abundant solar energy, which is capable of producing 5,000 trillion kilowatts of clean energy. Country is blest with around 300 sunny days in a year and solar insolation of 4-7 kWh per Sq. m per day. Based on this vision Jawaharlal Nehru National Solar Mission was launched with the brand name "Solar India". The Mission was adopted a 3-phase approach, spanning the period of the 11th Plan and 1st year of the 12th Plan (up to 2012-13) as Phase 1, the remaining 4 years of the 12th Plan (2013-17) are as Phase 2 and the 13th Plan (2017-22) as Phase 3. The 1st phase (up to 2013) focus on catching of the low hanging options in solar on promoting off-grid systems to serve populations without access the commercial energy and normal capacity addition in grid-based systems. In the 2nd phase, after taking into account the experience of the early years, capacity will be aggressively ramped up to create conditions for up scaled and competitive solar energy access in the country. The National Solar mission under the brand

name “Solar India” set an ambitious target of adding 20 GW of Grid connected and 100 GW of Off-grid capacity by 2022 in three phases. Phase wise target of the mission is presented below.[7] (table 1)[7]

Table 1[7]

S N	Segment	Target for Phase I (2010-13)	Cumulative Target for Phase II (2013-17)	Cumulative Target for Phase III (2017-22)
1	Utility Grid Power Including rooftop	1100 MW	10,000 MW	20,000 MW In will increased to 100,000 MW in 2015
2	Off Grid Solar Applications	200 MW	1000 MW	2000 MW
3	Solar Collectors	7 million sq mt	15 million sq mt	20 million sq mt

Phase I of National Solar Mission was divided into two Batches i.e. batch –I & II. In Batch I, capacity addition of 150 MW of grid connected solar PV plants and 500 MW of grid connected solar thermal plants was presumed. Where in Batch II, the remaining targeted capacity for Solar PV i.e. 350 MW was awarded.[7]

Under batch-I, Phase-I The selection of Solar PV projects of 500 MW capacity was decided to be undertaken in two batches over two financial years of Phase 1 i.e., 2010-2011 and 2011-2012. The size of Photovoltaic projects in the first stage in 2010-11 was fixed at 5 MW per project. Under Migration scheme NTPC Vidyut Vyapar Nigam Limited started the process of short listing the on-going projects to migrate to the JNNSM. A total of 16 projects of 84 MW capacity are selected. These project developers signed Power Purchase Agreement with NTPC Vidyut Vyapar Nigam Limited in October, 2010 and reported financial closure. The last date for commissioning of 54 MW capacity Photovoltaic projects was by end of October, 2011. The 30 MW capacity solar thermal projects are to be commissioned by March, 2013.[7]

Under Batch-II, Phase-I the total aggregate capacity of grid connected Solar Projects was 350 MW for the deployment of Solar Photovoltaic Power Projects. NTPC Vidyut Vyapar Nigam Limited had been designated as the nodal agency for procurement of solar power and for carrying out the bidding process. On August 24, 2011, NTPC Vidyut Vyapar Nigam Limited invited Request for Selection (RfS) from interested developers to develop 350 MW solar Photovoltaic projects with a capacity in multiple of 5 MW, Minimum capacity 5 MW and Maximum Capacity 20 MW for each project. Total Capacity for each bidder was limited which was 50 MW. NTPC Vidyut Vyapar Nigam Limited received 183 bids from project developers indicating discounts offered by each on CERC approved benchmark tariff of 1539 paisa/kWh. Discount offered by the bidders was in the range of zero paisa to 790 paisa per unit.[7]

In Phase-II the National Solar Mission envisages installation of around 10 GW utility scale and 1 GW off-grid solar power projects by the end Phase-II. Twelfth five year

plan (2012-17) also had targets capacity addition of 10 GW of grid connected solar power in India. It is envisaged that out of this 10 GW target, 4 GW would be developed under central scheme and 6 GW under various State specific schemes.[7]

A. *Rooftop Photovoltaic Programme*

Objective of Phase II would focus on Development of Both OFF-Grid and Grid Connected Rooftop Photovoltaic system in country. Grid connected rooftop PV system shall be connected to the grid either of 11 KV three phase line or of 220 V single phase line depending on the system installed at institution/commercial establishment or residential complex. Power generated by these systems would be utilized by Industrial and captive loads and feeding excess power to the grid as long as grid is available. The off grid roof top PV systems would be deployed at places which are not connected to the grid or not connected but getting electricity from the grid. The Phase II of JNNSM would target deployment of 1,000 MW of rooftop projects both at off-grid and grid connected levels.[7]

Government has revised the target of Grid Connected Solar Power Projects from 20,000 MW by the year 2021-22 to 100,000 MW by the year 2021-22 under the National Solar Mission and it was approved by Cabinet on 17th June 2015. [23]

In Year 2015 the Gujarat government had Released the policy “**Gujarat solar power policy**” This Policy will come into effect from date of its notification and will remain in operation up to March 31, 2020. The Government of Gujarat expects maximum participation from Investors in setting up MW scale solar projects under solar photovoltaic (PV) and solar thermal technologies. Besides, kilowatt (kW)-scale solar projects in the form of solar rooftop systems shall be encouraged during the Operative Period of this Policy. The installation capacity targets for the State DisComs will be as per the renewable power purchase obligation (RPO) defined by the Gujarat Electricity Regulatory Commission (GERC), from time to time. Further, the State proposes to undertake necessary activities and become an integral part of the National Solar Mission (NSM) in order to help the mission meet its goals. The minimum size of a MW-scale project shall be 1 MW and that for a kW-scale project shall be 1 kW. [8]

In Year 2015 the Jharkhand Government had released the Policy “**Jharkhand state Solar Power policy**” the policy will encourage participant of the private sector to set up Solar Power based Project in the State & increase solar Power generation to 2650MW by the year 2020 in phased manner. [9]

In Year 2015 the Telangana government had released the Policy “**Telangana Solar Power Policy 2015**” This policy will come into operation with effect from the date of issue and shall remain applicable for a period of 5 years.[10]

Projects under this policy:-

- 1) Solar power Projects

- a) a) Grid connected solar power projects based on both Photo Voltaic (PV) as well as Solar Thermal technologies.
- b) Projects set-up for captive generation/ group captive generation
- 2) Solar Rooftop Projects
- 3) Off grid Projects
- 4) Solar parks
- 5) Any other project which is established based on MNRE/GOI Schemes as amended from time to time. [10]

In year 2015 the Andhra Pradesh government had released the policy “**Andhra Pradesh Solar Power Policy 2015**” Under the policy, 34.85 MW capacity solar power projects were only commissioned before 30th June, 2014 though it was envisaged to add 2000 MW capacity by the Group of Ministers constituted for the purpose of promotion of Renewable Energy. [11]

In year 2018 the Government of Rajasthan had released the policy “**subsidy scheme For grid connected Solar rooftop Projects in Rajasthan**” target of the Solar Rooftop in the state of Rajasthan, the state Government has recently launched a rooftop solar subsidy program of 18 MW capacity through Rajasthan Renewable energy Limited. Firstgreen have been selected as successful bidder for implementation of the proposed solar rooftop program in the state of Rajasthan. Under the scheme the consumer have to pay only 70% of the project cost and balance 30% is paid directly by RREC as subsidy for the solar system. Also we are providing 5 year free operation and maintenance of the project. [12]

IV. WIND ENERGY

Wind energy in India till 2014-15 as Below [17]
Table 2 [17]

STATE	Upto 31.03.2002	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	Total
Andhra Pradesh	93.2	0.0	6.2	21.8	0.5	0.8	0.0	0.0	13.6	55.4	54.1	202.2	298.50	166.30	912.5
Gujarat	181.4	6.2	28.9	51.5	84.6	284.0	616.4	313.6	297.1	312.8	789.9	208.3	279.80	126.90	3581.3
Karnataka	69.3	55.6	84.9	201.5	143.8	266.0	190.3	316.0	145.4	254.1	206.7	201.7	183.00	230.50	2548.7
Kerala	2.0	0.0	0.0	0.0	0.0	0.0	8.5	16.5	0.8	7.4	0.0	0.0	0.00	0.00	35.1
Madhya Pradesh	23.2	0.0	0.0	6.3	11.4	16.4	130.4	25.1	16.6	46.5	100.5	9.6	37.40	143.90	567.3
Maharashtra	400.3	2.0	6.2	48.8	545.1	485.3	268.2	183.0	138.9	239.1	416.5	288.6	1074.50	273.45	4369.8
Rajasthan	16.1	44.6	117.8	106.3	73.3	111.8	69.0	199.6	350.0	436.7	545.7	615.4	98.80	267.70	3052.7
Tamil Nadu	877.0	133.6	371.2	675.5	857.6	577.9	380.7	431.1	602.2	997.4	1083.5	174.6	107.38	124.45	7394.0
Others	4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	4.3
Total	1666.8	242.0	615.2	1111.7	1716.2	1742.1	1663.3	1484.9	1564.6	2349.2	3196.7	1700.4	2079.4	1333.2	22465.6

Wind power is conversion of wind flow energy into a useful form of energy, by the using wind turbines to make electrical power, windmills for mechanical power, wind pumps are for drainage or water pumping, or sails to propel

ships. Large wind farms contains of hundreds of individual wind turbines which are connected to the electric power transmission network. For new constructions, onshore wind is an inexpensive source of electricity, competitive with or in many places cheaper than fossil fuel plants.[16] MNRE has incorporated Centre for Wind Energy Technology (C-WET) as technical focal point for development of wind energy in India.[13]
Recent Policy’s in India About Wind Energy

In year 2012 the Rajasthan government had released the policy “**policy of promoting generation of electricity from wind 2012**” The Policy will come into operation with effect from 18.7.2012 and will remain in force until modified or superseded by another Policy. The State will promote setting up of wind power plants of unlimited capacity for direct sale to the Discoms of Rajasthan upto year 2012-13 on the preferential tariff determined by Rajasthan Electricity Regulatory Commission (RERC). Target of this policy is have to set up 1300 MW wind power for direct to sale by year 2013- 2016 [14].

Table 3 [14]

Year	2013-14	2014-15	2015-16
Wind power plants to be set up for direct sale to Discoms of Rajasthan	300MW	400MW	500MW

In year 2012 the west Bengal government had to released the policy “**Policy on Co-generation and Generation of Electricity from Renewable Sources of Energy**” This Policy will include the following Renewable energy technologies-solar, wind, biomass, cogeneration, small hydro, municipal solid waste (MSW) and other energizing technologies. In west Bengal the wind power potential is 450 MW by year 2022. the government of west Bengal is owned wasteland in areas having minimum annual mean wind power density (WPD) of 200 Watt/m² measured at a

hub height of 50 meters and using new generation wind turbine generator will be offered for set up of wind Projects. 50 MW of power is targeted from waste-to-energy power projects covering municipal solid waste, municipal liquid waste and industrial waste by 2017. [15]

V. BIOMASS ENERGY AND COGENERATION ENERGY

Biomass have always been an important energy source for the country considering the benefits it offers. It is renewable, widely available, carbon-neutral and have the potential to provide significant employment in the rural areas. Biomass is also capable of providing firm energy. About 32% of the total primary energy use in the country is still derived from biomass and more than 70% of the country's population depends upon it for its energy needs. Ministry of New and Renewable Energy had Released the potential and role of biomass energy in the Indian context and hence has initiated a number of programs for promotion of efficient technologies for its use in various sectors of the economy to ensure derivation of maximum benefits Biomass power generation in India is an industry that attracts investments of over Rs.600 crores every year, generate more than 5000 million units of electricity and yearly employment is more than 10 million man days in the rural areas. For efficient utilization of biomass, bagasse based cogeneration in sugar mills and biomass power generation have been taken up under biomass power and cogeneration programs [18].

The current availability of biomass in India is estimated at about 500 millions metric tones per year. Studies sponsored by the Ministry and it have estimated additional biomass availability at about 120 – 150 million metric tones per annum covering agricultural and forestry relics corresponding to a potential of about 18,000 MW. This apart, about 5000 MW additional power can be generated through bagasse based cogeneration in the country's 550 Sugar mills, if these sugar mills were to adopt technically and economically optimal levels of cogeneration for extracting power from the bagasse produced by them [18].

Recent Policy's in India About Biomass Energy

In year 2017 the Bihar government Had released the policy "**Bihar Policy For Promotion of Bihar New and Renewable Energy Sources 2017**" The policy will remain in operative for a period of year from the date of the notification till the state government notifies the new Policy. The Policy will be evaluated for impact assessment at least once during this Policy period. The review will ensure inclusion of any new renewable technology that may evolve over the next few Year. The second evaluation will be undertake during 2022 with an objective of conducting a decision making assessment over policy continuation or extension. For giving effect to this Policy, necessary amendments in various policies, rules & regulation, wherever necessary, shall be expeditiously undertake by the concerned departments. The target of this policy is to install capacity of 2969 Mw Solar power & 244 MW biomass & bagasse cogeneration and 220 MW Small Hydro Power by 2022 in the state with an objective to meet the growing demand For Power in an environmentally sustainable manner [19].

In year 2018 the Haryana Government had Released the Policy "**Haryana Bio-energy Policy 2018**"

Haryana is primarily an agrarian State. Haryana have surplus biomass availability of 8416 thousand tons which has tremendous potential for utilization of the residues of these crops to generate electricity/biogas/ bio-CNG/bio-manure/bio-fuels etc. The State have potential to generate about 1000 MW of power or 11.5 lac ton of bio-CNG. This Policy have proposed to achieve a target of minimum 150MW biomass based Power generation by 2022. Agricultural land shall also be allowed to be used for setting up of biomass based Projects in the State [20].

In Year 2018 the Government of India had released the Policy "**National Policy on Biofuels 2018**" The focus for development of biofuels in India will be to utilize degraded forest and waste and non-forest lands only for farming of shrubs and trees bearing non-edible oil seeds for production of bio diesel. In India, bio-ethanol is produced mainly from treacle, a by-product of the sugar industry. In future also, it would be certified that the next generation of technologies is based on non-food feedstocks. Therefore, In Indian context the issue of fuel vs. food security is not relevant. Plantations of trees bearing non-edible oilseeds will be taken up on Government/community degraded land, wasteland or fallow land in forest and non-forest areas. Contract cultivation on private wasteland could also be taken up through the Minimum Support Price mechanism proposed in the Policy. Plantations on agricultural lands will be discouraged. In India There are over 400 species of trees bearing non-edible oilseeds. all these species potential will be exploited, depending on their techno-economic viability for production of biofuels. Quality seedlings would be raised in the nurseries of certified institutions / organizations identified by the States for distribution to the growers and cultivators. [21].

VI. SMALL HYDRO POWER

Ministry of New and Renewable Energy have been vested with the responsibility of developing Small Hydro Power (SHP) projects up to 25 MW station capacities. The 20,000MW is estimated potential for power generation in the country from such plants. Most of the potential of small hydro power plant is in Himalayan States as river-based projects and in other States on irrigation canals. The small hydro power program is now essentially private investment driven. Projects are normally economically feasible and private sector is showing lot of interest in investing in Small hydro power projects. With increase in the project capacity the viability of these projects improves. The Ministry's aim is that at least 50% of the potential in the country is harnessed in the next 10 years [22].

Hydro power projects are normally categorized in two segments small and large hydro. Hydro projects up to 25 MW station capacities have been categorized as Small Hydro Power (SHP) projects in India. Whereas for large hydro Projects Ministry of Power, Government of India is responsible, For the subject small hydro power (up to 25 MW) the mandate is given to Ministry of New and Renewable Energy.. [22]

Table 4 hydro power projects[22]

Class	Station Capacity in kW
Micro Hydro	Up to 100
Mini Hydro	101 to 2000
Small Hydro	2001 to 25000

Table 5 state wise Renewable energy installed capacity [24]

State-wise installed capacity of Grid Interactive Renewable Power as on 31.01.2019.											
S. No.	STATES / Uts	Small Hydro Power	Wind Power	Bio-Power				Solar Power			Total Capacity
				BM Power/Bagasse Cogen. (Grid Interactive)	BM Cogen. (Non-Bagasse/Captive Power)	Waste to Energy	Bio Power Total	Ground Mounted	Roof Top	Total	
		(MW)	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)
1	Andhra Pradesh	162.11	4076.45	378.20	98.98	23.16	500.34	2840.77	48.52	2889.29	7628.19
2	Arunachal Pradesh	107.100						1.27	4.12	5.39	112.49
3	Assam	34.11						10.67	7.98	18.65	52.76
4	Bihar	70.70		113.00	8.20		121.20	138.93	3.52	142.45	334.35
5	Chhattisgarh	76.00		228.00	2.50		230.50	215.83	15.52	231.35	537.85
6	Goa	0.05						0.95	0.74	1.69	1.74
7	Gujarat	45.70	5965.87	65.30	12.00		77.30	1836.3	166.73	2003.03	8091.90
8	Haryana	73.50		121.40	84.26		205.66	130.80	88.79	219.59	498.75
9	Himachal Pradesh	860.61			7.20		7.20	0.00	4.50	4.50	872.31
10	Jammu & Kashmir	179.03						8.49	5.89	14.38	193.41
11	Jharkhand	4.05			4.30		4.30	19.05	13.36	32.41	40.76
12	Karnataka	1230.73	4682.80	1783.60	15.20	1.00	1799.80	5175.06	153.75	5328.81	13042.14
13	Kerala	222.02	52.50		0.72		0.72	100.00	38.49	138.49	413.73
14	Madhya Pradesh	95.91	2519.890	93.00	12.35	15.40	120.75	1619.22	30.67	1649.89	4386.44
15	Maharashtra	375.570	4794.13	2499.70	16.40	12.59	2528.69	1447.30	172.26	1619.56	9317.95
16	Manipur	5.45						0.00	3.23	3.23	8.68
17	Meghalaya	31.03			13.80		13.80	0.00	0.12	0.12	44.95
18	Mizoram	36.47						0.10	0.40	0.50	36.97
19	Nagaland	30.67						0.00	1.00	1.00	31.67
20	Odisha	64.625		50.40	8.82		59.22	383.56	6.71	390.27	514.12
21	Punjab	173.55		194.00	123.10	9.25	326.35	828.1	77.52	905.62	1405.52
22	Rajasthan	23.85	4299.72	119.30	2.00		121.30	3045.69	96.2	3141.89	7586.76
23	Sikkim	52.11						0.00	0.01	0.01	52.12
24	Tamil Nadu	123.05	8764.34	941.00	56.48	6.40	1003.88	2098.27	135.07	2233.34	12124.61
25	Telangana	90.87	128.10	158.10	1.00	18.50	177.60	3519.27	64.34	3583.61	3980.18
26	Tripura	16.01						5.00	0.09	5.09	21.10
27	Uttar Pradesh	25.10		1957.50	160.01		2117.51	834.00	68.33	902.33	3044.94
28	Uttarakhand	214.320		73.00	57.50		130.50	239.78	64.49	304.27	649.09
29	West Bengal	98.50		300.00	19.92		319.92	50.00	19.56	69.56	487.98
30	Andaman & Nicobar	5.25						5.10	1.46	6.56	11.81
31	Chandigarh							6.34	26.06	32.40	32.40
32	Dadar & Nagar Haveli							2.49	2.97	5.46	5.46
33	Daman & Diu							10.15	4.32	14.47	14.47
34	Delhi					52.00	52.00	8.96	115.25	124.21	176.21
35	Lakshadweep							0.75	0.00	0.75	0.75
36	Pondicherry							0.03	1.77	1.80	1.80
37	Others		4.30								4.30
	Total (MW)	4528.045	35288.100	9075.50	704.74	138.30	9918.54	24582.23	1443.74	26025.97	75760.66

Small Hydro Power plant

Small Hydro Power Program is one of the vital areas of power generation from renewable in the Ministry of New and Renewable Energy. It have been recognized that small hydropower projects can play a grave role in improving the overall energy scenario of the country and in particular for remote and inaccessible areas. [22]

A. Aim and Potential of MNRE

The Ministry's aim is that, at the end of 12th Plan the Small hydro power installed capacity should be about 7000 MW. The focus of the Small hydro power program is to lower the cost of equipment, increase its reliability and set up projects in areas which give the maximum advantage in terms of capacity utilization. Water Mill, Uttarakhand. And the estimated potential of about 20,000 MW of small hydro power projects exists in India. Ministry of New and Renewable Energy (MNRE) has created 6,474 potential sites with an aggregate capacity of 19,749.44 MW for projects up to 25 MW capacity and it created a database of potential sites of small hydro have been identified. [22]

CONCLUSION

If India Follow the ambitious Plan it has volunteered for, it can accomplish the dual goal of economic Development and green-energy Production. Which is certainly within a Capacity. India has the goal to install the 175 GW power sources of Renewable energy by year 2022. This includes 100GW of Solar power , 60 GW of Wind Power ,15GW of Biomass and the rest covered by Hydro Power.

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