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RE-Energizing Maharashtra: An Assessment of Renewable Energy Policies, Challenges and Opportunities

Report Prepared by

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AMC	Annual Maintenance Contract
APPC	Average Power Purchase Cost
BIS	Bureau of Indian Standard
BOT	Build, Operate and Transfer
BPL	Below Poverty Level
CAGR	Compound Annual Growth Rate
CERC	Central Electricity Regulatory Commission
CNG	Compressed Natural Gas
CPP	Captive Power Producer
CPSU	Central Public Sector Undertaking
DISCOMs	Distribution Companies
ETC	Evacuated Tube Collector
FPC	Flat Plate Collector
GBI	Generation Based Incentive
GDP	Gross Domestic Products
IISc	Indian Institute of Science
IPP	Independent Power Producer
ISTS	Inter State Transmission
JNNSM	Jawaharlal Nehru National Solar Mission
LPG	Liquefied Petroleum Gas
MEDA	Maharashtra Energy Development Agency
MERC	Maharashtra Electricity Regulatory Commission
MNRE	Ministry of New and Renewable Energy
MSEDCL	Maharashtra State Electricity Distribution Co. Ltd
NSSO	National Sample Survey Organisation
O&M	Operation and Maintenance
PLF	Plant Load Factor
PWD	Public Works Department
RE	Renewable Energy
REC	Renewable Energy Certificate
RGGVY	Rajiv Gandhi Gramin Vidyutikaran Yojana
R Infra	Reliance Infrastructure
RPO	Renewable Purchase Obligation
RVE	Rural Village Electrification
SHP	Small Hydro Projects
SPV	Solar Photovoltaic
SWH	Solar Water Heater
TN	Tamil Nadu
VAT	Value Added Tax
WRD	Water Resource Department
WTE	Waste to Energy

EXECUTIVE SUMMARY

Maharashtra has been one of the most industrialized and urbanized states in the country. However, data suggests that there is an ample scope for making these growth benefits more inclusive. This can be clearly seen from the fact that more than 45% of households (~52 million people) in the state are still using firewood and other biomass as a fuel for cooking energy needs. Although rural electricity penetration under the central Governments RGGVY programme is complete for Maharashtra, a significant number of rural households in particular continue to rely on kerosene and firewood for lighting and cooking respectively. Even electrified rural households face long hours of power cuts each day. Industries are also affected by constant scheduled and unscheduled power outages and are required to opt for captive power generation or cut down their production. Due to long power cuts, other businesses both in rural and urban areas of the state also rely on back-up generators which has resulted in significant amount of diesel consumption towards non-transport purposes. Renewable energy (RE) technologies offer immense opportunities to address power shortage, promote energy access, and improve energy security by reducing conventional fuel consumption in the state.RE can also significantly minimize the subsidy to agricultural consumers in the state as well as help meet the industrial/commercial and residential sector’s rising energy needs.

Small-scale biomass and solar plants are well-suited to serve rural households and agricultural pump set loads, while captive solar/biomass based plants can be an option to meet both electricity and heating/cooling needs of commercial/industrial consumers. An important application of decentralized renewable energy systems is to meet the total energy needs of the scattered and dispersed rural population. It has been observed that due to various reasons, including an inadequate transmission and distribution network, large grid-connected projects (based on conventional or renewable energy) are typically not suited to scattered, remote un-electrified settlements. Here up scaling renewable energy-based micro grids can be an appropriate solution. In this context, the main objective of this study is to critically examine the state’s renewable energy landscape to find gaps, barriers and implementation challenges specific to Maharashtra.

Currently Maharashtra is one of the leading states with RE installations. Maharashtra declared a policy for power generation from non-conventional sources of energy in Dec 2008. The state also has set targets for capacity installation for four different renewable based power generation options (i.e. wind, biomass, bagasse based cogeneration and SHP). However it does not have any provisions for the development of critical renewable energy resources such as solar and waste-to-energy. The policy is also largely restricted to the development of power generation and not energy which has a wider range of applications including thermal, mechanical etc.as a whole. Keeping this in view, it is critical that Maharashtra should implement a comprehensive renewable energy policy with a focus on promoting large scale solar projects (including grid connected rooftop and off grid projects) in both urban and rural areas of the state.

In this study, we reviewed the major barriers, issues and gaps facing accelerated deployment of appropriate renewable technologies through literature review as well as interactions with key stakeholders across this sector. Those stakeholders included project developers, representatives from the State Electricity Regulatory Commission, the State Nodal Agency, and other government agencies, etc. The primary audiences of this study are the state legislators and policymakers. Various issues and barriers identified (technology wise) in the study are summarized in the following table:

Technologies	**Issues**
Wind Energy	Technical: Un-availability of high resolution wind potential maps at kW scale as well as at above 80m height for MW scale plants is a major issue. Grid evacuation arrangement is also not conducive for adding more capacity. Integration of the energy generated depends upon the forecasting mechanisms by the wind developers, in absence of which load dispatch center faces major hurdles in maintaining grid stability. Financial: Promotion of generation based incentives coupled with competitive bidding can minimize the tariff impact on the consumers and attract more investment which in turn will spur further growth of sector. Regulatory/Administrative: Delays in clearances such as land clearances become major hurdles in planned project timelines.
Solar PV	Maharashtra receives good solar radiation however; the growth of the sector has been sluggish compared to other states like Gujarat and Rajasthan. Technical: Lack of high resolution solar resource maps availability is a challenge for developers and investors in planning targeted development of sector. There are no clear guidelines on standardization & quality control of solar PV panels system. Policy/Regulatory: Almost all of the states with good solar radiation availability have a dedicated Solar Policy which clearly mentions targets and roadmaps for sectoral development along with incentives and administrative facilitation by the state. In absence of such a policy, the solar sector in Maharashtra could not get the clear state support. Dedicated Independent Power Producers also suffer from unavailability of grid evacuation mechanisms along with rooftop producers who face hurdles in the absence of a clear net-metering policy. Developers also face bad governance practices in availing subsidies and required clearances.
Solar Thermal	Solar thermal technologies have advantage of shifting the electricity and energy load demand pattern if substituted for thermal applications such as industrial heat and domestic heating applications. However, in absence of complete substitution of conventional fuels, the technology has to compete with the conventional subsidized fuels. As a result, from industrial (end user) point of view, the payback period for solar thermal solutions seems to be significantly higher. Further, in the absence of recognized standards, quality control and technology awareness, it becomes difficult for the sector to grow.
Waste to Energy Technologies	These technologies have the additional advantage of waste disposal still it is one of the most underdeveloped energy options in the state. There is a clear absence of successful case studies, both at state and national level. Unorganized nature of fuel supply chain along with variation in the quality and quantity of waste and lack of financing poses a serious challenge for development of the technology.
Biomass and Cogeneration Technologies	The current installed power generation capacity in the state, except for cogeneration projects where supply chain linkage is organized, is suffering heavily from the fuel supply chain instability (with quantity & quality of fuel and biomass prices). Achieving continuous fuel supply of desired quantity at desired prices depends upon the social engineering efforts taken by the developer/investor, in absence of which, low plant load factor hampers the financial viability of power plants

Recommendations: The following section provides a summary of the main recommendations.

Comprehensive State RE Policy:

A new comprehensive renewable energy policy which can promote integrated development of all feasible resources in the state for both electric and non-electric applications is urgently required.

The following points should be taken in consideration while formulation of the new comprehensive RE policy:

- There should be clear roadmap and targets for development of RE technologies based on the overall resource potential.
- The policy must focus on bottleneck areas like net metering for solar rooftop, grid evacuation, ensuring RPO compliance, developing a solution for better forecasting of renewable energy generation such as wind.
- The policy should also address the issue of land acquisition and availing multiple clearances.

State Cooking Energy Mission:

Despite being an industrialized state, over 78% of rural households in Maharashtra use firewood as principle cooking fuel. In that context a dedicated State Cooking Energy Mission is required. The following measures should be taken while strategizing the mission:

- Focus should be given on accelerating the use of modern sources of energy including sustainable and clean cooking system backed by fuel supply chain.
- The mission should clearly strategize the innovative business model/plan, financial mechanism and standardization of technologies to promote adoption and investment.

Rural Electricity Service through RE micro-grids:

Although the state has achieved a complete electrification status as per the RGGVY scheme definition, the service quality of electricity (in terms of hours of supply, time of supply, voltage and current fluctuations etc.) is very poor. Establishing a network of RE based micro-grid can bring effectiveness in electricity service provision as well as provide entrepreneurship opportunities and socio-economic development at the local level.

State level Action Plan: At the moment, no state-level plan currently exists to promote RE deployment for rural electrification. In order to deploy more RE in rural areas, the state Government must implement a state-level action plan which has a target-driven approach for un-electrified rural households which are not covered under the central scheme of RGGVY.

Improved Financial Support: At present lack of supportive low-cost finance in a major barrier for off-grid rural RE projects. The State Government should offer more financial support for rural electrification projects which may also be channelized through rural regional/cooperative banks in the form of low interest loans.

Grid Infrastructure & RE integration

Adequate network augmentation is required in absence of which future RE capacity addition in the state could lead to local-grid saturation in RE rich areas and to grid congestion between power generation and load centers. Developing a solution for better forecasting of renewable systems, such as wind and solar is critical from load management and needs urgent attention.

Capacity Building and O & M Network:

Developers are facing the problem of lack of skilled human resource for implementation of RE projects as well as for O&M. The following measures should be adopted to improve the capacity building and O&M network:

- Industrial Training Institutes in the state must run RE related courses and training programs in curriculum and those should be linked to employment in industries.
- Current network of Akshay Urja shops can further be strengthened to improve O&M.

Standardization and Quality Control:

To address the lack of quality control protocols and product standardization, appropriate technical standards can be decided by MEDA in collaboration with BIS to improve the quality across all RE related systems and components in the state.

Single Window Clearance Mechanism:

It is very difficult for the large scale project developers to get the required permits and clearances in a time bound manner. No investor grievance redressal mechanism exists for the stalled clearances either which leads to delay in project implementation. The following measures should be adopted to avoid such delays:

- A single window clearance mechanism as well as subsidy availing facility for all of the renewable energy options must be established. MEDA has a critical role to play in the facilitations of different clearances required for such projects.
- Establish an appropriate mechanism for investor grievance redressal.
- The clearance processes should have time bound deadlines.
- Land acquisition process should be streamlined for speeding up utility scale RE projects.

Legislators as energy champions:

Maharashtra MPs and MLAs can implement various small scale RE projects in their constituencies (both urban and rural areas) through active utilization of MP and MLA LAD funds. Besides, they can also demonstrate suitable examples in provision of lighting, cooking, water and other services through renewable energy in line with the recent initiatives like the Sansad Adarsh Gram Yojana (SAGY) and other national and state level schemes. The success of such renewable energy led integrated community projects will help with scaling up efforts throughout the rural districts and eventually across the state.

CHAPTER 1: CONTEXT

Maharashtra is one of the leading industrialized states in the country. It is also one of the most urbanized and populated states in the country. Maharashtra's economy is growing at a faster pace and so its energy needs are continuously increasing. It contributes around 15% of the country's GDP. State's GDP has also been growing at a rate of 14.5%with highest contribution coming from industrial and services sector. Data suggests that there is an ample scope to make economic growth in the state more inclusive with provision of access to basic services for each household of the state. At present, there are some major disparities in the key indicators in the state, for e.g. there is a big gap in the electricity consumption across the state as the per capita electricity consumption of the state as a whole is 780 kWh whereas in rural districts like Nandurbar the per capita consumption is only 92kWh [1]. As per 2011 census, in Maharashtra, around 12.4 million households are in urban and around 9.7 million in the rural areas [2]. To sustain the rapid growth of such a large population, a provision for reliable and affordable energy services is extremely important. While electricity is the most versatile form of energy, end uses for transportation and thermal requirements such as cooking energy, domestic water heating, and industrial heating requirements, also constitute a major share of the total energy demand. The state's electricity consumption is directly proportional to its GDP growth. Although the current energy scenario of the state is relatively better as compared to many other states in the country, the ever growing demand for energy along with the urgent need to improve energy access while balancing the socio-economic development and overall environmental impacts is a challenge for the state. In this context, increased utilization of renewable energy resources for both electrical and non-electrical applications across all sectors in the state is extremely critical.

1.1 STATE ELECTRICITY SCENARIO

Maharashtra has four electricity distribution utilities: the unbundled state utility, Maharashtra State Electricity Distribution Co. Ltd. (MSEDCL) and three private utilities *viz.* Tata Power, BEST and Reliance Infrastructure. Except for MSEDCL, other utilities have their presence only in and around Mumbai and its suburbs. The total electricity requirement for the year 2012-13 was 123984 MUs [3]. From year 2007-08 to year 2012-13, the electricity consumption in the state has grown at a CAGR of 7.7%. The share of different sectors in the overall electricity

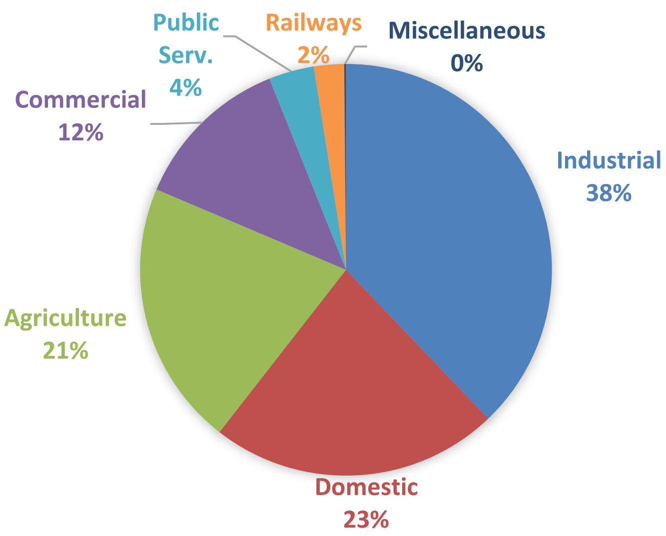


Figure 1: Sectoral Consumption of Electrical Energy in Maharashtra for FY 2012-13

Source: [2]

consumption for the year 2012-13 is shown in Figure 1. As seen in Figure 1, more than one third of the power demand in the state comes from the industrial sector, followed by the domestic and agriculture sector. Agriculture sector demand comes mostly from the large number of irrigation pumps. The CAGR of consumption from the different sectors has been growing over the period 2006 to 2013as mentioned in Table 1.

Table 1: Sectoral Growth of Electricity Consumption

Source: [2]

Sector	Growth
Industrial	6%
Domestic	8%
Agriculture	14%
Commercial	11%
Railways	3%
Public Services	8%

Out of the total electricity sales in the state, almost 20% of the electricity is sold through the three private utilities which cater to Mumbai city and its suburbs. The electricity demand in the state peaks typically during 9 am to 12 noon in the morning hours and during 6 pm to 10 pm in the evening [4]. During the peak hours, a power deficit of around 4,652 MW was experienced by the state during the year 2011-12 [5, 6]. This demand was satisfied with a wide portfolio of supply fuel options employed by the state. Historical growth pattern of peak electricity demand of the state against the total electricity supply can be seen in Figure 2. The total installed capacity in the state as on June 2014, including the central sector allotted share as well as privately owned capacities is around 35,167 MW [7].

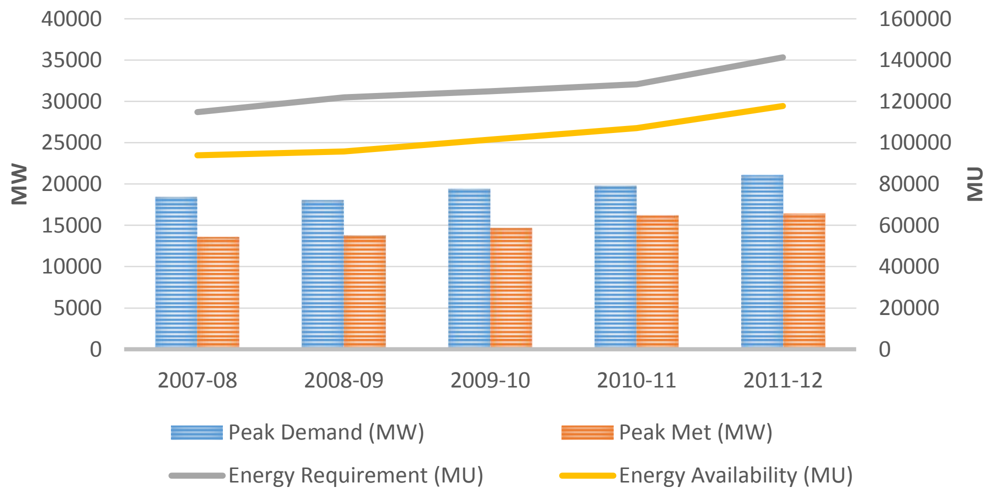


Figure 2: State Electricity Supply-Demand Situation in Maharashtra

Source: [6]

The existing share of various conventional and renewable electrical energy alternatives in the total energy mix of the state is shown in Figure 3. The existing installed capacity of renewable based power generation in the state is around 17% of the total installed capacity.

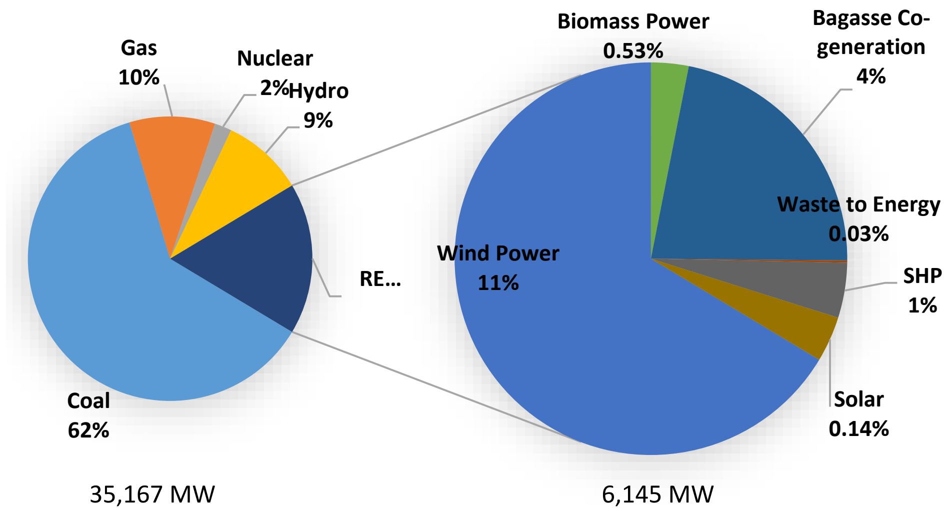


Figure 3: Share of Different Energy Sources in Installed Capacity (as on June 2014)
Source: [8]

The choice of fuel for power generation in the state energy mix largely depends upon various commercial aspects such as capital cost, gestation period, and levelized cost of electricity over life time as well as local socioeconomic impact of the power plant such as rehabilitation, land and water requirement aspects. Among various fuel alternatives, coal based power generation share is most significant with almost 60% of the total installed capacity [9]. There are 3 major coal based power plants located in the 3districts of the state *viz*. Nagpur, Chandrapur and Beed. Due to local coal availability, these districts have become the hub for Maharashtra's coal power plants. There are 4 large hydroelectric projects i.e. Koyna, Vaitarna, Bhira and Ghatghar, contributing 5.6% of installed power capacity and2 natural gas based power plants located on the coastal area of Dabhol and Uran. Other than these, there are also central sector allocated projects in the state, contributing around 5,076 MW. Most of the renewable electricity options such as biomass, co-generation, and small hydro and solar PV have been explored very recently. Although the share of renewable energy installed in the state is moderate (~17%), state owned installed capacity is only about 6% [7]. This is mainly due to the higher capital requirement, and intrinsic variability and uncertainty associated with these sources. For example, wind based electricity usually come online during base load periods with achieving maximum yields in monsoon which might not find required demand.

1.2 ACCESSTO ELECTRICITY IN THE STATE

Through the Rajiv Gandhi Gramin Vidyutikaran Yojana (RGGVY), a central government sponsored scheme to electrify villages across the country, whole of Maharashtra state has achieved complete household electrification over the last decade in accordance with the definition of village electrification. The progress of RGGVY electrification as on 15/10/2013 in the state can be seen in Figure 4.

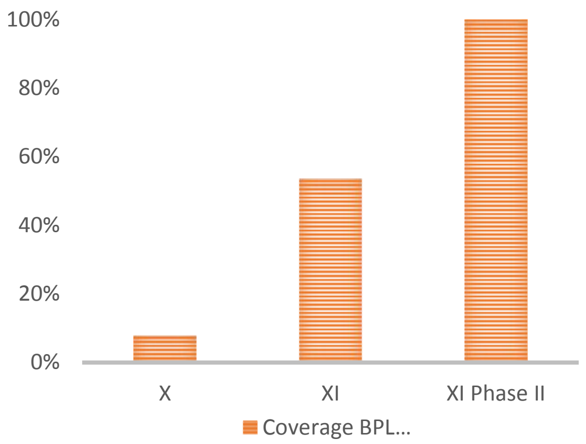


Figure 4: RGGVY Progress in Maharashtra

However the definition of electrified village as per the new scheme is limited only to the reach of infrastructure up-to the last mile and neither guarantees access to electricity nor electricity as a service required as a livelihood generation tool. The current definition of village electrification is as follows:

"A village would be declared as electrified if:

1) *Basic infrastructures such as distribution transformer and distribution lines are provided in the inhabited locality as well as the dalit-basti/ hamlet where it exists. (With a provision that, for electrification through Non-Conventional Energy Sources a distribution transformer may not be necessary),*

2) Electricity is provided to public places like schools, panchayat offices, health-centers, dispensaries, community centers etc. and,

3) The number of households electrified should be at least 10% of the total number of households in the village."

Though RGGVY covers villages and habitations with population of above 100, it has helped to reach remote villages and hamlets in the state. As per the scheme the areas where conventional grid extension is not feasible or economic, RE based Decentralized Distributed Generation systems would be utilized. The funding is on same pattern of 90% subsidy from Government of India and 10% loan from Renewable Energy Corporation (REC) or from own funds of the State. 90% capital subsidy also includes cost of operation for 5 years. Electrification of these hamlets by RE technologies is being covered by Maharashtra Energy Development Agency (MEDA), the State Nodal Agency (SNA) for renewable energy. In the last five year plan i.e. 2007-12, around 1.2 million BPL households have been electrified in the state. This large level of electrification is also evident from the census data on households using electricity as a source of lighting, as depicted in Figure 5.

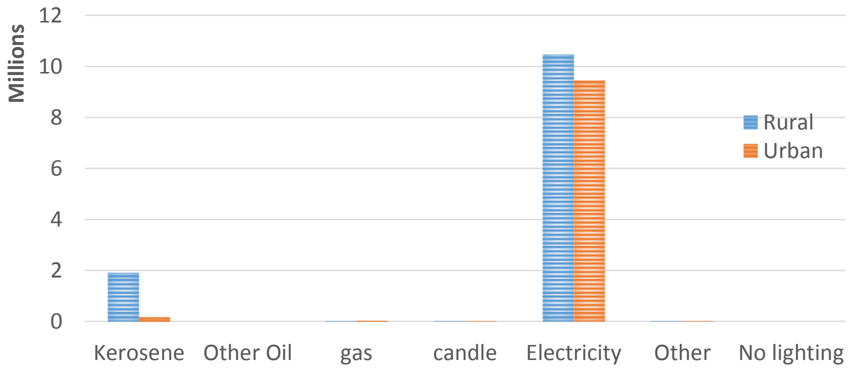


Figure 5: Reported Fuels Used for Lighting

Source: [10]

As per the latest NSSO census round, around 2.08 million households are using kerosene for lighting purpose, out of which 92% are in the rural areas. The district wise use of various fuel sources for lighting purpose is shown in Figure 6.

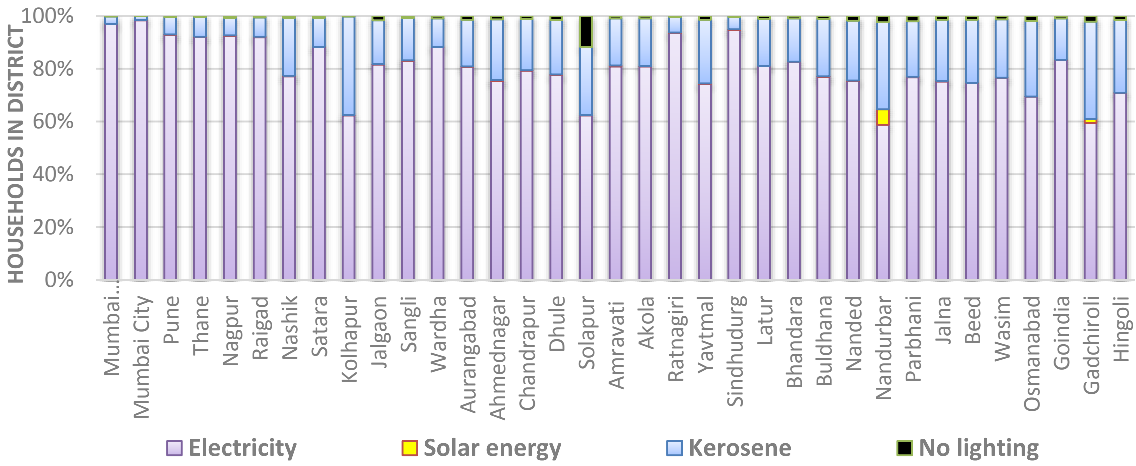
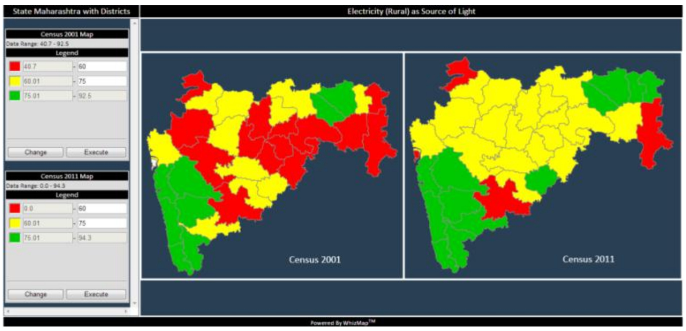


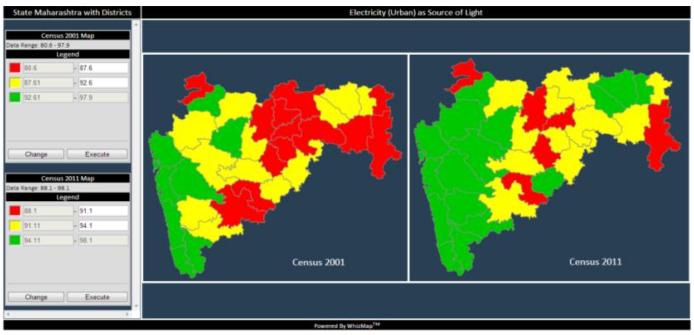
Figure 6: District-wise Use of Various Fuels for Lighting in Maharashtra
Source: [2]

It is clearly seen from Figure 6 that in all districts electricity is the principle source for lighting purpose. This is mainly attributed to the wider implementation of RGGVY. The penetration of electricity as lighting source in rural area has significantly improved in the last decade. Except a few districts; more than 60% of rural households use electricity as lighting energy source. Where as in urban areas, more than 80% of the households use electricity as lighting energy source, as shown in Figure 8.



Color	Percentage of households
Red	0-40%
Yellow	60-75%
Green	75% & above

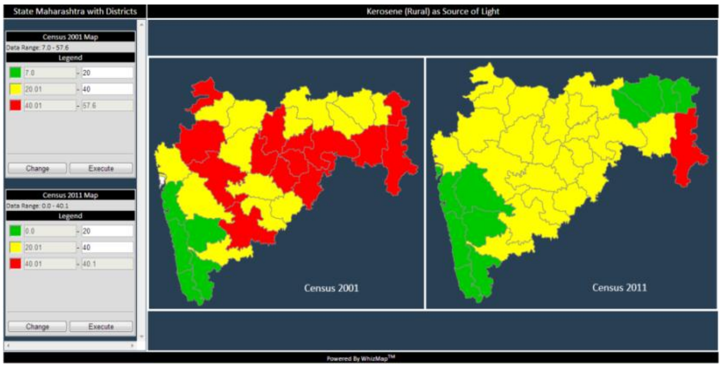
Figure 7: Spatial Mapping of Change in Electricity as Lighting Fuel over a Decade (Rural Maharashtra)
Source: [11]



Color	Percentage of households
Red	80-90%
Yellow	90-94%
Green	94% & above

Figure 8: Spatial Mapping of Change in Electricity as Lighting Fuel over a Decade (Urban Maharashtra)
Source: [11]

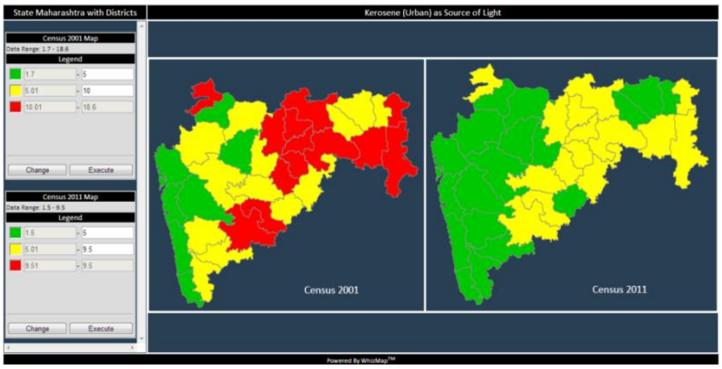
Use of kerosene for lighting purpose has drastically decreased over the last decade in both rural as well as urban area, as shown in the Figures 9 & 10.



Color	Percentage of households
	40% & above
	20-40%
	0-20%

Figure 9: Spatial Mapping of Change in Kerosene as Lighting Fuel over a Decade (Rural Maharashtra)

Source: [11]



Color	Percentage of households
	9% & above
	5-10%
	0-5%

Figure 10: Spatial Mapping of Change in Kerosene as Lighting Fuel over a Decade (Urban Maharashtra)

Source: [11]

1.3 COOKING ENERGY

In rural Maharashtra like many other rural areas in the country, the major energy need is for cooking, which is primarily met by using traditional sources of energy like biomass. During 2009-10 in rural Maharashtra, firewood and wood chips were used as a principle source of energy for cooking by more than three quarters (78%) of households, LPG by 17%, and kerosene by 1.6% [10]. About 2% of households did not have any arrangement for cooking during that period [10]. The remaining households used other sources, including biogas (0.7%) and dung cake (0.1%). On the other hand, in urban areas, LPG was used by 73% of the households, firewood & chips by 8.5% and kerosene by 10% households respectively. As many as 6.5% of the urban households did not have any cooking arrangement. Figure 11 shows that spread in absolute numbers.

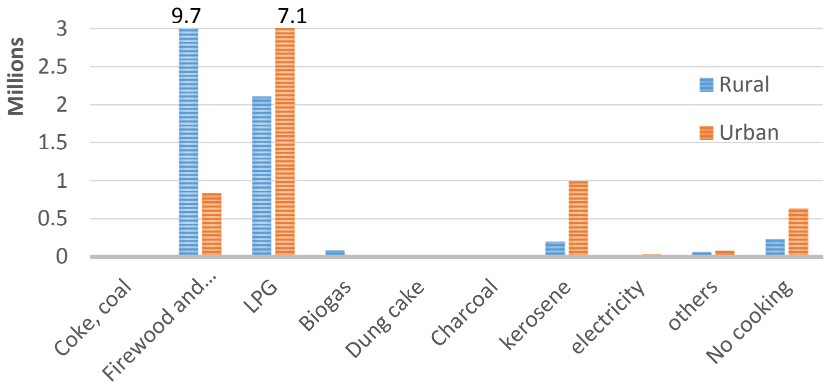


Figure 11 Cooking Fuels Used in Rural and Urban Areas of Maharashtra

Source: [10]

The percentage of households depending on firewood and chips for cooking exceeds 50% in almost all districts in the state except the most industrialized district i.e. Mumbai, Pune, Thane, Raigad and Nagpur [2]. In all industrialized districts of Maharashtra, 56-80% of households used LPG as principle fuel for cooking as illustrated in figure 12

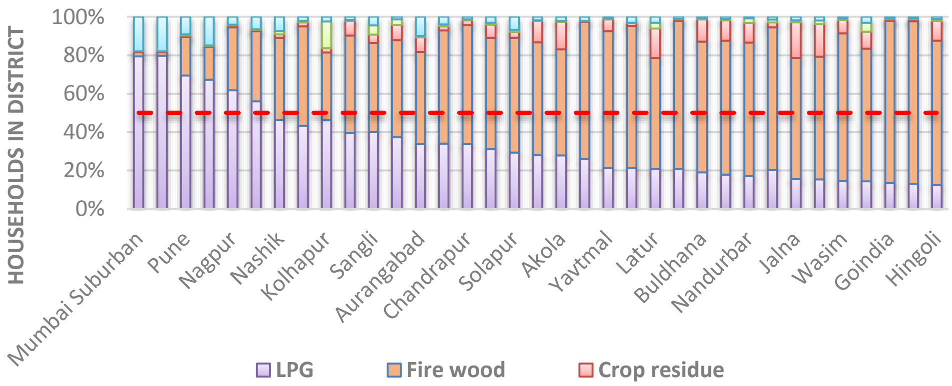
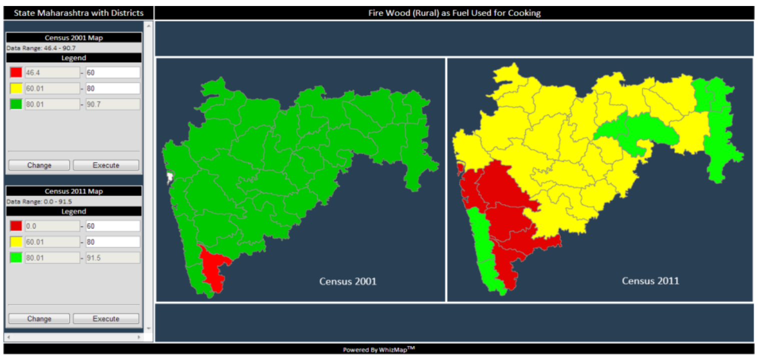


Figure 12: District Wise Use of Various Fuels for Cooking in Maharashtra

Source: [1]

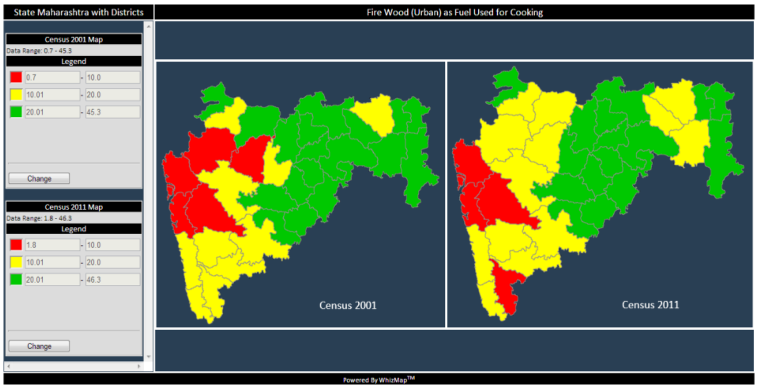
The dependence of rural households on firewood and other biomass for cooking purpose drastically decreased over the last decade, as shown in Figure 13. This is mainly due to increased penetration of LPG. Same pattern can be seen in urban areas as shown in Figure 14.



Color	Percentage of households
	0-60%
	60-80%
	80% & above

Figure 13: Spatial Mapping of Change in Firewood as Cooking Fuel over a Decade (Rural Maharashtra)

Source: [11]

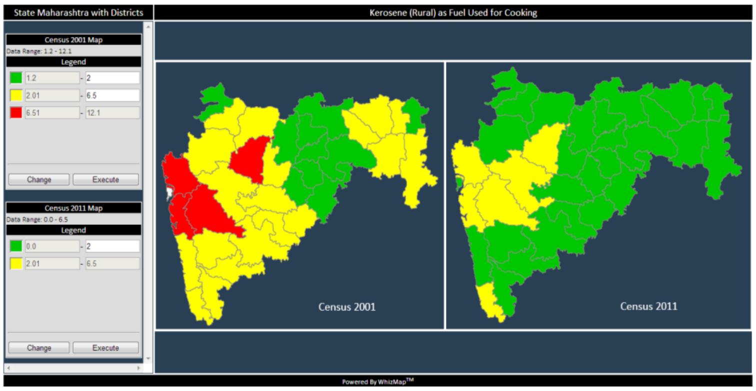


Color	Percentage of households
	0-60%
	60-80%
	80% & above

Figure 14: Spatial Mapping of Change in Firewood as Cooking Fuel over a Decade (Urban Maharashtra)

Source: [11]

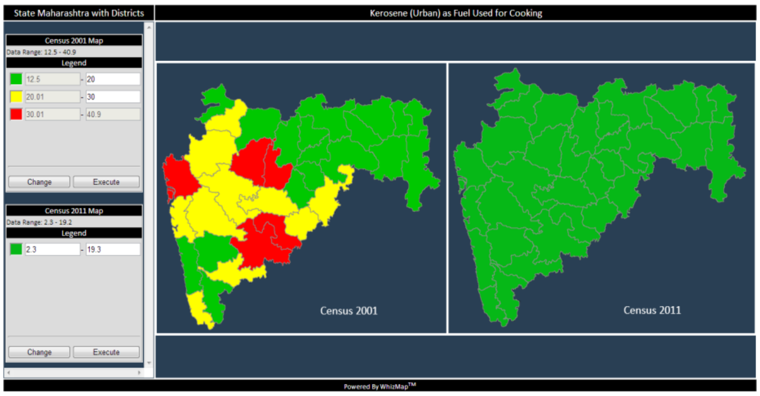
From Figure 15, it is clearly seen that the use of kerosene for cooking purpose in rural area which ranged from 0-12% in 2001, has decreased to 0-6% in 2011; where as in urban area it decreased from 0-40% in 2001 to 0-20% in 2011 as shown in Figure 16. This lesser use of kerosene in rural area compared to urban is attributed to the use of firewood.



Color	Percentage of households
	12% & above
	2-6%
	0-2%

Figure 15: Spatial Mapping of Change in Kerosene as Cooking Fuel over a decade (Rural Maharashtra)

Source: [11]

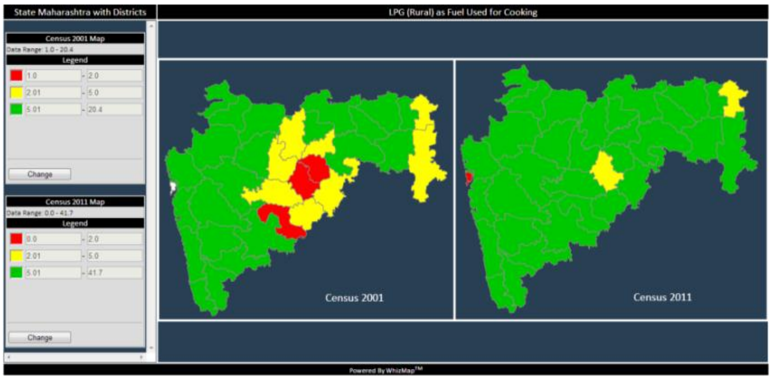


Color	Percentage of households
	30% & above
	20-30%
	0-20%

Figure 16: Spatial Mapping of Change in Kerosene as Cooking Fuel over a decade (Urban Maharashtra)

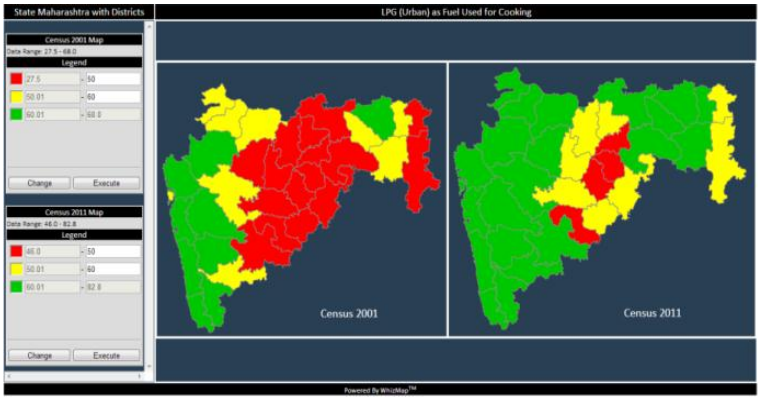
Source: [11]

The successful penetration of LPG for cooking purpose in both rural as well as urban area can be seen in Figures 17 & 18, respectively.



Color	Percentage of households
(red)	0-2%
(yellow)	2-5%
(green)	5% & above

Figure 17: Spatial Mapping of Change in LPG as Cooking Fuel over a decade (Rural Maharashtra)
Source: [11]



Color	Percentage of households
(red)	0-50%
(yellow)	50-60%
(green)	60% & above

Figure 18: Spatial Mapping of Change in LPG as Cooking Fuel over a decade (Urban Maharashtra)
Source: [11]

1.4 NEED FOR RENEWABLE ENERGY

Although Maharashtra is one of the most urbanized states there is an ample scope for urban services quality improvement and delivery to people. This increase in urbanized life style will need much more energy in the near future. Also there is also need for a quick midterm solution to satisfy energy needs of rural areas where there is a lack of access to clean, reliable and affordable energy services. Renewable energy alternatives have potential to satisfy both the challenges of inclusive and low carbon growth. To summarize, there is an urgent need to equally push all possible forms of renewable energy technologies as solutions. Although almost all of the villages have been electrified in the state, condition of electricity supply has ample scope to improve in terms of quality, reliability and quantity. There is a wide disparity in electricity consumption in urban districts like Mumbai, Thane, Raigad, versus the rural districts like Nandurbar, and Gadchiroli. Even with lifeline consumption provided to the poor, the ability to pay for the electricity restricts them from quickly benefitting from the access. Typically poor consumer from rural areas can't sustain paying for electricity for a duration in which they can see its return in terms of both change in livelihood and better life style. One of the major livelihood use for electricity is using electricity for irrigation. However the average load shedding for rural areas in case of irrigation feeders is around 8 hours. There are around 4 million pump sets in the state which are energized as on 31st May 2014[12]. With poor quality of electricity supply, a vicious circle is formed between the farmer who is unwilling to pay for the poor supply and the utility for which there is no incentive to upgrade the service quality (which includes hardware infrastructure) and provide electricity at very low to negligible commercial profit. In presence of such poor supply quality, farmers adopt diesel pump sets, which can be very inefficient as compared to the electric motors, resulting not only in huge increment in input cost for farmers but also increased carbon footprint of the agriculture sector. RE options such as solar/wind pumps can easily help to solve this twin problem. With solar pumps, the time of irrigation requirement typically matches with average sunshine hours unlike current supply during night hours. RE applications such as solar water heater for domestic purposes, specifically in the urban areas, can similarly help in reduction of peak load during the morning hours. Shifting to RE at a large power generation scale however have many dimensions such as maturity of technology, life cycle cost etc. on which its penetration depends however with current financial situation of state utilities across the country, it is difficult to imagine such uptake. In case of Maharashtra, the state utility, MSEDCL requires huge amount of direct as well as cross subsidy, for subsidizing power to domestic as well as agriculture consumers. This clearly creates a financial disincentive to procure high cost electricity from renewable options on a large scale. With high purchasing power cost, the subsidy burden on the state distribution utility will increase. Also with options such as open access gaining momentum, there is a risk of losing consumers such as commercial and industrial consumers, which cross subsidizes the domestic and agriculture consumption. Hence it also will have to keep the electricity service for these consumers at the best level it can with increasing urbanization and industrialization. With more and more shift to captive power generation or thermal generation, there is also a risk of reduction in load of high paying consumers such as commercial establishments and industry. It is also possible that some of these consumers might find investing in RE electricity more financially viable than state utility. Thus on one hand, there is a huge scope and need for better service e.g. agricultural pumping, cooking energy, domestic water heating where renewable options can be appropriately promoted; while on the other hand, there are mainstream grid connected electric options for which there is a need for creating innovative financial incentives for uptake of RE without substantial increase in subsidy burden. Hence, a careful dissemination of various RE technologies to suit the needs of different end users through innovative business models are required which will result in lowest tariff impact on the consumers. This is clearly a challenge and at the same time a great opportunity for the Government to address the issues associated with access to reliable, quality and affordable electricity.

1.5 PURPOSE AND SCOPE OF STUDY

The purpose of the study is to present a detailed overview of the status of renewable energy in Maharashtra and to identify the key barriers and challenges to the growth of RE in the state. The study has been carried through analysis of secondary sources of information and engagement with key experts and stakeholders representing industry, Government, research and policy think tanks etc. to get their views and recommendations. The present study does not include the transport energy scenario of the state and the potential renewable options in the sector such as electric vehicles, non-motorized transport, water transport etc. However, we feel that such study is equally needed in the wake of huge fuel import burden on the state. In the following two chapters, first we will present the landscape of renewable energy options for electrical as well as thermal energy needs, followed by policy environment of the state indicating the key issues, barriers and gaps. The final chapter will present a set of recommendations and a set of actions which can upscale renewable energy development in the state.

The overall supply of energy from renewable energy sources can be divided into various categories based on the end use demand and scale of energy generation *e.g.* 1) Non electric/direct thermal energy supply for applications such as cooking and water heating, 2) Grid connected electricity supply at MW scale of operation with the merit of scale of economy and, 3) Off-grid or standalone systems of electricity supply for applications such as irrigation and street lighting.

The estimated potential and achievement of grid connected renewable energy systems in the state are shown in Table 2. So far the growth in Maharashtra has been largely limited to harnessing of few renewable energy sources like wind energy and bagasse cogeneration. Section 2.2 explains the grid connected RE segment in the state in more detail.

Table 2: Grid Connected Renewable Energy: Estimated Potential and Achievement up to 2014

Source: [9]

RE Technology	Potential	Achievement
Wind	5,439[1] MW	4,079.6 MW
Waste to energy	287 MW	11.7 MW
Bagasse cogeneration	1,250 MW	1,362.7 MW
Biomass Power	1,887 MW	182 MW
Small Hydro Power	733 MW	278.6 MW
Solar PV	4-7 kWh/m^2/day	230.25 MW

2.1 NON-ELECTRIC/DIRECT THERMAL ENERGY SUPPLY

Cooking energy: As seen in the previous chapter, there is an urgent need to provide access to modern services for cooking and other thermal energy demand in the state. The LPG penetration in most of the districts in the state is very poor as only around 42% households (9.2 million) use LPG as a cooking fuel. Of these, about 7 million households are from urban areas (73% of total urban households), and 2.2 million households are from rural area (17% of total rural households). Except Mumbai and its suburban areas, only three districts have more than 50% of household level penetration of LPG (also see figure 19). The numbers of rural households which depend primarily on LPG for cooking are largely from the higher income group as biomass remains the primary energy source for the vast majority of the rural households. The rising price of LPG and the fact that firewood is an unregulated fuel is pushing more small businesses largely in rural areas but also partially in some urban areas to move towards use of firewood as the preferred heat source. Renewable based alternatives to LPG are biogas, improved biomass cook-stoves, solar cookers and concentrated solar thermal units.

Biogas is a clean fuel and works as an advanced and convenient means in rural areas especially where LPG supply can be challenging. Biogas plants installation also helps significantly in employment generation.

[1]Potential is estimated with an assumption of 80m Height for Hub of Wind Turbine.

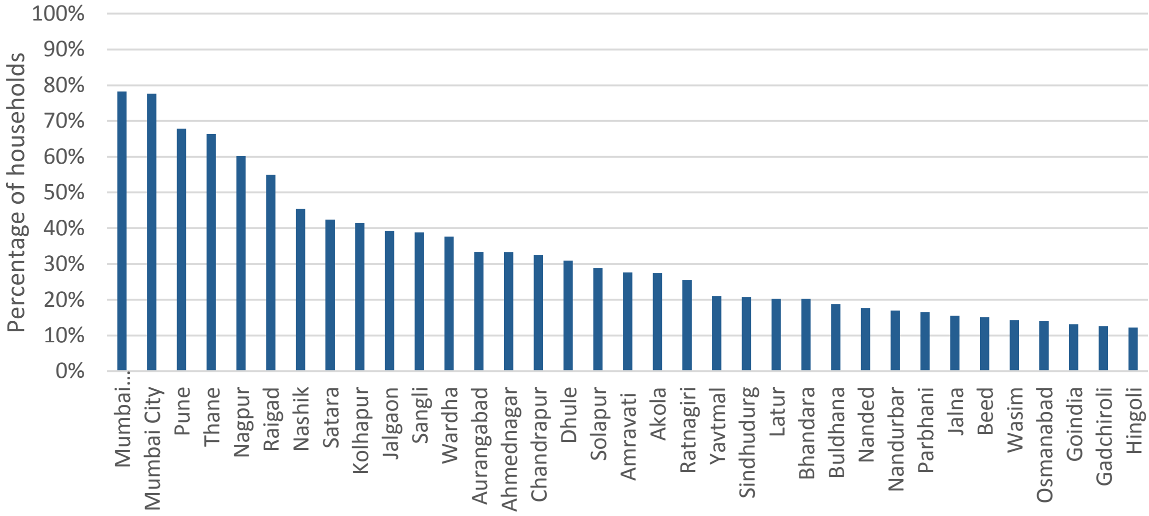


Figure 19: District-wise LPG Penetration in Various Districts of Maharashtra

Source: [2]

Although Maharashtra has largest number (824,000) of biogas units installed in the country, it covers only 3.6% of total households of the state [8]. On the other hand, it is also reported that only 158,706 households are using biogas as a fuel source for cooking, which is only 0.67% of total households [10]. This shows that as high as 80% of biogas unit installed in the state may not be operational/ functional. This also explains why a large number of households continue to use firewood and other biomass based solutions for cooking energy even when around 15,000 biogas units are added each year. Figure 20 illustrates the existing biogas scenario in the state.

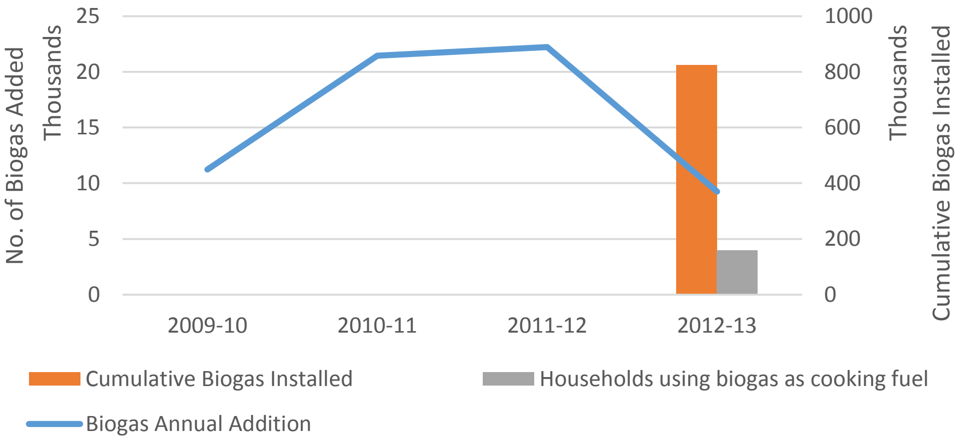


Figure 20: Household Biogas Scenario in Maharashtra

For biogas systems, National Biogas and Manure Management Programme (NBMMP), a central government scheme, has yearly targets for biogas units installation for each state. Under this program, Maharashtra state has a target of 13,700 biogas units to be added per year. Although out of all the renewable energy based alternatives, piped biogas is one of the cleanest solutions, it requires a high operation and maintenance from the end user side. Other clean option for non-LPG based cooking is use of solar cookers or improved biomass cook-stoves. There are various models of improved cook stoves which have had limited success in the state. Even the national program for improved cook-stoves is acknowledged to have a limited success. Although solar cookers might not completely replace the existing cook-stoves in the villages due to limited hours of operation, they can significantly reduce the time and effort required to fetch the biomass. A steady number of solar cookers are being added since 2008 to 2012 in the state under the MNRE scheme.

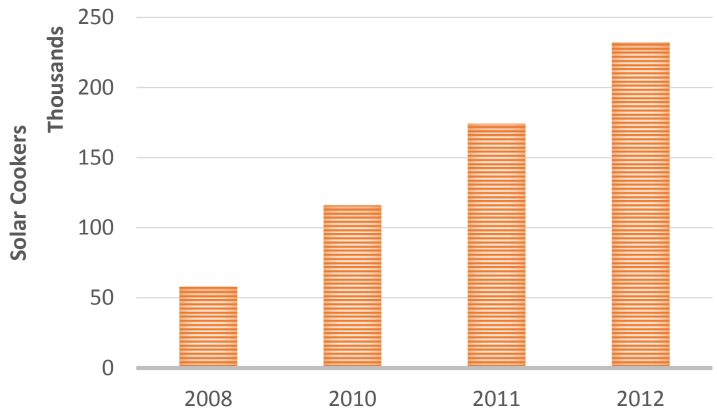


Figure 21: Annual Solar Cooker Addition in Maharashtra

Source: [8]

In order to promote the adoption of these technologies, there is a capital subsidy for various solar collector and concentrator systems from MNRE which includes direct heating solar collector systems, dish solar cookers and concentrators. Another important domestic thermal need is water heating. Typically gas or electric heaters are used for this application, other than biomass fuels. Solar water heaters come in two variations: 1) Flat Plate Collector (FPC) in which typically air is the medium of heat transfer without any concentration of solar energy along with direct sunlight and, 2) Evacuated Tube Collector (ETC) in which other fluid is used to transfer the heat to water in a concentric pipe which is insulated with vacuum.. The total numbers of solar water heaters installed during 2010-2014 (both FPC & ETC) are 103,785; of which around 18% are FPC types. In case of solar thermal systems/ devices, a capital subsidy is available through MNRE [13].Besides capital subsidy, soft loan at 5% for balance cost of system excluding beneficiary share of 20% is also available. Also for special category states, this subsidy is double, limited to 60% of project cost. In case of un-electrified rural areas, subsidy for solar thermal power plants is 60% of the project cost across the country.

2.2 GRID-CONNECTED RENEWABLE POWERGENERATION

Maharashtra has the second highest installed capacity of the renewable based power options, among all the states in India. The combined renewable power generation capacity of the four leading states in RE *viz*. Gujarat, Maharashtra, Tamil Nadu, and Karnataka, is almost 75% of the country’s total renewable power capacity. Each of these states has relied on the renewable resource which is abundantly available there, for e.g. Gujarat massively developed solar power whereas Tamil Nadu has developed its wind resource.

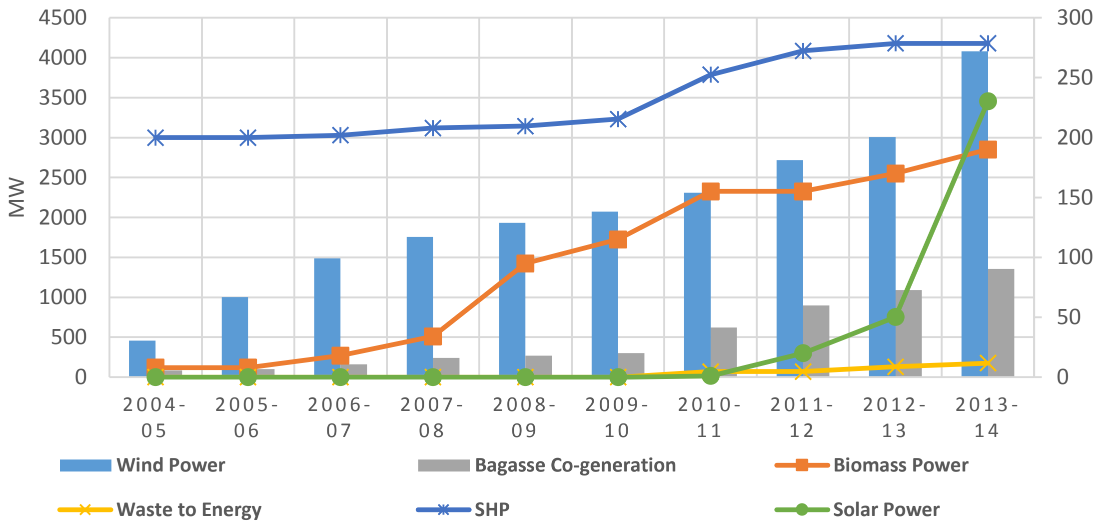


Figure 22: Renewable Power Capacity Addition in the State of Maharashtra
Source: [9]

Maharashtra has a large potential for wind and biomass followed by solar. The state has till now developed mainly two resources: wind and bagasse based cogeneration as shown in Figure 22 and Table 2.

Grid connected power development is shaped by both national as well as state policies which is discussed in later chapters. The role of Maharashtra Electricity Regulatory Commission (MERC) in setting tariffs for feeding generated renewable power to the grid has been also quite important. MERC decides the tariff for various technologies based on factors such as technology maturity and tariff impact on the consumers. Thus tariff impact on consumers can be a deciding factor in determining not just which technology to be promoted in the state but also which technology can be incentivized for its development.

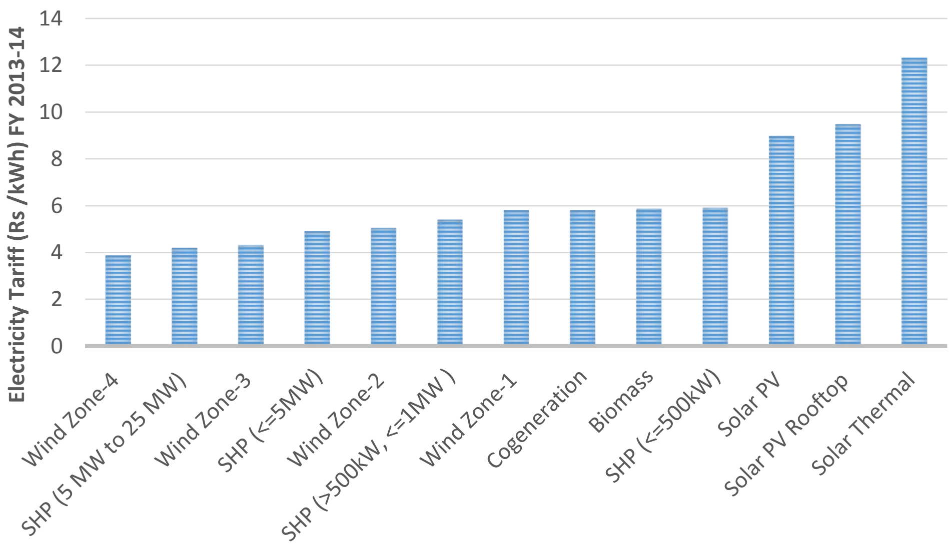


Figure 23: Electricity Tariff for Various RE Options in Maharashtra
Source: [9]

One of the major hurdles faced by most of the grid connected renewable energy technologies have been relatively higher tariff impact it can have on the consumer. At present the renewable energy tariffs allowed by the MERC, are much higher compared to tariffs charged to the domestic consumers. However, the tariff for commercial category consumer in the state is at parity with most of the renewable energy based options. Thus, it would be more appropriate to promote technologies in the consumer sectors such as in commercial establishment followed with industrial sector and finally for mass domestic consumers. Details of technology-wise tariffs in Maharashtra for the current scenario in the state are as shown in Figure 23. In the following sections, various grid connected RE technologies, schemes or incentive structures and their development against the estimated potential in the state are discussed.

2.2.1 Solar Photovoltaic (SPV) Power Generation

Solar energy based electricity can be generated through two technologies–Solar Photo-Voltaic (SPV) which uses the visible component of radiation spectra to convert it into electricity through photovoltaic effect in solar cells and Solar thermal which uses the infrared component of radiation spectrum to heat the fluid which can be further used to rotate turbines. Maharashtra is one of the few states in the country, which receives solar radiation equivalent to 5-5.5 kWh/m^2/day.

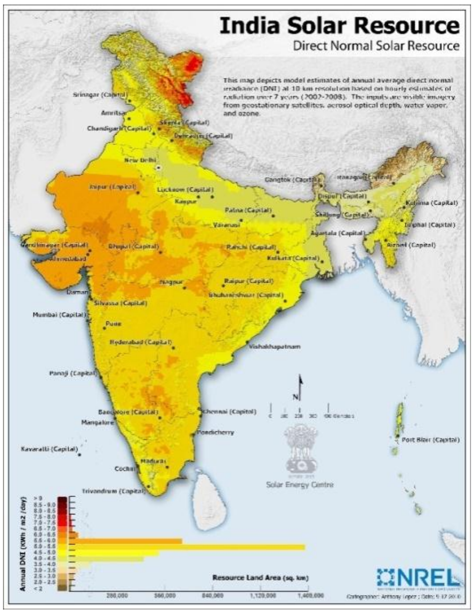


Figure 24: Solar Energy Potential Map of India

Source: [15]

Few districts such as Dhulia, Jalgaon and Nandurbar receive even higher radiation - almost 6 kWh/m^2/day. Actual SPV potential in the state based on other considerations such land availability is not yet estimated by many resource assessment studies. In a recent assessment conducted by the National Institute of Solar Energy (NISE) that factors in the waste land data, Maharashtra has a potential of over 64 GW for solar power generation. Such assessments and their accuracy have a direct impact on the project viability. Therefore that should to be carried out by the state nodal agencies in partnership with other organizations and the results must be shared with the developers to promote investment in the solar sector. In order to provide a conducive environment for solar energy technologies i.e. both SPV and thermal, Government of India has constituted Jawaharlal Nehru National Solar Mission (JNNSM), with set targets for three years 2013, 2017 and 2022. Under this mission, various tax exemptions, capital subsidies and incentives are available for several components and sub-components of solar energy value chain. JNNSM promotes the assembly of solar modules after import of cells which is free from import duty. Other incentives like Generation Based Incentives (GBI), Accelerated Depreciation (AD) (as high as 80%) and income tax benefits are provided. Overall, from a developer's point of view, there are three major routes for getting returns on investment which are possible under various schemes, policies and mechanisms:

i) The JNNSM route - incentives and schemes are available but the tariff is determined through a competitive bidding process.

ii) The Average Power Purchase Cost (APPC) and REC combination route in which tariff is negotiated between utility and developer with maximum tariff capped by average pooled power purchase in the state [14].

iii) The Feed-in-Tariff route in which the MERC determines the tariff for various renewable power projects, which is levelized tariff for a long period. Till now, total projects commissioned of grid interactive SPV in the state are of 230 MW capacities. This capacity addition got kick-started after the countrywide launch of JNNSM in 2010 (see Figure 25).

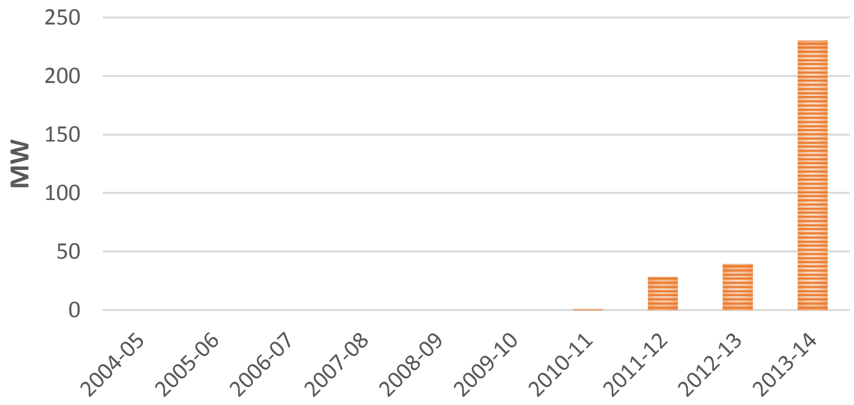


Figure 25: Progress of Solar PV Based Power Generation (Installed Capacity)
Source: [8][9]

However, most of the capacity addition in the state has so far developed through non-JNNSM route. Figure 26 shows the respective share of projects commissioned under various schemes.

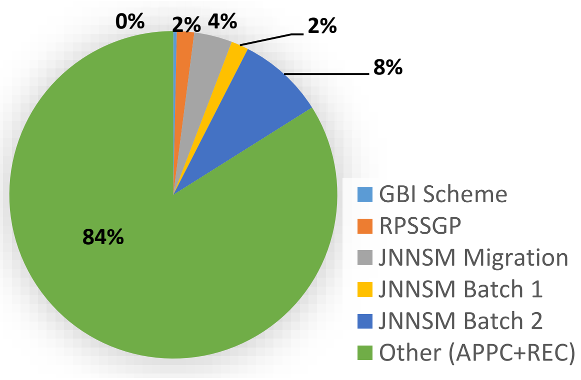


Figure 26: Share of Various Promotional Schemes in Development of Solar PV Projects
Source: [16]

Only 6 projects of 21 MW have been commissioned under JNNSM in the state, whereas 33 projects of around 200 MW have been commissioned without JNNSM route, specifically APPC and REC combination route.

2.2.2 Wind Based Power Generation

Wind turbines can be used as stand-alone applications independently or in combination with solar PV, or they can be connected to a utility power grid. For utility-scale development of wind energy, a large number of wind turbines are usually built close together to form a wind plant. The total in-land wind power generation potential is estimated to be around 5439 MW in Maharashtra. Although the off-shore wind generation potential can be much more than in-land, it is not yet estimated. Total installed capacity of wind power in Maharashtra upto 2013-14 is 4079 MW, which is 75% of the estimated potential[2].The annual capacity addition which has been sluggish post 2008-09 witnessed an accelerated growth during the last year (2013-14) as shown in Figure 27 [9].

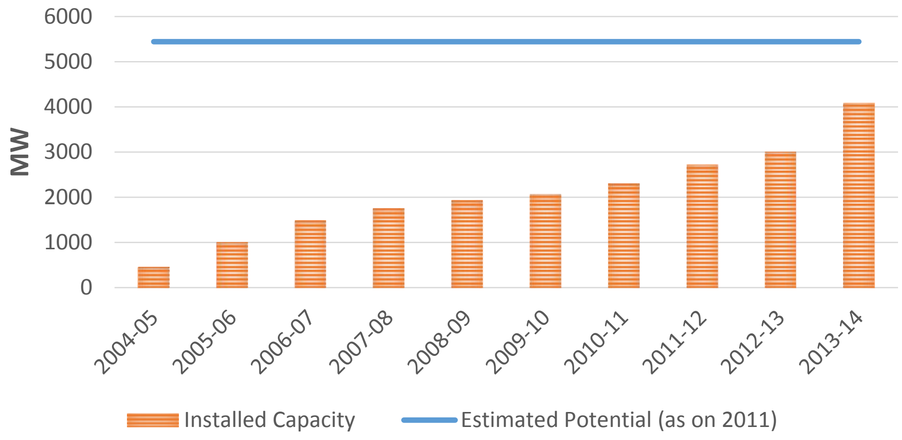


Figure 27: Wind Based Power Projects &Estimated Potential in Maharashtra
Source: [9]

2.2.3 Bioenergy for Power Generation

Bioenergy is derived from biomass through various conversion processes such as direct burning of biomass or conversion into liquid or gaseous fuels. Biomass power is the use of biomass for electricity generation. There are five major types of biomass power systems: burning of biomass or direct fired (biomass as primary fuel), co-firing (biomass as partial substitution of primary fuel), gasification (partial combustion), anaerobic digestion (through bacterial organisms), and pyrolysis (distilling organic matter without air supply). Most of the biomass based grid connected power plants at MW scale use direct-fired system to generate steam required to run the turbine. Many coal fired power or heat generation units can use co-firing systems to reduce emissions, especially sulfur dioxide emissions as well as reduce fuel costs. Gasification systems use high temperatures and an oxygen-starved environment to convert solid biomass into a gas (a mixture of hydrogen, carbon monoxide, and methane), which then can be used to run gas turbine or engines. The decay

[2]Wind Power is directly proportional to the height at which turbine is installed. The current potential is estimated at 80m hub height.

of biomass produces a gas (a mixture of methane and carbon dioxide), that can be used as an energy source. Methane can be generated from biomass through the process called anaerobic digestion, which involves using bacteria to decompose organic matter in the absence of oxygen. Methane can be directly burnt in a boiler to generate steam or it can used be in a gas engine to generate motive power.

2.2.3.1 Bagasse Co-Generation Based Power Generation

Cogeneration is essentially the generation of heat and power, where already steam is being generated for existing industrial process purpose. Typically, there is a component of waste heat in power generation which can be used for the process as useful heat in case of co-generation resulting in thermodynamically efficient use of the fuel. The relatively better growth of Bagasse based cogeneration (see Figure 28) in the state can be attributed to organized nature of fuel supply chains as well as financial support provided through state policy i.e. role of energy fund called Urjankur Nidhi.

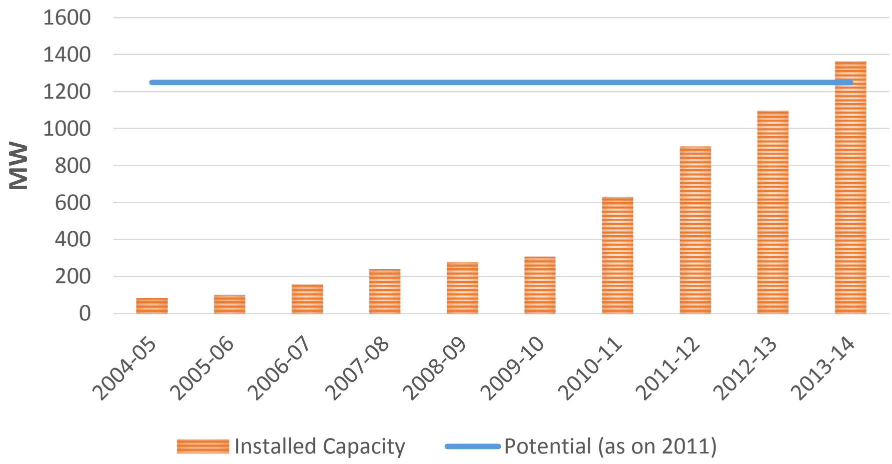


Figure 28: Cogeneration Power Projects &Estimated Potential in Maharashtra

Source: [9]

Cogeneration projects can utilize either bagasse or any other biomass as fuel. Cogeneration plants get the added advantage of established and organized fuel supply chain. The total installed capacity up to year 2013-14 was 1,354 MW, which is second largest contributor after wind power to the current renewable energy portfolio of the state. This capacity addition of bagasse cogeneration in the state is attributed to the number of sugar factories. Only one biomass based cogeneration project of 8 MW has commissioned till date. The installed capacity exceeds the potential estimated in year 2011 i.e. 1,250 MW. In order to promote cogeneration based power development, there are incentives and subsidies available from both state policy as well as central level. The state policy provisions are covered in detail in the next chapter. A capital subsidy is available through a central scheme [17].

2.2.3.2 Biomass Based Power Generation

Biomass energy based power generation has a huge scope in the state. According to IISc study on estimating the potential for biomass based power, there is a potential for around

1800 MW capacity in the state. However, this depends upon the cropping pattern and calorific value of various crop waste. Figure 29 shows the estimated potential for biomass based power generation in the state based on agriculture waste and forest and waste land availability in the state.

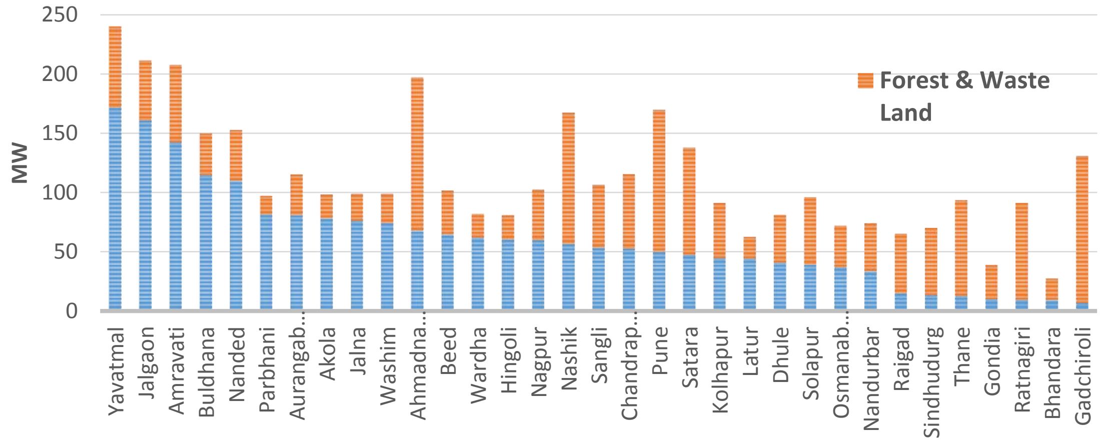


Figure 29: District Wise Biomass Power Generation Potential in Maharashtra

However, due to many hurdles such as fuel quality, dependence upon rainfall and cropping pattern, the actual installed capacity in the state is around 10% of the potential. There are a total 182MW biomass based power generation projects commissioned till 2014, as against the total estimated potential of 1,887 MW. Total 17 projects have been installed so far, out of which 14 are in Vidarbha and Marathwada region and remaining 3 are in north Maharashtra. Particularly in rural Maharashtra gasifier projects can not only address electricity shortage but also the most energy intensive and vital household process, cooking while utilizing charcoal (a byproduct of the gasifier). The gasification process produces about 10% residue, which incidentally is high quality charcoal, which, in turn, can be used for cooking in village households. This village-level cooking energy solution will reduce fuel gathering time significantly and provide a smoke-free environment to the rural households.

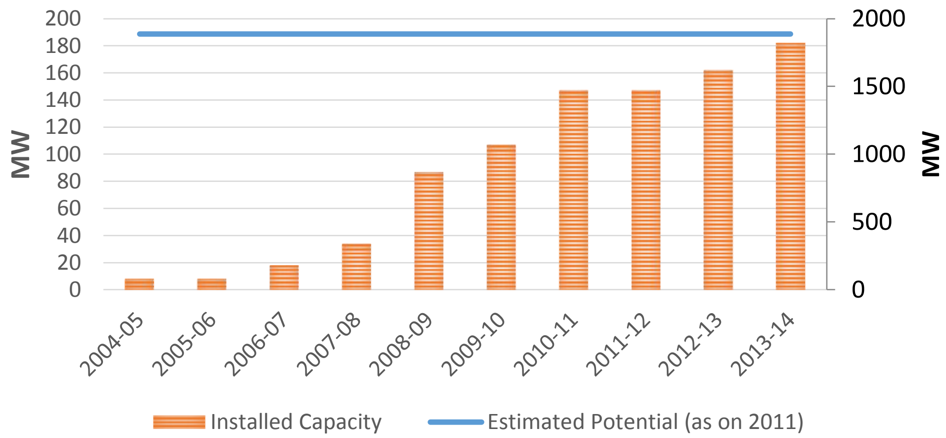


Figure 30: Biomass Based Power Projects and Its Estimated Potential in The State (Excludes Co-gen)

Source: [9]

2.2.3.3 Waste to Energy

Waste-to-energy or energy from waste is the process of generating energy in the form of electricity and/or heat from the incineration of waste. It is a form of energy recovery. Most waste-to-energy processes produce electricity and/or heat directly through combustion, or produce combustible fuels, such as methane, methanol, ethanol or synthetic fuels. Although the potential estimated for waste to energy is 287 MW, but only 11.7 MW projects have been realized till now [9]. Mumbai generates 8,000 metric tonnes of garbage every day, and had announced to set up 10 power plants based on waste-to-energy technology.

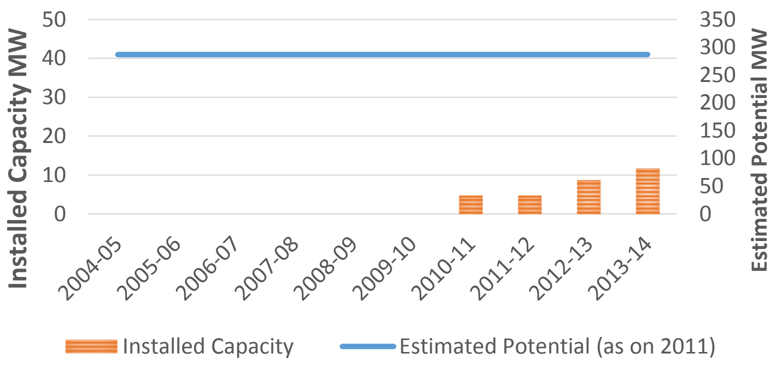


Figure 31: Waste-to-Energy Projects and its Estimated Potential in Maharashtra

Source: [9]

For promoting the waste-to-energy based power generation in the country, a capital subsidy for the promoter is available for different types of processes such as Biomethanation at sewage treatment plants and bio-CNG production [18].

2.2.4 Small Hydro-Power

Hydro power projects are generally categorized in two segments i.e. small and large hydro. In India, hydro projects up to 25 MW station capacities have been categorized as Small Hydro Power (SHP) projects. The Small Hydro-Power (SHP) growth has been steady in the state throughout the last decade. The current installed capacity is 278.6 MW against the estimated potential of 733 MW.

Various subsidy schemes for both the new development as well as renovation and modernization of existing SHP are available through MNRE scheme [19]. Other than that the Maharashtra's policy on renewable also promotes SHP through various incentives which will be discussed in detail in next chapter.

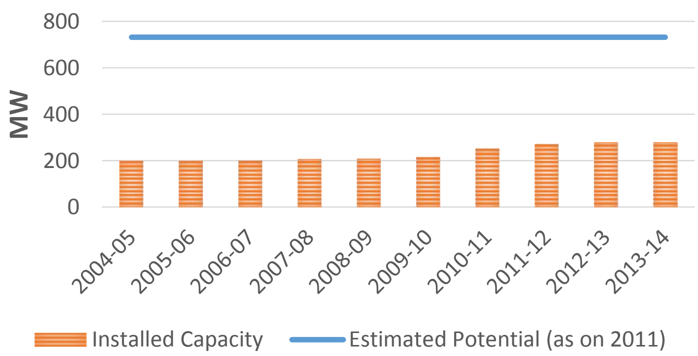


Figure 32: Progress of Small Hydro Projects and its Estimated Potential

Source: [9]

2.3 OFF-GRID OR STANDALONE POWER SUPPLY SYSTEMS

The government is implementing a programme for electrification of those remote un-electrified census villages and un-electrified hamlets of electrified census villages where grid-extension is either not feasible or not cost effective and is not covered under RGGVY scheme. Such villages are provided basic facilities for electricity/lighting through various renewable energy sources. Small hydro-power generation systems, biomass gasification based electricity generation systems, solar photovoltaic power plants, etc. may be used in distributed power generation mode depending upon the availability of resources for generation of required electricity. Under this program, central financial assistance of up to 90% of the cost of the renewable electricity generation systems (including the cost of Annual Maintenance Contract or AMC, if any, for 5 years) will be provided for approved projects for electrification of remote un-electrified census villages and remote un-electrified hamlets of electrified census villages.

2.3.1 Solar Street Lighting, Solar Home Lighting and Solar Lantern

There are several specifications laid down by the MNRE for solar street lighting, home lighting systems, and solar lanterns to avail capital subsidy benefits.

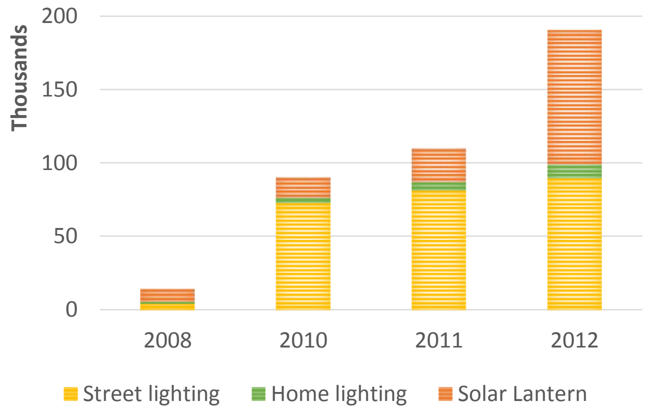


Figure 33: Progress of Various Standalone Lighting Systems Installed in Maharashtra

Source: [8]

The total number of standalone systems installed during 2008 to 2012 is 1.9 lakhs, of which 47% are street lighting systems and 48% are solar lanterns.

2.3.2 Wind Solar Hybrid

A hybrid renewable energy system utilizes two or more energy production methods, usually solar and wind power. The major advantage of solar / wind hybrid system is that when solar and wind power production is used together, the reliability of the system is enhanced. Total 193 wind solar hybrid systems have been installed, most of which are for institutional set ups. Total installed capacity upto the year 2012 is 1,352 kW (see Figure 34).

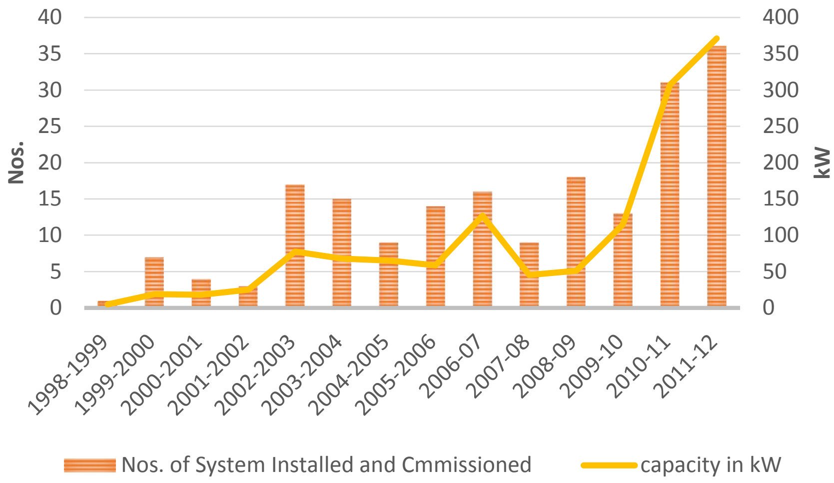


Figure 34: Progress of Off-Grid Wind Solar Hybrid Systems Installed in Maharashtra
Source: [8]

A capital subsidy to the tune of 1-1.5 Lakh per kW is available for aero generators/wind solar hybrid systems through central finance assistance of MNRE [20].

2.3.2 Renewable Based Irrigation Systems

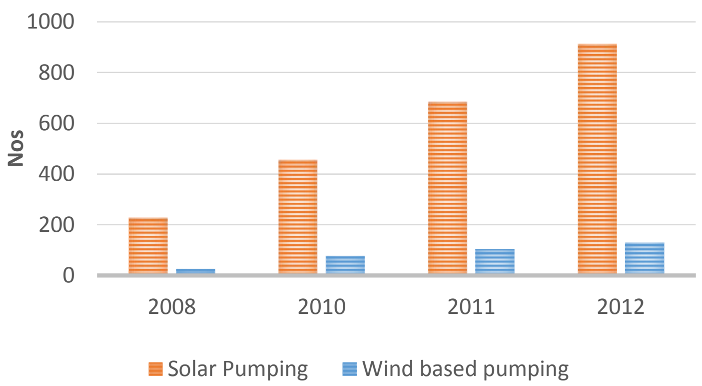


Figure 35: Renewable Based Pump sets installed in MH
Source: [8]

Other major demand for energy in rural areas comes from irrigation pumping systems. There are around 0.2 million pump sets electrically energized in the state every year. The total number of electric pumps in the state is estimated to be more than 4 million, which is one of the highest in the country as on 31st July 2014 [7]. One of the major problems of using electricity based water pumps, especially in rural areas, is the quality of electricity supply. Typically, the electricity is available for limited hours only during nights, which results in large number of pump sets coming online at the same time. This results in poor voltage distribution along the feeder and increased water drawdown from ground water table, which in turn results in motor failures. Another alternate to electric pumps is diesel pumps where farmer has freedom to use pump set as and when he wants. However the running cost of diesel pumps is getting higher and higher with increase in diesel prices. In remote areas or where quality of electricity supply is very poor, diesel pump sets have penetrated substantially.

Renewable energy based pumps using solar PV and wind mills can replace these diesel pumps, reducing the financial burden on the farmers. One of the important advantages of renewable energy based pumping systems is their negligible operating cost since no fuel is required for the pump like electricity or diesel. This benefit makes its wide scale application in drought prone regions like Vidharbha extremely critical where providing reliable and quality electricity service through conventional infrastructure is challenging. Up scaling this technology can make a huge socioeconomic impact on the local economy of the region. PV panels can be used to energize the pumps either directly through DC power or by using invertors to convert to AC. Windmills can either directly use mechanical energy or use DC power generated. The average size of pump sets required is around 5 HP. A total of 912 solar pumps and 156 wind based pumps have been installed in Maharashtra during 2008 to 2012 (see Figure 35).

2.4 SUMMARY

The progress of grid connected renewable electricity generation has been impressive in the state. However, this growth was dependent on only two resources i.e. wind and bagasse, out of which over 75% of the wind potential and 100% of the cogeneration potential is already tapped. This growth in these two sectors can be mainly attributed to the financial incentives such as accelerated depreciation, state energy fund, as well as other key factors such as organized nature of fuel supply chain for cogeneration projects and categorization of wind potential sites in the state. However other sectors such as solar didn’t grow with such rate in absence of clear policy signals among other reasons. The small hydro sector has also been growing steadily. To continue the same growth trend, it is essential for the state to equally stress on other renewable resources such as bioenergy, solar PV and waste-to-energy, which are abundantly available in the state. All of the bioenergy options depend upon an assured supply of biomass fuels for its operation. The scattered point sources of fuel and the unorganized nature of fuel supply chain pose additional challenges of social engineering, awareness and good governance in operation of these power plants. This demands efforts and/or skills beyond the conventional energy generation business. Failure to address of any of these challenges can have an impact on the viability of the power plant. This can be easily seen from the fact that only cogeneration projects which had pre-established supply chain could grow successfully and consistently. Development of solar PV has been sluggish in the past and it can be promoted with a clear policy direction and time bound targets. Given the high urbanization in the state, waste-to-energy offers a dual advantage of energy generation as well as waste disposal. However, the WTE based energy generation has not really picked up in the state.

Although most of the state is electrified as per the new definition of the RGGVY scheme, it is a long way from achieving its purpose of providing means of livelihood. From this perspective, attractive business models around grid interactive and decentralized systems needs to be promoted. As seen in previous chapter, access to modern cooking energy means is a huge challenge facing the state. A clear policy guideline to tackle this issue through integrated applications of various renewable energy technologies at village level (e.g. biogas plants) needs to be tested and developed. Other domestic as well as industrial thermal needs can be met through solar thermal applications. This will not only reduce the peak electricity demand in non-monsoon period but also shift to more renewable and clean energy utilization. In the following chapter we will look at the current policy scenario in the state for all the renewable energy technology options.

CHAPTER 3: RENEWABLE ENERGY POLICY LANDSCAPE IN THE STATE

Energy is treated as a central subject with state interventions limited to capacity addition, subsidy provisions and creating conducive environment for quick adoption /development of generation potential. After reforms in 1990s, the previously known State Electricity Board got unbundled into three companies looking after generation, transmission and distribution separately. With privatization of capacity addition there are many private independent as well as captive power generators growing in the state. As mentioned earlier, there are three distribution licensees in addition to the state distribution company. There is an independent regulatory institution, Maharashtra Electricity Regulatory Commission (MERC), which among many other functions, also looks at the tariff setting process for all the distribution companies. It also determines the generic tariff applicable for all types grid connected renewable power projects. The renewable energy sector development on the other hand is coordinated by the state established nodal agency, Maharashtra Energy Development Agency (MEDA). The agency also coordinates the energy efficiency activities in the state, which puts it into unique position to plan and integrate both the clean energy alternatives at the state level. Major functions of MEDA are as follows:

- Planning and budgeting for relevant schemes
- Identifying potential sites and feasible technologies
- Installing demonstration plants
- Facilitating private power projects
- Regulating renewable power generation and energy efficiency in the state

In the current policy framework, Maharashtra State has a state renewable energy policy, which covers various provisions such as subsidies, infrastructure support to biomass, bagasse cogeneration and wind power development in the state. Development of Small Hydro Power is governed by State Hydel Policy developed by the State Water Resources Department. Most of the renewable energy development technologies are supported and promoted through the schemes, policies and programs under the Ministry of New and Renewable Energy, through the state nodal agency MEDA. In the following section, we will briefly cover these policies along with incentives provided by the Central Government.

3.1 STATE RENEWABLE BASED POWER GENERATION POLICY

Maharashtra has declared a policy for power generation from non-conventional sources of energy in December 2008 [21]. The state has set targets for capacity installation for four different renewable based power generation options. This policy will be revised or redesigned as a new policy once the set targets for various renewable based capacity additions in the state are achieved. The targets set by the policy for different renewable energy options are shown in Table 3. As per the policy, the promoters/developers/investors will have to sell all of the electricity generated to a licensee or client within the state itself. Under this policy, MEDA will have to prepare a master plan for achieving the set targets of 3.5 GW. Provisions for different renewable resource based power generation options in the State Renewable Policy are summarized in Table 4:

Table 3: Capacity Addition Targets in State Non-Conventional Energy Policy in Maharashtra

Source: [21]

Renewable source	Capacity Target (MW)
Wind	2,000
Bagasse (Cogeneration/other)	1,000
Biomass	400
Small Hydro	100

Also, it is interesting to note that, the state renewable policy does not have any provisions for development of critical renewable energy resources such as solar energy and waste-to-energy. The policy provisions are summarized in Table 4. The policy is restricted to development of power generation and not energy as a whole. The government of Maharashtra announced its first policy to promote renewable energy in 1996 which did not elicit much interest from the industry. It revised its policy in 1998 but again could not stir up the private sector for investment. Total wind capacity added was 79 MW by 2001 whereas TN had added 771 MW by then. So the government finally came out with a policy in 2003 which really kick-started the sector in 2003 and since then we have witnessed a steady capacity addition in the state. It was the first time the classification of tariff was done according to wind zones and differential tariff was announced for each zone depending on the resource availability. Later, the government revised its policy in 2008 and stated a target of 2000MW post the achievement of which anew policy will be launched. Since then there have been no revisions in the policy apart from updating the procurement price via tariff orders. Maharashtra has announced its RPO for the next few years with no special treatment to wind as in the case of Gujarat. One of the major hindrances is the lack of compliance penalty for meeting the RPO. Off-shore wind has elicited some interest from the developers but cost is the major consideration holding it back. Also the appropriate regulations and policies are not yet in place.

Remote Village Electrification (RVE) policy plans to provide solar home lighting systems and solar street lights for tribal and remote villages of the state in the next 5 to 7 years i.e. till the year 2016-2018. Under that MEDA has undertaken the survey of villages, and prepared Detailed Project Reports (DPRs), helped constitute village energy committees, and installation of solar lighting systems in households, streets and for community uses. SHP development in the state is governed by the SHP policy by the Water Resource Department [22]. Under this policy, potential SHP sites are identified by WRD for development through either IPP or CPP route. The SHP allotted under this policy shall be on Build, Operate & Transfer Basis (BOT) for a period of 30 years. At the end of the BOT period the absolute ownership of the SHP along with land, switchyard & allied equipment shall automatically stand transferred to WRD free of cost. However, the release of water shall be strictly as per irrigation/domestic/industrial demands and the generation will have to be synchronized with these releases. WRD reserves the right to decide the release schedule and modify it from time to time as per the requirements. Developer shall arrange for all the necessary clearances & financial closure within 6 months from the date of signing HPDA. WRD shall facilitate developer in getting clearances. However, it shall be the primary responsibility of developer to arrange for various clearances within the stipulated time. Evacuation arrangement will be as per the dispensation emerging from the tariff and procurement process determination exercise initiated by MERC. These are the major provisions in the policy to promote SHP in the state.

Table 4: Policy Provisions of State Renewable Policy

Source: [21]

Provisions		Wind	Bagasse and Agri-waste Cogeneration	Agriculture waste based biomass	SHP
Evacuation Arrangement	Erection of HV,EHV substations	Project Developer			
	Erection of T&D lines	Project Developer			
	Ownership of evacuation arrangement	MSETCL/MSEDCL			
	Expenditure	Subsidy: 50% reimbursement from Green Energy Fund			
Electricity Duty		Not levied for first 10 years			
Capital Subsidy		-	After minimum 1 year of operation at 80% PLF, 1 Cr per project for installing HV/EHV substation. In case of cooperative sugar factories, 100% exemption on purchase tax for 10 years	-	Applicable up to 5 MW Capacity subsidy of Rs.50,000/- per KW is given, for Kolhapur type weir, waterfall, and run of the river. Maximum limit for subsidy is Rs.1.5 Cr. per project after project runs with min 80% PLF for minimum one year
Other		100% refund of Octroi Tax / Entry Tax for equipment of Wind power project is made through Green Energy Fund by MEDA	-		
Land Acquisition		Barren land can be available at lease for 30 year term	-		

3.2 MEDA PROGRAMS AND POLICIES

Other than the schemes mentioned so far, MEDA also has a scheme of promoting network of O&M manpower across the state. For many of the off-grid and non-electric renewable application a good infrastructure and network of O&M services is required. In this regard, there is a very crucial policy present in the state. The policy plans for setting up "Akshay Urja Shop" in every district of the state. The "Akshay Urja Shop" has four major functions: 1) Sale of different renewable energy and energy efficient devices; 2) Repair and servicing of renewable energy devices 3) Dissemination of information on renewable energy devices/ systems and, 4) Facilitate individuals/companies to go in for renewable energy devices. It will provide repair & servicing facility not only for the products being sold by the shop but also for other renewable energy products/devices installed/procured from any other source at a reasonable price. These shops have been provided with the following financial support: a) soft loan at 7% for upto 10 lakh of capital required for establishment, b) monthly grant of Rs. 5000/- and performance (turnover) based incentive along with service charges.

3.3 REC & RPO STATUS

The National Action Plan on Climate Change (NAPCC) targets 15 % of the electricity procurement in the country to be from renewable energy technologies by 2020. Renewable purchase obligations or RPOs have been mandated by the Electricity Act 2003 as a mechanism to ensure demand for RE. To comply with this, each State Electricity Regulatory Commission (SERC) has set an RPO target (varies between 0.5 to 10 % of total electrical energy demand) for distribution companies and other obligated entities in the state. The National Tariff Policy of 2011 has also announced specific targets for solar RPO – starting from 0.25 % in FY12-13 and going up to 3 % in FY21-22.Renewable Energy Certificate (REC) mechanism to balance the geographical constraints in harnessing available renewable resources in the country in tandem with Renewable Purchase Obligations (RPO) for the distribution utilities was established under the JNNSM [23].Towards enhancing the contribution of renewable energy in power generation, the MERC stipulated in 2010 that every obligated entity in the state should purchase at least 0.25% solar and 5.75 % other renewable power of its total annual consumption of energy under the RPO regulations. Both solar and non -solar targets increase incrementally over the years. The RPO targets for Maharashtra are shown in the following table.

Table 5: RPO Target for Distribution Licensee

Source: [9]

Year	Minimum Quantum of purchase (in %) from renewable energy sources (in terms of energy equivalent in kWh)		
	Solar	**Non-Solar**	**Total**
2010-11	0.25%	5.75%	6.00%
2011-12	0.25%	6.75%	7.00%
2012-13	0.25%	7.75%	8.00%
2013-14	0.50%	8.50%	9.00%
2014-15	0.50%	8.50%	9.00%
2015-16	0.50%	8.50%	9.00%

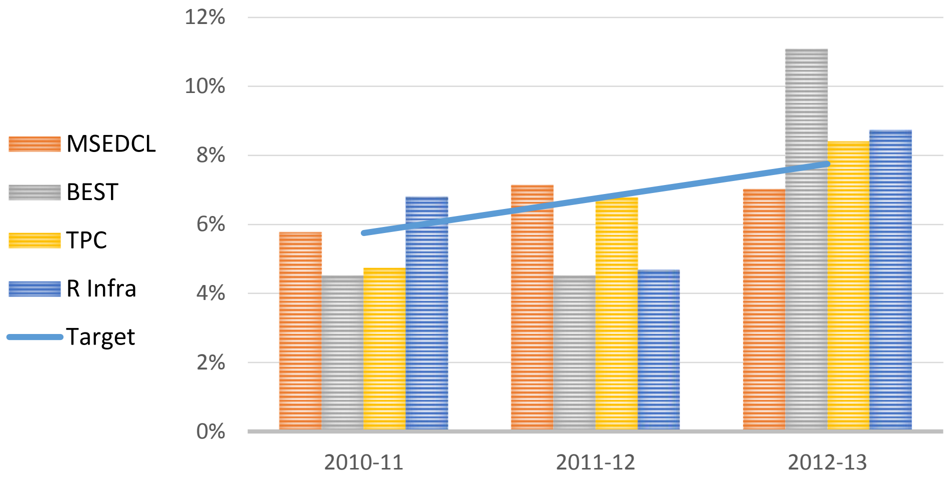


Figure 36: Non-Solar RPO Compliance by Various Utilities in Maharashtra
Source: [9]

At present, Maharashtra has differentiated RPOs for solar and small hydro based power generation. This essentially focuses on development of demand for these two renewable resources. However in absence of a dedicated policy or provisions in the state renewable policy, supply side development remains a weak link in solar power development. The fact that solar PV technology is yet to mature, clearly needs policy support for initial years. This could be one of the reasons behind most of utilities achieving the non-solar RPOs whereas the solar RPOs are hardly met.

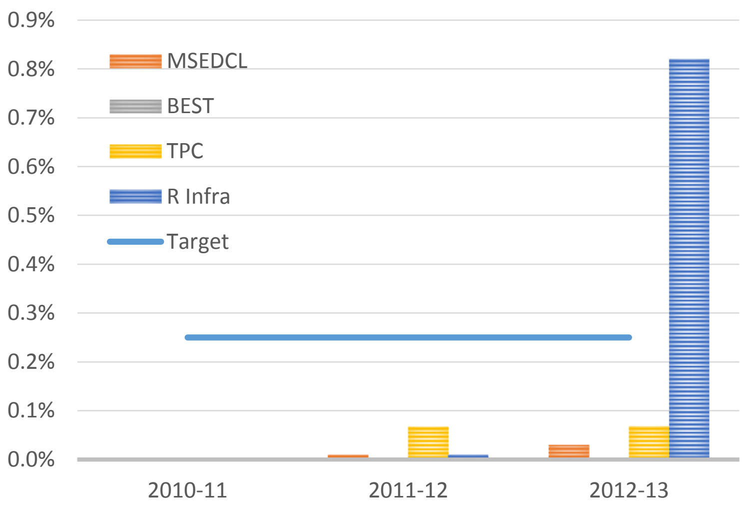


Figure 37: Solar RPO Compliance by Various Utilities in Maharashtra
Source: [9]

The progress of RPO compliance against the corresponding targets for last three years can be seen in Figures 36 and 37. For success of the REC mechanism, however, it is necessary to ensure that utilities are buying renewable based power even if that means imposing stricter measures such as penalty provisions. In the current scenario, the underperforming utilities have not been penalized by the MERC, which urgently needs to be changed. Recently though MERC has come up with a very clear order on strict measures against non-compliance with RPO requirements [24]. MERC in the past has also directed MEDA to formulate a committee to investigate and take a review of existing formats for data collection for RPO compliance of obligates entities [24]. Majority of these findings are on streamlining the governance processes for open access and captive uses of renewable energy in the state. The findings of the committee are summarized in the Table 6:

Table 6: Findings of the MEDA Investigating Committee

	Issues
1	**Identification of Obligated Entities and listing:** The list of obligated Captive Users and Open Access Consumers in the State with MEDA is not exhaustive. Further, there exist no streamlined process for identification and registration of such Obligated Entities and MEDA would require considerable support from DISCOMs and Electrical Inspector's Office (PWD)
2	**Verification of Data submission by Captive Users:** Electrical Inspector's Office (PWD) reported that the energy generation data submitted by Captive Users is self-certified and may not be authentic for the purpose of RPO compliance
3	**Verification of Data submission by Open Access consumers:** Data submission by Open Access consumers for RPO compliance is currently not verified.
4	**Practical difficulties in monthly data submissio**n: MERC RPO Regulations (11.1) specifies obligated Captive Users and Open Access Consumers to submit data to the State Agency (MEDA) on a monthly basis, which is found to be practically difficult from data submission and collection point of view.
5	**Lack of standard data Formats:** Though standard format exist for collection of data from Captive Users and Open Access Consumers by MEDA, there should also be standard formats for data submission by DISCOMs/Electrical Inspector's Office (PWD) to MEDA and MEDA to MERC for RPO compliance data submission. The same would ensure effective data flow between each entities involved
6	**Standard methodology for Energy Accounting for computing RPO compliance of Obligated Entities:** For Captive Users and Open Access Consumers other than those having in-situ captive power plants, the base energy to be considered for RPO compliance could be computed either based on the net energy or based on the gross energy at the generation point after accounting for the wheeling /transmission losses Incurred during the wheeling of power from the source of generation.
7	**Lack of check on Double accounting of RPO compliance:** No check exist to verify that RPO compliance by Captive Users and Open Access Consumers is not counted towards RPO Compliance of the host Distribution Licensee.
8	Lack of streamlined RPO related data flow between obligated entities and MEDA.
9	Lack of awareness among Obligated Entities.

With open access there is a freedom with the consumer to choose electricity supplier/distributor; this pushes the distribution utilities to provide better service quality. Any ambiguous regulatory open access charges make RE power producers cautious to invest in Maharashtra. MERC through a recent order has allowed Open Access for the Solar Power in Maharashtra. MERC should provide clarity on the open access charges applicable for other renewable energy projects such as wind and biomass. MERC should also encourage open access sales by easing cumbersome procedures, providing a roadmap for progressive reduction in cross subsidy surcharge (CSS) for all RE projects and a clear time-frame for which regulatory charges are applicable.

3.4 SOLAR PHOTOVOLTAIC POWER GENERATION

As seen earlier in the solar potential map, the western along with some north-central states of India i.e. Rajasthan, Gujarat, Madhya Pradesh, Maharashtra and Karnataka have very good solar potential in terms of incident energy. However, solar PV development has not happened in all these states at the same pace.

Table 7: Solar PV Electricity Generation (MW) Growth in Various States in India

Source: [25]

State	Total MNRE Projects	State Schemes	RPO	REC	Private Initiative	CPSUs	Total
Andhra Pradesh	46.7			46.2			92.9
Chhattisgarh	4			1.1			5.1
Gujarat		860.4					860.4
Haryana	7.8						7.8
Jharkhand	16						16
Karnataka	6	25					31
Madhya Pradesh	5.4	130		59.9			195.3
Maharashtra	47	150		37.3	3		237.3
Orissa	13			2.5			15.5
Punjab	9.3						9.3
Rajasthan	493.5		40	133.2			666.7
Tamil Nadu	16.1			15.7			31.8
Uttar Pradesh	12.4					5	17.4
Uttarakhand	5.1						5.1
West Bengal	2.1	5					7.1
Andaman & Nicobar	0.1					5	5.1
Delhi	0.9				2.1		3
Others	1.6						1.6
State	Total MNRE Projects	State Schemes	RPO	REC	Private Initiative	CPSUs	Total

It can be clearly seen that, most of the solar PV power coming online is at a utility scale, grid connected and incentive driven. However this also needs a primary support from the state government since delays in land acquisition and abstract policies affect the rapid growth momentum. Table 8 also shows that Gujarat is the only state with substantial capacity addition happened through state government initiatives. A quick look at the policy scenario of these states can show that except Maharashtra, most of the other states have a dedicated solar policy. In the following section we compare the solar policy of Gujarat with Maharashtra's policy provisions on Solar PV development in the state.

JNNSM and Gujarat solar power policy have been the major drivers of solar power in Gujarat. Gujarat was the first state in the country to come out with a policy dedicated only to solar power in 2009. In the following year, it came out with a solar tariff order where it fixed the levelized cost at which the licensees will procure solar power. In the same year, it also released its Renewable Purchase Obligation (RPO) schedule for its distribution licensees and included a specific target for solar power (solar RPO). Further in 2011 it came out with targets applicable for all existing and new generating companies including solar. In 2012, it came out with a discussion paper and then a final tariff order on pricing of solar power. Recently, Gujarat has announced a gross metering policy for the promotion of solar power under which all power produced is bought by the state. All the projects coming up in Gujarat are coming under state policies and Gujarat has exceeded its solar targets 850 MW (till now) and is also the highest in the country. Gujarat also has a dedicated solar rooftop policy. One of the major advantages is the solar park infrastructure provided by the state government. Gujarat is also looking into the ambitious solar canal projects. Interestingly, since it has exceeded its capacity, it has also exceeded its solar RPO targets. Thus state of Gujarat has utilized many financial as well as policy measures to push growth of solar power in, whereas on the other hand, Maharashtra has not done much in promotion of solar power - either grid connected or rooftop. Maharashtra has come up with a solar power tariff order in 2010 and has given RPO visibility for some time into the future. Maharashtra has not met its solar RPO targets and only 63% of the total capacity has come under the state policy (237 MW in total). A brief comparison of policy treatments given in Gujarat and Maharashtra is shown in Table 8.

Table 8: Comparing Solar PV in States of Gujarat and Maharashtra

Parameters		Gujarat	Maharashtra
Dedicated Solar PV based power generation policy		Yes	NA
Dedicated Solar rooftop PV policy		Yes	NA
Target		500 MW in 5 years	NA
Promotion of Green power using solar power	RPO	Yes	Yes
	Solar Specific RPO	Yes	Yes
Flexible enough to leverage CDM	Sharing CDM benefits	Yes	Yes
Use of wastelands for Socio Eco transformation		The state government has specially created solar parks developer	NA
Employment generation		Government views solar industry as a major employment generator	NA
Promotion of R&D and Facilitation of Tech transfer		It has created GERMI for the promotion of R&D and technical excellence in the state	No such steps have been taken
Local Manufacturing capabilities		It plans to come out with a manufacturing policy	NA
Raising environmental awareness among citizens		Conducts various workshops and activities	Conducts various workshops and activities
Other incentives	Accelerated Depreciation	Yes	Yes
	Wheeling charges	Yes	Yes

	Electricity duty exemption	Yes	
	Demand cut exception	Yes	
	No Electricity Cess For 10 Years.	Yes	
	No Electricity Duty For 10 Years	Yes	
	Wheeling Charge 2%	Yes	Yes
	Third Party Sale Allowed	Yes	
	100% Banking Permitted		
	Contract Demand Reduction Permitted		
	No Water Charges For Generation Of Power	Yes	
	No VAT		
	Entry Tax Exempted		
	Benefits Of Industry Status		
	Stamp Duty Exemption (50%) On Purchase Of Private Land		
	No Land Related Inspection		
	No Local Body Approvals Required		
Robustness and Comprehensive	Metering	Yes	
	Grid connectivity and evacuation	Yes	
	Open Access	Yes	
	Forecast and Scheduling	Yes	
	Reactive power charges	Yes	
	Cross Subsidy surcharge	Yes	
Penalty for non-compliance		No	No

The major reasons for the Gujarat state showing a superior performance in terms of solar power deployments are a robust and dedicated solar policy, support from the state government in terms of infrastructure, good solar resource, appropriate incentives and the political will to make the state a leader in solar technology. Thus there is a clear and urgent need for Maharashtra to come up with dedicated solar policy which will strategically develop solar resources in the state. In the next chapter, we will look at various barriers, issues and gaps faced by the stakeholders in development of renewable energy through various technologies.

CHAPTER 4: RENEWABLE ENERGY TECHNOLOGIES- BARRIERS, ISSUES AND GAPS

This chapter covers various barriers, issues and gaps across various renewable energy technologies in the state. These aspects have been captured through secondary literature and through discussions with a range of stakeholders.

Wind Energy Technologies: Comparatively wind is one of the most mature technologies among renewable energy technologies. The current cumulative capacity added in the state has already achieved 75% of the estimated potential, which means for new power projects to come, mapping of new potential with higher hub height needs to be done. A very good provision for the wind power projects in the existing policy is the categorization of wind sites as per wind density and setting tariff according to these zones e.g. plant in lowest wind density will have highest feed-in-tariff. This ensures equitable incentive to develop all the sites in the state as returns from all projects remain the same from the developers' point of view. The feed-in-tariff offered by MERC is also one of the highest in the state as compared to other states. However, one of the major incentives which helped wind sector to grow rapidly until 2012 both in the state and the centre was Accelerated Depreciation (AD) and Generation Based Incentive (GBI) provided by the Central Government. The purpose of this provision was to provide support to the market till the technology becomes mature and can compete with conventional alternatives. However, recent discontinuation of accelerated depreciation by the Central Government (from financial year 2012-13) has come out to be a major issue for continuation of past wind growth in the state. GBI was reintroduced in late 2013 whereas reinstating accelerated depreciation has been recently approved during this year budget presentation [25].

Major entry hurdles from wind developer's point of view are land acquisition, clearance procedure and availability of high resolution wind potential maps. The availability of wind power maps of higher resolution can significantly benefit small wind developers along with larger ones. Another hurdle from utility's point of view is the difficulty in scheduling the intermittent nature of wind power availability. A year before, in July 2013, CERC has issued a scheduling and forecasting order, which requires the developers to forecast their generation for the next day with a 15 minutes time period. However, there has been resistance to this from developers as such provision may affect the profitability of the firm. Grid evacuation also proves to be a major hurdle as state transmission utility is not streamlined at the same level as Inter State Transmission System (ISTS). In absence of good forecasting measures taken by developers, such nature of power availability makes it harder to integrate with the grid. In case of small scale wind development, the unavailability of data on potential from the sites at the required resolution proves to be a major hurdle.

Biomass and Cogeneration Technologies: Biomass based projects in this category have one of the lowest capital expenditure required in the whole portfolio of renewable energy options. It is also seen as an option which provides maximum low-skill employment in the catchment area and has a potential to achieve the highest PLF among all the renewable power options. There are around 18 large scale (MW) agro waste based biomass projects which are commissioned in the state and around same number of projects are in the pipeline.

However, most of the commissioned projects are running at extremely low PLF due to reasons such as uncertainty of fuel supply and rising prices of fuel. As mentioned in Chapter 2, the state has a large agro-waste based biomass project potential. Also this resource is distributed in such a manner that districts with lower electricity consumption also have a good resource potential. One of the major issues with such projects is the operation of the plant. Electricity generation is a continuous process which requires continuous availability of fuel. Agro-waste biomass based power plant needs to depend upon the farmers' supply chain for its operation. Unorganized nature of fuel supply chain, quality and quantity of fuel, unregulated fuel price variation, dependence of year round availability of fuel on monsoon and cropping pattern are some of the major issues facing the biomass power projects in the state.

Solar Photovoltaic Technologies: In absence of clear policy and targets for development of solar PV based generation in the state, the growth seems to be lower than other states such as Gujarat. Other hurdles such as land acquisition and clearances required for the large scale utility projects also pose major hurdles in the rapid development of the sector. The major barriers for the development of rooftop SPV systems are high capital cost and administrative hurdles. Also at times, end user has perception and expectation of roof top solar as a substitute to the grid electricity. However, what it actually results in, is a supplementary option to the grid electricity. Following barriers are identified during discussion with various stakeholders:

- High capital cost (in order to avail subsidy): Initial investment cost for rooftop system is high because of 6 hours backup mandated by MNRE. This additional backup requirement adds to the system cost.
- Administrative hurdles and delays in availing subsidy: Central Government through MNRE has announced 30% subsidy on all Solar PV systems. However, many a times, getting this subsidy becomes a long (as long as more than 3 years) and tedious process which effectively removes the advantage of any financial assistance. The process of getting subsidy is not clearly defined. Also the process has many loopholes for bad governance practices. In effect, the subsidy provision with an aim to ease the burdens of developers and early adopters of the technology becomes rather discouraging.
- Institutional structure: The strength of current two tier institutional structure i.e. of MNRE and MEDA, is perceived to be low in relation to task of implementing the large number of policies, programs and schemes in the state.
- Standardization & Quality Control: Many of the system components don't have BIS standards. In the current scenario, there is no robust mechanism for quality control on import from other countries. Although IEC certification has been made mandatory for products, the raw materials used or the processes used at system level skips the quality control mechanisms. There is also delay experienced from certifying agency (SEC) due to lack of infrastructure and resources. Existing norms set for availing subsidies in the state at times do no support latest developments in the technologies e.g. System specifications for battery box in SPV off grid systems,

mandate that the battery box should be made of GI sheet however with change in technologies plastic box are more appropriate at lower costs.

- Evacuation mechanism and net metering should be clearly designed in the policy for small capacity generators. In absence of such clear policy, excess generation does not get utilized.

Waste-to-Energy (Biogas, Briquetting, and Biomethanation): Waste-to-Energy is an option where the society also gets added advantage of waste disposal. As seen earlier, WTE is one of the most underdeveloped options among all renewable power options. WTE can be used either for electric output or directly for thermal energy applications through briquetting or CNG. One of the major hurdles for development of waste to energy power generation is the variation in calorific value due to uneven and unregulated fuel mix, and particle size. In a typical urban setting, separating the organic waste from other dry waste such as paper, plastic, glass becomes a pre-requisite. Overall, the technology also seem to be at a lower place on the learning curve, as there are very few successful projects operating at a small scale. Biogas generation from waste is being tried in city of Pune at a considerable scale. In this model, urban local body owns the hardware and assures the quality and quantity of supply of MSW feedstock to the plant, whereas the existing supply chain of garbage collection with little modifications to accommodate the segregation condition is continued. In case of Biomethanation, less maturity of technology, high first cost and raw material availability prove to be the major barriers. Compared to other technologies such as briquetting or direct combustion, Biomethanation is a less proven and less mature technology. The ROI can be very good from an industrial perspective, if these barriers are taken care of. In terms of technology maturity, there is need for further research and development to prove the technology in the field so that it can be replicable e.g. there is no efficient technology existing to handle H_2S. The system is comprised of large number of small components. If it is scaled up for power generation level, reliability and life of the system as a whole become major issues in the absence of standardization.

Solar Thermal Technologies: One of the major barriers for solar thermal energy for cooking energy needs has been technology transfer. On the other hand penetration of LPG based stoves has been sole function of market signals. For solar thermal energy industrial applications the low payback period, as compared to end users ‘expectation is also a key barrier to its adoption. This is a result of partial substitution of existing fuel by solar thermal. Also the capital cost increases as better multi-fuel integrating systems and storage solutions are added for more comprehensive solutions. As a result, it is crucial to bring together industries for which it is financially attractive for better market penetration. However, awareness about technology is also one of the major barriers. At present, most of the developers are Indian companies. Solar thermal based power generation is just emerging in the country and at very nascent stage of maturity as a technology. Solar thermal energy for domestic water heating requirements is well developed technology which becomes attractive with subsidy provision. There are also many equipment providers for both the FPC and ETC type heating arrangements. However, in the absence of strong state level policy, the potential for domestic solar water heaters has not really been tapped. Most of the projects become more attractive through availing of subsidies. However, delays and hurdles in availing the subsidy rather make the project unviable. There is also an issue of standardization and certification, as currently there is no acknowledged and prescribed testing procedure for solar thermal systems. There is also missing link between academic/R&D institutions and the end users, which will not only build confidence in indigenous technologies but also will help in creating awareness. A comprehensive and better targeted policy (e.g. solar thermal for certain types of industries or solar thermal for particular class of cities), for solar thermal applications can definitely help achieve the dual goal of peak load management and shift to renewable based energy.

CHAPTER 5: RECOMMENDATIONS

There are several gaps in the current thinking on promoting the reliable and affordable energy availability in the state. Addressing these calls for the adoption of more holistic &pragmatic approaches to energy planning in general and to renewable energy development in particular. The study shows that there is a huge scope to upscale renewable energy for meeting both electricity and thermal energy requirements in the state. In this context, the following recommendations are made.

Comprehensive State RE Policy:

The existing state renewable energy policy largely focuses on the power generation through a few RE technologies. However there is a wider need to utilize renewable energy systems for various other non-electric applications like mechanical, thermal, transport etc. Besides, it has become slightly outdated now as many developments have happened in the renewable power sector in recent times. Therefore a comprehensive renewable energy policy which can promote integrated development of all feasible resources in the state for both electric and non-electric applications is urgently required.

The following points should be taken in consideration while formulation of the new comprehensive RE policy:

- There should be clear roadmap and targets for development of RE technologies based on overall resource potential.
- Prioritization of RE technologies should be based on various aspects such as maturity of technology, manufacturing potential and tariff impacts on the consumer.
- The policy must focus on bottleneck areas like net metering for solar rooftop, grid evacuation, ensuring RPO compliance, developing a solution for better forecasting of renewable energy generation such as wind.
- The policy should also address the issue of land acquisition and availing multiple clearances. Land acquisition has been a challenge for the state over many years despite this being highlighted as one of the critical barriers towards large scale grid connected projects development.
- There should be a focus on creating incentives and measures that establish a strong renewable energy manufacturing base and supply chain in the state.

State Cooking Energy Mission:

Despite being an industrialized state, over 78% of rural households in Maharashtra use firewood as principle cooking fuel. The challenge of lack of access to modern fuels for cooking can be addressed through implementing a dedicated Cooking Energy Mission.

The following measures should be taken while strategizing the mission:

- Focus should be given on accelerating the use of modern sources of energy including sustainable and clean cooking system backed by fuel supply chain.

- The mission should clearly strategize the innovative business model/plan, financial mechanism and standardization of technologies to promote adoption and investment.

Rural Electricity Service through RE based micro-grids:

Although the state has achieved a complete electrification status as per the RGGVY scheme definition, the service quality of electricity (in terms of hours of supply, time of supply, voltage and current fluctuations etc.) is very poor. The poor quality of power supply essentially hampers the core purpose of providing electricity to the village level. Hence, establishing a network of RE based micro-grid can bring effectiveness in electricity service provision as well as provide entrepreneurship opportunities and socio-economic development at local level. In this regard, a clear strategy on micro-grid development in the state needs to be formulated.

State level Action Plan: At the moment, no state-level plan currently exists to promote RE deployment for rural electrification. In order to deploy more RE in rural areas, the state Government must implement a state-level action plan which has a target-driven approach for un-electrified rural households which are not covered under the central scheme of RGGVY.

Improved Financial Support: At present lack of supportive low-cost finance in a major barrier for off-grid rural RE projects. The State Government should offer more financial support for rural electrification projects which may also be channelized through rural regional/cooperative banks in the form of low interest loans.

Grid Infrastructure & RE integration:

Adequate network augmentation is required in absence of which future RE capacity addition in the state could lead to local-grid saturation in RE rich areas and to grid congestion between power generation and load centers. Developing a solution for better forecasting of renewable systems, such as wind, is critical from load management and needs urgent attention. In this context, the following measures should be adopted:

- State Transmission Unit should prepare a long-term transmission plan with a focus on RE-rich districts
- State grid infrastructure should be strengthened between RE rich areas/Generation sites and urban load centres
- All solar and wind power plants should be mandated to install advanced data monitoring technologies which provide real-time RE data to load dispatch centres so as to enable better grid integration
- Solar parks, land banks etc. with required grid evacuation infrastructure should be established.

Capacity Building and O & M Network:

Developers are facing the problem of lack of skilled human resource for implementation of RE projects as well as for O&M.

The following measures should be adopted to improve the capacity building and O&M network:

- Industrial Training Institutes in the state must RE related courses and training programs in curriculum.
- These training courses can be linked to employment in industries.
- Current network of Akshay Urja shops can further be strengthened to improve O&M.

Standardization and Quality Control:

One of the major challenges for developers and manufacturers of RE technologies is lack of quality control protocols and product standardization. To address this, appropriate technical standards can be decided by MEDA in collaboration with BIS to improve the quality across all RE related systems and components.

Single Window Clearance Mechanism:

It is very difficult for large scale project developers to get the required permits and clearances in a time bound manner. No investor grievance redressal mechanism exists for stalled clearances either which leads to delay in project implementation. The following measures should be adopted to avoid such delays:

- A single window clearance mechanism as well as subsidy availing facility for all of the renewable energy options must be established. MEDA has a critical role to play in the facilitations of different clearances required for such projects.
- Establish an appropriate mechanism for investor grievance redressal.
- The clearance processes should have time bound deadlines.
- Land acquisition process should be streamlined for speeding up utility scale RE projects.

Other Cross Cutting aspects:

Informal discussions with RE sector professionals highlighted the following cross cutting issues and recommendations that need to be adequately addressed so as to attract investments towards the overall development of the sector:

- Strengthen MEDA by building its resource capacity to execute all type of RE projects in the state. Building their capacity would improve the overall ease of project execution and subsidy related activities across different technologies segments. This is quite important as MEDA being the nodal agency is responsible for the development of the renewable energy utilization in the state.
- The state support for renewable energy through policy, subsidy, facilitating clearances etc. should be transparent and participative to enhance competition in the market and creating a level playing field
- Create adequate demand for renewable energy implementation within large state programmes and schemes in critical areas like health, education, water, sanitation, agriculture, livelihoods etc.
- Maharashtra MPs and MLAs can also implement various small scale RE projects in their constituencies (both urban and rural areas) through utilization of MP and MLA LAD funds. Besides they can also demonstrate suitable examples in provision of lighting, cooking, water and other services through renewable energy in line with the recent initiatives like the Sansad Adarsh Gram Yojana (SAGY) and other national and state level schemes.

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