BRIEFING PAPER

CUTS Centre for Competition, Investment & Economic Regulation
CUTS C-CIER

5/2014

Rooftop Technology for Power Generation in India
Issues and Challenges

India faces acute shortage of energy, with a proportion living without any access to electricity. The bulk of the responsibility for fulfilling the energy demands of the nation has been on non-renewable sources which are plagued with issues of supply and irreparable damage caused to the environment. Thus, the focus on renewable energy sources is increasing. This Briefing Paper aims to provide an overall understanding of the rooftop photovoltaic solar technology and its possible role in addressing the issue of energy security in India. It discusses policies in place in India at the Centre and state-level and also the potential challenges in large scale adoption of this technology.

Introduction

India is the second largest nation in terms of population and ranks fourth in terms of electricity consumption.[1] However, the per capita energy consumption is only one-third of the global average[2] with about 25 percent of the population lacking access to electricity.[3] This indicates the potential for increased energy requirements as India continues on its path towards higher growth. The energy shortage in India during 2013-14 was approximately 4.2 percent.[4]

Traditionally, the bulk of the responsibility for fulfilling energy demands of the nation has been on non-renewable sources as out of the total installed power generation capacity, 59 percent was provided by coal-based thermal power plants in 2013-14.[5] However, some factors, such as lack of permanent supply and irreparable damage caused to the environment due to excessive dependence on fossil fuels is compelling the nation to take steps to increase the proportion of energy generation using renewable sources. The renewable energy capacity in India has grown by 20 percent from 14.4 gigawatts in 2009 to 31.7 gigawatts at the end of March 2014. 21.1 gigawatts (67 percent) of this total installed capacity is accounted for by wind energy while solar accounts for 2.6 gigawatts.

In terms of generation, renewable energy provides 6.5 percent of the total energy generated in the country with a vast potential of approximately 2,49,188[6] megawatts yet to be tapped.

Why Solar Energy?

Solar and wind energy are two sources with the largest potential in India. India has on an average 300 sunny days in a year with the total estimated potential of 1460 gigawatts, thus a vast potential to be harnessed.[7] The Jawaharlal Nehru National Solar Mission (JNNSM), launched in January 2010 was a positive step towards harnessing this potential and sets a target of deployment of 20,000 megawatts of grid connected solar power by 2022.[8]

However, solar plants require vast amount of land as on an average an area of 5 to 6 acres is required per megawatt capacity,[9] the availability of which is a challenge. One of the possible solutions is solar rooftop photovoltaics which are electricity generating solar panels installed on the roof of buildings and this can potentially overcome the space concerns associated with ground

mounted solar panels. The electricity generation depends on the time of day as well as the season and can be connected to the grid as well, to transfer surplus generation. Rooftop technology reduces the reliance on grid power for consumers along with reducing the dependency on diesel and can possibly create entrepreneurs out of the homeowners. According to a report by Bridge to India, small rooftop solar plants could potentially create 3.25 lakh cumulative new jobs in the next 10 years.[10]

It could help meet the rising demand, reduce the transmission and distribution losses and also lessen the need for excessive transmission lines as production is close to consumption. The prices for solar cells have also significantly declined in the recent years due to economies of scale and improvements in technology with China leading the market.

Global Scenario

Many countries globally are making extensive use of rooftop photovoltaic systems for their energy demands. Germany has been the leader in terms of adoption but has been overtaken by China, Japan and US in terms of installed capacity in 2013. Germany still continues in the leadership position in terms of overall capacity with 35.5 gigawatts installed capacity with Australia at 33 gigawatts at the end of 2013.[11] The German, Australian and Japanese markets are largely driven by residential consumers.

The market in Germany developed largely due to feed-in-tariffs which means that the energy firms have to pay a higher rate for electricity generated from renewable sources. Germany relies on solar energy for approximately 5 percent of its overall electricity needs[12] and has set a target of building a capacity of 52 gigawatts by 2020.[13] China, on the other hand, developed the sector mainly through large scale utilities with nationwide feed-in-tariffs and incentives. US has nationwide as well as state-level policies with state-wise feed-in-tariffs and the market is largely driven by utility scale projects.

Rooftop Technology in India

The role of the government is pivotal in the development of rooftop technology as is seen from numerous global examples. The government designs policies and frameworks which would support the development and adoption of the technology. The responsibility for creating a favourable climate for rooftop photovoltaic systems to thrive rests with both the Central and state governments. The Ministry of New and Renewable Energy plays an important role in terms of policies, subsidies and soft loans. The state governments need to take decisions on the tariff systems, strengthening of the DISCOMS in the state and setting other subsidies and tax benefits.

Jawaharlal Nehru National Solar Mission

One of the initiatives under the National Action Plan for Climate Change is the JNNSM which was launched in 2010. The targets set were: (i)deployment of 20,000 megawatts of grid connected solar power by 2022; (ii) 2,000 megawatts of off-grid solar applications including 20 million solar lights by 2022; and (iii) 20 million sq. m solar thermal collector area to achieve grid parity by 2022. It aims to achieve these targets by formulating long-term policy, setting large scale deployment goals, extensive research and development and domestic production of raw materials, components and products.

There is a three-phase plan under the JNNSM with specified targets for each. The first phase was upto 2012-13 with a target of 1,000-2,000 megawatts, the second phase is from 2013-17 with a cumulative target set of 4,000-10,000 megawatts and the third phase is from 2017-2022 with a cumulative target of 20,000 megawatts. Under the first phase a capacity of 1154 megawatts of grid connected power projects were allocated. The Ministry of New and Renewable Energy (MNRE) launched a pilot scheme in 2013 for grid connected rooftop photovoltaic projects which allows for size from 100-500 kilowatts. Surplus electricity generated would be fed back into the grid under this project. The projected market size of residential rooftop segment is expected to be 494 megawatts by 2016.

Government Policies

The government provides certain subsidies and tax benefits in order to promote the installation of rooftop photovoltaic systems in the country. A 30 percent subsidy is provided on capital expenditure for rooftop solar systems for plant sizes of up to 500 kilowatts.[14] Some states have

announced an additional subsidy above this Central Government subsidy. Soft loans are also provided by the government at 5 percent per annum on 50 percent of the capex for a period of five years. A commercial enterprise can claim either the capital or the interest subsidy but a non-commercial enterprise can claim both. The government also provides accelerated depreciation of 80 percent in the first year which can be claimed by both commercial and non-commercial entities.

Apart from these, the government has also set up the Renewable Purchase Obligation (RPO) programme through the Central Electricity Regulatory Commission (CERC). Under this, it is stipulated that 15 percent of all power in the country has to be sourced from renewable sources by 2020 and the target set for solar power is 3 percent. States have taken up this initiative and set their targets.

As the availability of renewable energy sources in the states are not evenly distributed, another measure introduced is the Renewable Energy Certificates (REC). The goal was to correct the mismatch between the availability and the requirement of renewable energy and help develop the capacities of states with greater potential. The value of one REC is 1 megawatt hour of electricity fed into the grid and there are two options for sale of the same; either sell the renewable energy at a preferential tariff or sell the electricity generated and the environmental attributes of the same separately. Generation Based Incentives are also provided for every unit fed into the grid.

There is a provision of spending 2 percent of the operating profits of companies on corporate social responsibility (CSR) activities, and investments into solar plants can be considered a CSR activity. Another measure being adopted across some states is net-metering, which is for solar photovoltaic systems connected to the grid. In this case the rooftop technology is the primary source of electricity for the household and any deficit is met by the electricity service provider for which the consumer is charged. In case the electricity generated through the rooftop photovoltaic system is in excess of the household demand, the same is fed back into the grid and purchased by the service provider at a pre-determined rate.

In the net-metering approach, the meter employed provides two readings; one for electricity drawn from the grid and second, the electricity supplied to the grid. In case the electricity consumed from the grid is higher the consumer pays for the additional amount, and if the electricity is fed into the grid then the same is credited to the homeowner's account and the accounts are cleared at the end of the cycle. Thus, the solar photovoltaic system is the primary source of electricity for the homeowner and the deficit is supplied by the grid. This reduces the financial burden on the utilities as they only have to reimburse the homeowner for any net electricity fed into the grid.

The cost of installing a rooftop photovoltaic system prior to availing subsidies and accelerated depreciation is approximately ₹1,00,000 for a 1 kilowatt rooftop solar plan. Post the reductions amounting from the 30 percent subsidy and 80 percent accelerated depreciation the cost is approximately ₹50,400 with a life of around 25 years.[15] This would generate approximately 4 kilowatt hour of electricity in a day.

State-level Policies

Many states have formulated their own policies in order to promote solar power projects and some have also announced the net-metering policy and tariffs for purchase of excess electricity.

Gujarat: This was the first state in the country to design a solar specific policy in 2009. Gandhinagar has generated 1.39 megawatts of solar power through rooftop photovoltaic systems.[16] The state has launched another scheme to develop 25 megawatts of solar power in five other cities in the state.

One of the programmes implemented for Gandhinagar and under consideration for the latest scheme, is the 'rent-a-roof' programme. This is a public-private-partnership model under which the private players are selected through competitive bidding and post selection are responsible for leasing the rooftops from private, commercial or industrial owners. The selected private player is responsible for financing, installing and maintaining the rooftop photovoltaic systems and the rooftop owners get an income.

Rajasthan: There is a vast untapped potential to harness solar energy in the state and as part of the Rajasthan Solar Energy Policy, 2014, the state has set a target of 25,000 megawatts for solar power through state, private enterprises, public private partnerships or individual efforts. There is focus on developing and promoting the adoption of rooftop photovoltaic systems to help achieve the target. The new policy also mentions supply of excess energy to the grid and development of a net-metering policy for undertaking the task.

Delhi: The process of developing a solar policy is underway and rooftop photovoltaic systems will also be a significant contributor. The Delhi Electricity Regulatory Commission is in the process of finalising regulations in its proposal to implement net-metering. The Delhi government plans to start with installations on rooftops of government buildings, colleges and hospitals and the Gujarat programme of 'rent-a-roof' may also be adopted. According to some estimates, Delhi has the potential to install a capacity of 2 gigawatts of rooftop solar technology by the end of 2020 and could be cheaper than the grid, for any residential, industrial or commercial consumer by 2018.[17]

A proposal being debated is to waive a part of the loan interest rates. In case the individual takes a loan of 80 percent of the cost with a 12 percent interest rate, nine percent would be paid by MNRE. Thus, this could further incentivise the consumer to adopt the technology.[18]

Kerala: The state has announced 10,000 rooftops programmes with an aim of generating a total 10 megawatts of solar power annually by installing solar panels of 1 kilowatt capacity on 10,000 houses across the state.[19] An additional subsidy of 20 percent is also offered over and above the MNRE. This scheme is already underway and in the process of implementation. A similar scheme for 25,000 additional rooftop systems has also been announced.

West Bengal: The Government of West Bengal has set a target of harnessing 18 megawatts of solar power by 2017 through rooftop and small solar installations.[20] All public buildings will be required to have solar devices to meet their energy needs. There are set targets for all upcoming commercial and business establishments which have a demand greater than 1.5 megawatts, which mandate them to install rooftop photovoltaic systems to meet atleast 2 percent of their demand. All existing and upcoming schools, colleges, hospitals, large housing societies and government establishments with a demand higher than 500 kilowatts need to meet atleast 1.5 percent of their demand through rooftop photovoltaic systems.

Potential Challenges to Overcome

Some of the potential challenges associated with rooftop photovoltaic systems are:

- One of the primary challenges associated with adoption of this technology for homeowners is the high cost. Though the government has announced subsidies and schemes to promote the growth, the uncertainty regarding the disbursement of subsidies, obtaining the necessary approvals poses a challenge.
- Many rooftops may not be suitable for the adoption of rooftop solar systems as they may not receive adequate irradiation or require extensive refurbishment.
- Net-metering and feed-in-tariffs are standard practices adopted in most countries to promote rooftop photovoltaic systems. However, there is a threat of electricity from cheaper sources fed into the grid while claiming the high feed-in-tariffs.
- The distribution systems were designed for electricity to flow from the grid into the homes, but net-metering would reverse this process, thereby requiring adequate inspections and possible upgrades. Net-metering can also lead to voltage upsurge which can potentially damage the appliances. The rooftop photovoltaic systems can alter the load profile of the grids as the demand in the day would fall while at night would increase and weather changes would also have an impact, thus posing a significant challenge for DISCOMs in terms of load management.
- The DISCOMs will also need to ensure the necessary systems, such as procuring the net meters and manpower are in place prior to the launch of the schemes in their state.

- The current metering systems in India are unreliable with some estimates indicating that close to 11 percent of them are faulty.[21] Thus, the DISCOMs ability to monitor and verify the process adequately would have to be strengthened as they would be paying a higher rate to consumers as per the feed-in-tariffs. The cost of rooftop systems are higher than those of large scale solar projects, thereby placing additional financial burden on utilities to purchase from homeowners with rooftop photovoltaic systems as they would be mandated to purchase the additional electricity produced, if any.
- Estimating the feed-in-tariffs is another impediment due to the dynamic nature of the market, the technological advancements and lack of availability of data.
- The success or failure of rooftop photovoltaic systems depends on consumers since this technology is largely consumer driven. Hence, it is crucial to communicate various aspects and benefits of this technology effectively to consumers. Generating awareness is the first step towards the process of adoption. However, at this stage the consumer's involvement is mainly passive and he/she would be unaware of the details of the proposition. The state of Tamil Nadu developed a communication to stimulate the adoption of rooftop technology among consumers which said "spend ₹50,000, put up a rooftop solar plant, save ₹9,200 a year."[22]

  Such communications can attract consumers towards the usage of rooftop technology. Since the purchase of rooftop photovoltaic systems is a high involvement decision with financial risks associated with it, the consumer will need to be persuaded to come forth to gather more information, evaluate the benefits and adopt the technology. Hence, keeping in mind the nature of the proposition, the communication needs to be effective in not only generating awareness, but also persuading the consumer to adopt rooftop photovoltaic systems. This goes hand in hand with the subsequent processes of purchase which needs to be extremely user friendly. Thus, policies and regulations need to be carefully formulated and should be easily accessible and simple to understand for a lay person, the absence of which can discourage the consumer.
- Uncertainties in terms of policies, regulations, disbursement of subsidies, government approvals need to be reduced and the processes streamlined to ensure smooth functioning of the scheme for the consumer.

Conclusion and the Way Forward

There is a vast untapped potential for solar energy in India and with decreasing cost of panels this could be a viable solution for the energy crisis. Rooftop technology looks promising to overcome some of the constraints of large scale systems; however as is seen from global examples this also comes with its fair share of challenges. The feed-in-tariffs, though successful in many countries to promote the adoption of rooftop photovoltaic systems, needs to be developed with care and here net-metering seems to be the better approach.

Most Indian states have adopted net-metering and thus, will not have to bear the burden of paying very high feed-in-tariffs as electricity fed into the grid would be credited to the consumer's account to be cleared at the end of the cycle. Also, subsidies need to be gradually reduced keeping in mind the falling prices for purchasing and operating the systems. Another major task is grid connectivity and management to ensure the smooth functioning of the system. The current systems would need adequate upgrades in order to meet the challenges posed by grid connectivity.

The current government is considering doubling the target for the upcoming phase of the JNNSM to 3,000 megawatts and hopes to achieve grid parity by 2017.[23] The private sector is also beginning to adopt this technology. Tata Power Solar has recently commissioned a 2 megawatt rooftop photovoltaic plant for Murugan Textiles, which is the largest power loom producer in India, in Tamil Nadu. This will be the largest rooftop plant in South India.[24]

DLF is also installing rooftop photovoltaic panels on top of its office buildings to become the first real estate developer in the country to generate its own power using this technology.[25]

Infosys plans to be completely carbon neutral and fulfill all its electricity needs from renewable sources by 2017. The company has rooftop photovoltaic systems on campuses where the reliance on diesel is substantial.[26] As per certain estimates factories and businesses have installed over 30 megawatts of rooftop photovoltaic systems in 2013.[27]

This signals the government and private players' intent on further harnessing solar energy and their use of rooftop technology. The government's role will be, to ensure that the policies and regulations are in place and the processes are streamlined in order to make the entire cycle of adopting the rooftop photovoltaic systems hassle free for consumers. With the right policies and efficient management rooftop photovoltaic systems could help ease the burden on electricity service providers and help in resolving the energy crisis.

Endnotes

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Printed by Jaipur Printers Pvt. Ltd., M. I. Road, Jaipur 302001, India