PERSPECTIVE

Strategies to harness Bengaluru's solar potential

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Abstract: Solar energy is a key component of cities' climate mitigation and energy security plans, due to its ease of installation & operation and drastic decline in costs. In Bengaluru, residential, commercial and industrial (C & I) consumers contributed to around 85% of the electricity consumption and resultant emissions during 2014 and 2015. What are the options for these consumers within the ambit of current policies to procure solar power? Are changes required in these policies to scale up the adoption of solar power? WRI India has explored both off-site and on-site procurement of solar energy.

On-site procurement

In 2013, net-metering which allows export of excess power to the grid was not available in Bengaluru. This, in addition to expensive electricity storage options meant that the complete potential of an on-site solar plant could not be realized.

WRII has found that net-metering regulations for rooftop solar projects in Karnataka, introduced in November 2014, were met with moderate success among C & I consumers. The adoption among residential consumers was slow due to information gaps about financial parameters, net-metering procedures and credible installers.

On May 2, 2016 gross metering scheme is introduced for both categories of consumers. WRII intends to look into the effectiveness of the new scheme.

Off-site solar procurement

Grid-connected solar power projects in Karnataka, commissioned before 31 March 2018, were exempted from payment of wheeling, banking charges and cross subsidy surcharge for the first 10 years for sale to 3rd party customers.

Since the typical payback period for a utility scale solar project is around 7 years, this order provided long term clarity for investors, solar project developers and consumers. For certain categories of consumers (commercial), the exemption meant that solar energy became more viable.

However, challenges in procuring land and bottlenecks in power evacuation, may delay the large scale deployment of solar projects to the latter half of 2016.

Keywords: Bengaluru, solar, on-site, off-site, roof-top, policy, residential, commercial, industrial

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Received: November 7, 2016; **Accepted:** December 17, 2016; **Published Online:** February 18, 2017
Citation: Thanikonda A K and Krishnan D S, 2017, Strategies to harness Bengaluru's solar potential. *Journal of Sustainable Urbanization, Planning and Progress*, vol.2(1): 73-82. http://doi.org/10.18063/JSUPP.2017.01.003

1 Introduction: Solar Cities

Cities contribute to 70%[1] of the world's emissions, and rightly they are a key focus area for climate mitigation activities. On an average electricity consumption accounts for 75% of these emissions[2]. Renewable energy is a reliable way of reducing electricity related emissions while boosting economic output. Within the gamut of renewable energy sources, solar power is scaling up rapidly across the world, due to its ease of installation & operation and drastic decline in costs. Hence cities across the world are actively considering solar power in their climate mitigation and energy security plans.

However, cities are complex entities with various stakeholders who need to be engaged to bring in any systemic change. In particular businesses, residents and utilities define the electricity consumption patterns of any city. Each of these groups have fundamentally different outlook towards electricity and hence the strategies to engage them during the solarization process should be different.

Bengaluru, with an estimated population of 9.5 million[3] in 2016, is the fourth largest metropolis in India. It is an economic powerhouse and contributed ~2.3% to India's GDP as of during the financial year 2012−2013[4–6]. As a result, the city's electricity footprint is huge and is largely powered by thermal energy. In addition, Karnataka/Bengaluru has ambitious solar power targets to diversify its electricity supply mix and also to align with India's climate change mitigation plans.

Table 1. Circles and Zones in Districts served by BESCOM[7].

	Districts	BESCOM Circles		BESCOM Zones
1	Bangalore Urban	Bangalore East	Bangalore West	Bangalore Metropolitan Zone (BMAZ)
		Bangalore North	Bangalore South	
2	Bangalore Rural	Bangalore Rural		Bangalore Rural Area Zone (BRAZ)
3	Kolar	Kolar		
4	Chikka Ballapura			
5	Ramnagara	Ramnagara		
6	Tumkur	Tumkur		Chitradurga Area Zone (CTZ)
7	Davenagare	Davenagare		
8	Chitradurga			

2 Bengaluru's Electricity Consumption: A Snapshot

Bangalore Electricity Supply Company (BESCOM) is the utility that serves the 8 districts in and around Bengaluru. BESCOM serves these districts through the following three administrative zones and 9 circles (Table 1).

For the purpose of this paper, we will refer to all the circles in Bangalore urban and rural districts as Bengaluru city. Electricity consumption across various categories of consumers in Bengaluru city during FY 2014 (Apr 2013 – Mar 2014) and FY 2015 (Apr 2014 – Mar 2015) is as follows:

2.1 Bengaluru's Electricity Supply and Deficit

BESCOM's total energy requirement has grown from 21,909 MU during FY 2011 to 28,256 during FY 2016 at a CAGR of 5.22%[8]. Since hydro power is BESCOM's second largest source of power supply, any shortfall in annual precipitation affects it badly. As recently as September 2015, BESCOM faced a peak demand deficit of ~800 MW[9].

The state of Karnataka is trying to fill this deficit in BESCOM and other state utilities through a combination of 1) Demand Side Management (DSM) and 2) supply augmentation with more renewable energy. As of June, 2016[10] the state has successfully exploited 13.4% (134 MW) of biomass, 27.9% (838.5 MW) of small hydro, 20.8% (2,918 MW) of wind and 63.4% (1,267 MW) of cogeneration resources by the end of 2015. In contrast the state has exploited only 0.7% (174 MW) of its solar potential[11].

To further diversify its energy mix, the state has turned its focus to solar power with the Karnataka Solar policy (2014–2021). This policy set a target of 1.6 GW of utility scale solar projects and 0.4 GW of rooftop solar projects by 2021[12]. As per the latest national target of 60 GW of utility scale solar projects and 40 GW of rooftop solar projects by 2022, the rooftop solar target for Karnataka

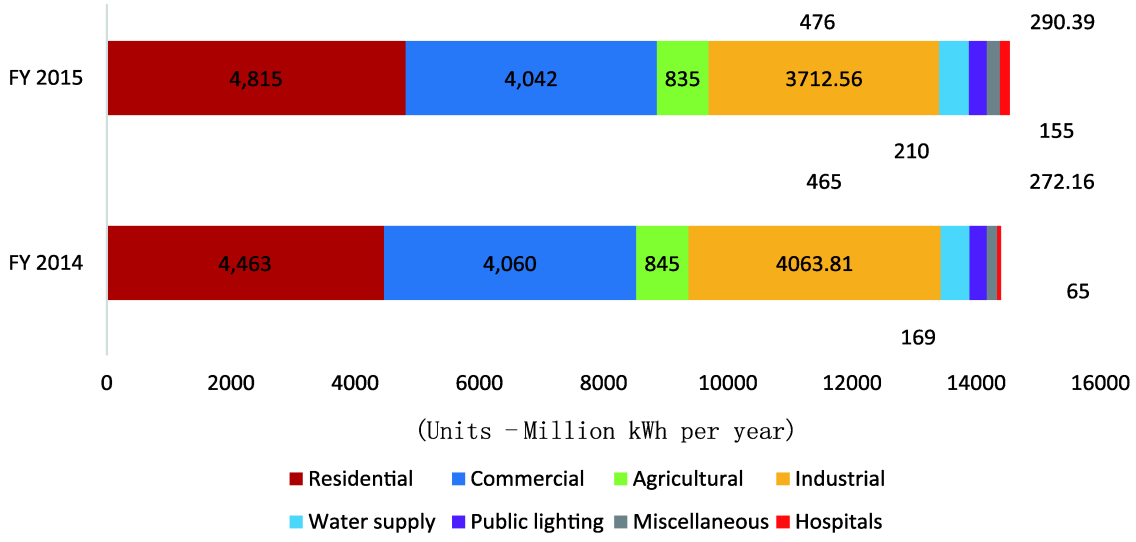

Figure 1. Category wise electricity consumption Bangalore Urban and Rural Circles[7].

is revised to 2,300 MW by 2022[13]. The estimated utility scale solar target for Karnataka will be close to 4,371 MW by 2022[14].

Of this, BESCOM's estimated targets, based on its share (48%[6]) of electricity within Karnataka, will be 1,104 MW of rooftop solar PV and 2,098 MW of utility scale solar PV respectively by 2022. In contrast the current installed rooftop solar PV and utility scale solar PV capacity in BESCOM area is 9.5 MW[15] and 174 MW[16] respectively.

To achieve the targets and fill the energy deficit, it is important for BESCOM to devise suitable strategies to engage with its stakeholders.

WRI India, in its bid to support Bengaluru scale up solar power, has devised some strategies to engage with each of the utility's stakeholders. This paper tries to capture how these strategies are designed and lessons learned from the work done based on such strategies.

2.2 Choice of Consumer Groups to Engage

Within Bengaluru city, commercial, industrial and residential consumers collectively have consumed more than 85%[8] of BESCOM's electricity consistently over the last 3 years. This makes for a strong case to engage with these stakeholders to scale up the deployment of solar across Bengaluru.

2.3 Existing Policy Framework for Solar Power Procurement as of 2014

In India, only consumers connected at >1 MW are eligible for procuring power through the grid, from sources other than the state utilities. This mechanism is called Open Access. Residential consumers, except apartment complexes connected at >1 MW, are not eligible for (solar) power procurement through Open Access mechanism[17].

2.3.1 On-site Solar Procurement by Commercial and Industrial Consumers

On-site solar PV projects connected behind the utility meter on consumer premises are not governed by any regulations. Businesses could either invest in a rooftop solar installation by themselves or sign a Power Purchase Agreement (PPA) with a third-party investor/developer. In both the cases the investors could make use of the Accelerated Depreciation benefit that helps write off 80%[18] of the asset value in the first year of the project.

Net-metering that allows for exporting excess power generation (especially because of no demand during weekend) to BESCOM was not allowed before 2014. As a result, on-site solar PV project sizing had to be done according to the base minimum load on weekends – and this limited the scale of deployment. At INR 8.40/kWh[19], rooftop solar was still expensive compared to the ∼ INR 5.75−7.25/kWh[20] for grid tariff of C & I consumers at that time. It was still not perceived as a reliable technology by the large buyers.

Because of the above reasons, only progressive companies went ahead for rooftop solar either on pilot basis or as part of corporate sustainability efforts.

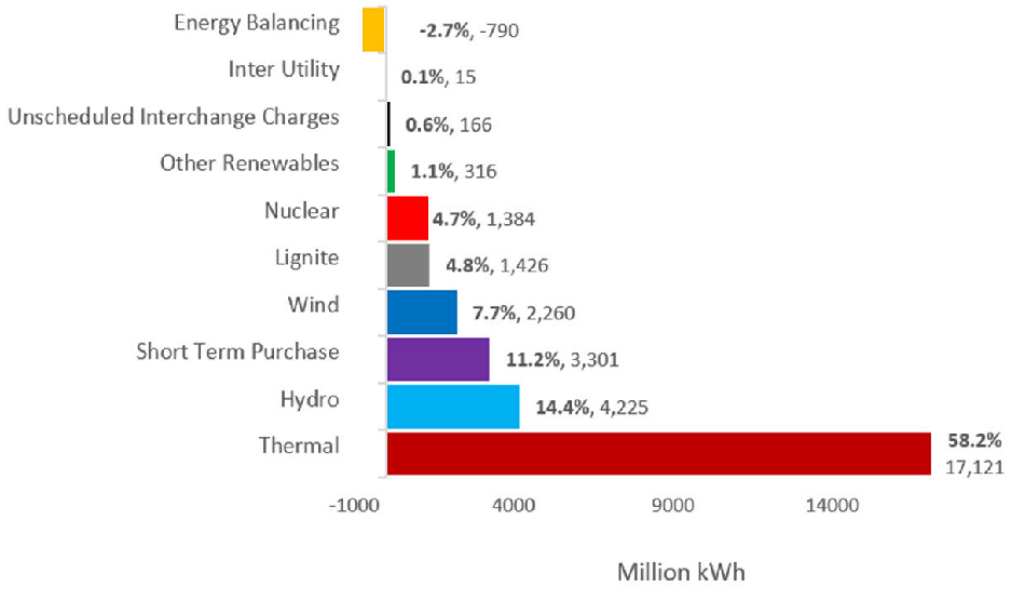

Figure 2. BESCOM's electricity procurement during 2014−2015: Share of various fuel sources[8].

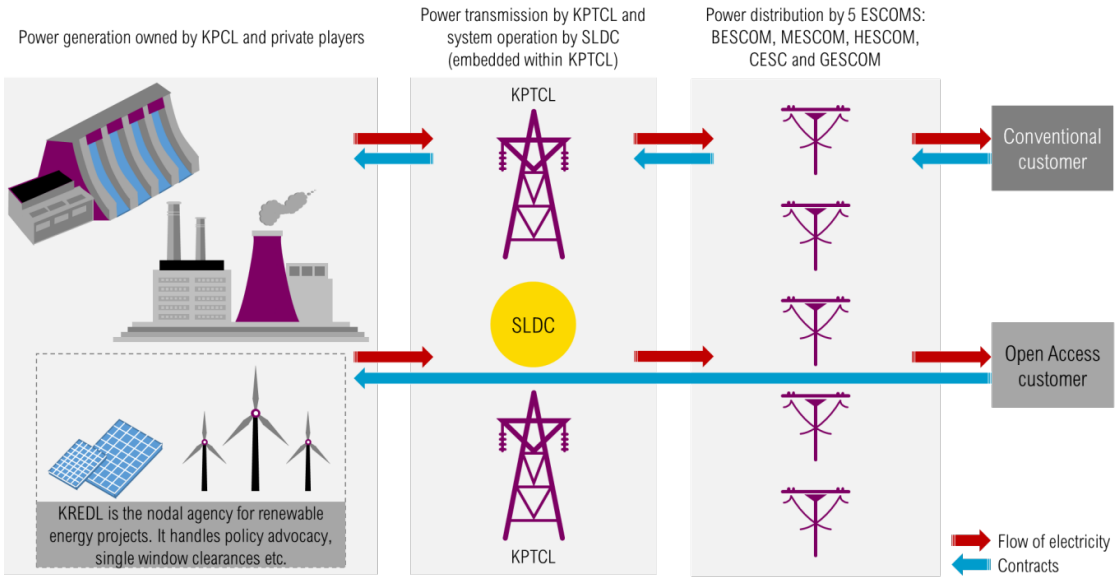

Figure 3. Open Access Mechanism.

2.3.2 Off-site Solar Procurement by Commercial and Industrial Consumers

Businesses could either invest in an off-site solar installation by themselves or sign a Power Purchase Agreement (PPA) with a third-party investor/developer. In both the cases the investors could make use of the Accelerated Depreciation benefit that helps write off 80% of the asset value in the first year of the project. Grid usage charges and Cross Subsidy Surcharges (CSS) are to be paid to the relevant transmission and distribution utilities. Grid usage charges include transmission charges, banking charges, reactive charges etc., whereas CSS is meant to offset the utility's loss of income from these high paying consumers.

2.3.3 Deployment of Roof-top Solar in the Residential Sector

Residential roof-top solar projects that are connected behind the utility meter are not governed by any regulations. Tax benefits are not available for residential solar projects. Limited capital subsidies are available on first come first serve basis from the central and state governments. Net-metering that allows for exporting excess power generation to the utility (BESCOM) was not allowed before 2014. As was the case in C & I consumers, project sizing has to be done according to the base minimum load on weekends – and this limited the scale of deployment. At INR 8.4/kWh solar power was still expensive and still not perceived as a priority by the residential consumers. Because of the above reasons, only environmentally conscious High Net-worth Individuals (HNI) went ahead with rooftop solar projects.

3 Bengaluru Electricity Consumers' Characterization and Engagement Strategies

Each category of Bengaluru's electricity consumers represents a diverse set of needs, preferences, purchasing parity and behavioral patterns. Understanding these factors can go a long way in devising the strategies to help them get on to the solar bandwagon. Hence we have used SWOT analysis to characterize each of the consumer group below.

Testing the engagement strategies

In line with the strategies devised for both sets of consumer groups, WRI India has worked on scaling up solar power through the following 3 activities in Bengaluru:

- Collaborative Solar PV Procurement Project
- Policy advocacy on grid usage charges for utility scale solar projects and
- Identifying the barriers to the BESCOM's net-metering policy for residential rooftop solar projects

The lessons that we learned in each of these activities are summarized below.

3.1 Collaborative Solar PV Procurement Project

WRI India and Confederation of Indian Industry (CII) through the Green Power Market Development Group (GPMDG) initiative attempted to aggregate energy demand from six corporate buyers in Bengaluru – Coca

Commercial and industrial consumers	
Strength	**Weakness**
• Ability to pay for costly power, if needed. HT[1] commercial and industrial consumers are already paying in the range of INR 7.85 – 8.35 /kWh and INR 6.20 – 6.75/kWh respectively, as energy charges to BESCOM[21]. • Ability to invest in capital intensive projects. Some of the early movers have already invested in wind mills and rooftop solar projects. • Sustainability is part of the core business principles of large corporates. • The sheer volume of their energy requirement brings in benefits of economies of scale.	• Typically, require payback times of 3–5 years for investments • Complicated decision making process that involves several levels of approvals • Even more tricky in case of MNC with Indian operations • Information gaps and lack of internal capabilities, as electricity is not the core business
Opportunity	**Threat**
• Solar energy costs are falling rapidly. They are already cheaper than the tariff commercial consumers pay to the grid[22]. • A contract for solar power can lock in the energy costs for ~25 years. • Renewable energy offers an opportunity to reduce the carbon foot print and contribute towards achieving the sustainability goals of the business.	• Grid tariffs are rising continuously. BESCOM's commercial and industrial tariffs have risen at 6.09% and 4.46% on an average between FY 2011 – FY 2015[20]. • Regulatory framework and customer preferences do not favor businesses with large carbon footprint. Renewable Purchase Obligations (RPOs) mandate consumers with self-owned thermal power plants or 3rd party thermal power purchase contracts, to procure a certain percentage of the power from renewables. Non-compliance with RPO attracts penalties[23].
Engagement strategy	
• Use cost hedging and sustainability benefits of renewables as a lever to engage. • Fill-in information gaps about costs, government policies and business models to convince the top management, through direct engagement or by creating peer-to-peer networks. • Aggregate demand, wherever possible, to achieve economies of scale. • Use the power of their network to engage with policy makers about long-term policy stability.	

Residential consumers	
Strength	**Weakness**
• A typical individual house has enough roof space to generate at least ~70% power from installation of rooftop solar plant. • Significant proportion of individual houses already have inverters that can be used to store energy from rooftop solar plant.	• Multi-storied residential complexes have very small ratio of roof space to floor space. Hence such roofs have competing uses. • Cannot invest upfront in rooftop solar projects. • Information gaps and lack of internal capabilities, as electricity is not the core concern.
Opportunity	**Threat**
• Rooftop Solar energy costs are falling rapidly. It can help residential consumers offset the costly power from the top most consumption slab. • A contract for solar power can lock in the energy costs for ~25 years.	Grid tariffs are rising continuously. Reliability concerns in case of frequent load shedding especially during summers.
Engagement strategy	
• Unlike the commercial and industrial consumers, engaging with select residential consumers cannot yield a critical mass of projects that can go on to create a systemic impact. • Policy advocacy can have wide reaching impacts on the residential sector.	

Cola, Infosys, IBM, Cognizant, Philips and Bangalore International Exhibition Center (BIEC). The aim was to combine their rooftop solar procurement into one bid to achieve economies of scale and reduce transaction costs per project. This larger combined project size made this opportunity more attractive for project developers and financiers. Our hope was to demonstrate a new aggregated procurement model that could be replicated across India to accelerate the deployment of rooftop solar power. GP-MDG called this aggregated procurement model as the Collab Solar project.

CII helped in convening the buyers. WRI India helped the buyers in preliminary site assessments, tender documentation, and evaluation of the proposals from vendors etc. During the final negotiations the process slowed down because of the possibility of anti-dumping duty being contemplated on imported solar equipment. Because of this, the vendors wouldn't commit to a specific price. Therefore the project was called off. Following are some of the important lessons[24] that we learned during the Collab Solar project:

- The Aggregation model works best with companies within a small geographic area such as an industrial or business park level.
- Aggregating across a group of buyers with a collective minimum renewable energy demand of 8−10 million kWh/year (∼5−6 MW in project size) will negate the risk of project failure from any one individual buyer pulling out of the initiative.
- The creditworthiness of the buyers helps to mitigate the financial risks to project developers and can reduce the cost of project financing. Usually large companies which consume at least 1 million kWh

per annum tend to fall under this category and they can act as the anchor buyers.

- Aggregating demand based on the preference of the procurement business model is critical to be able to select the right vendors. For example, commercial buyers in our bundle paid a higher tariff to the grid and hence preferred a Power Purchase Agreement (PPA) with a solar power vendor to save on their bills. Industrial buyers in our group paid a lower tariff to the grid and preferred to invest in the renewable energy plant directly to make use of the capital tax benefit.
- Buyers need to become more comfortable with providing roof top data in order to get accurate proposals. Buyers we worked with were typically wary of disclosing rooftop data to the solar power vendors because of perceived security/confidentiality concerns. Design of solar power plants is highly location specific and needs to be optimised to maximise the return on investments. Better design leads to lower costs and more value to the buyers. Making buyers more comfortable with signing Non-Disclosure Agreements (NDAs) with the supplier to provide this information will improve the data collection process.
- Net-metering schemes which allow for excess rooftop solar power to be sold to the utilities will improve the economics of on-site solar. However, at the time of this pilot, Bengaluru did not have such a scheme in place. Thus the systems at individual sites had to be sized to the minimum load as there was no compensation for power sold to the grid. We used electricity demand on a typical weekend as a reference to quantify the minimum demand of a buyer. Sizing systems to the minimum load resulted in a smaller transaction size, as neither the vendor nor the buyers wanted to pay for the excess generation during the weekends.
- Early engagement with building owners/property management companies is needed. Several of the participants were in a leased space and found that in order to install a rooftop solar system on their premises, a tripartite commercial agreement between the buyer, vendor and the landlords was needed. Some building owners expressed interest in supporting a solar purchase, but others did not.
- Multi-National Companies (MNCs) who prefer to invest their own capital in a rooftop solar plant need to change their corporate charter to permit their entry into power generation business. While some companies in the collaborative solar project were willing to invest the time engaging relevant stakeholders to make this change to their corporate charters, most of them preferred a PPA as this does not require a change to their corporate charters. Companies need to check on the feasibility of changing their charters before making a final decision between a captive purchase model (using their own capital) and a PPA model (using operating budgets).

This experience will inform the design of the next iteration of demand aggregation projects to be handled by GPMDG across industrial or business parks in Karnataka, Tamil Nadu and other states. The idea is to make demand aggregation a well-established business model to be taken up by the market forces.

3.2 Policy Advocacy on Grid Usage Charges for Utility Scale Solar Projects

Large C & I consumers typically procure renewable energy from the grid through a Power Purchase Agreement (PPA) with third-party sellers or by investing in their own plants (captive projects). In both these cases they have to pay the grid usage charges to the utility, with an exception of waiver of Cross Subsidy Surcharges for captive projects. The Karnataka Electricity Regulatory Commission (KERC) had revised these charges multiple times in the past decade, leading to a great deal of uncertainty for developers & investors. Since the pay back for investment in a solar plant in India is between $8-10$ years, and is dependent on the grid usage charges as well, banks were unwilling to finance long term power purchase contracts in the absence of this policy certainty.

On 31st July 2014, KERC organized a public hearing meeting to decide on a draft regulation that fixed the grid usage charges for utility scale grid connected solar projects for only 5 years. The representation made by the GPMDG sought clarity and long term certainty on the solar tariff policy – especially in the light of a proposed national anti-dumping duty on imported solar equipment at that time. GPMDG was the only group at these meetings representing the large energy buyers who would be impacted by the decision.

On 18 August 2014, the Karnataka Electricity Regulatory Commission (KERC) passed order[25] number S/03/01 called '*Wheeling Charges, Banking Charges & Cross Subsidy Surcharge for Solar Power Generators*', whereby all solar power generators in the state who achieved Commercial Operation Date (COD) before 31 March 2018 were exempted from payment of grid usage charges (wheeling and banking charges) and cross subsidy surcharge[2] for a period of ten years from the date of commissioning.

This landmark order provided long term clarity for solar project developers and consumers. For C & I consumers, this exemption meant that solar energy became more viable while planning their energy mix.

From KERC's perspective, the main drivers for passing this order was the low rate of growth of solar en-

ergy installations in Karnataka and the prevalent trend of a reducing solar tariff seen against rising utility tariffs. The Commission hoped that this measure would facilitate greater and rapid growth of solar energy through third party open access and captive routes.

Without the timely intervention of the GPMDG, this policy would have likely been weaker as the earlier policy that was proposed provided certainty for 5 years, and after the GPMDG intervention, certainty was provided for 10 years.

The importance of this order can be gauged from the fact that the Bangalore International Airport Limited (BIAL) went ahead with its planned procurement of 12 MW through the open access route. It is expected that many other buyers would take advantage of this order.

3.3 Identifying the Barriers to the BESCOM's Net-metering Policy for Residential Rooftop Solar Projects

Net-metering is an arrangement through which solar PV system owners are credited for electricity that they export to the grid. In November 2014, BESCOM introduced a net-metering program after the Government of Karnataka's Solar Policy 2014−2021, and the Karnataka State Regulatory Commission's 2013 tariff order[26]. Under BESCOM's net-metering tariff, owners of rooftop solar PV systems are paid a promotional rate of 9.56 INR per kWh for net excess generation provided to the grid on a monthly basis. As of March 2016, over 5.6 MW of grid-connected rooftop solar PV systems on 262 rooftops had been connected[27]. But, while Bengaluru is making progress in capacity addition, the pace of rooftop solar PV system adoption will need to accelerate if Karnataka is to meet its solar goals.

To better understand the current barriers to BESCOM's net-metering program, WRI India interviewed a small set of local industry experts, project developers, and customers who have installed or want to install a rooftop solar PV system. The interviews shed light on what may or may not be working successfully to date with BESCOM's net-metering program, and what may or may not be discouraging potential prosumers from participating in the future.

Based on the interviews, we identified six barriers that appear to be preventing a wider scale-up of rooftop solar PV in Bengaluru:

- **Poor understanding of PV performance, cost, and payback**
  For example, 3 out of 12 residential prosumers interviewed did not know how much energy their rooftop solar PV system should produce annually (in kWh) and two more were unsure. Current residential prosumers without battery backup quoted a wide range of prices, from 70 to 135 INR per watt, depending on the installer and system requirements. While actual quotes from project developers varied less significantly, they still varied by roughly 20 percent, from 83 to 120 INR per watt.
- **Confusion on net-metering specifications**
  Consumers were not sure about being able to use hybrid inverters that allow them to use stored solar power during nights or power outages. They were also confused about contractual terms with the installer, tenure of contract with BESCOM, rate at which their regular grid consumption will be charged, and permissible size of the solar installation etc.
- **Uncertainty in project developer selection and interaction**
  Potential prosumers are often reliant on project developers for information about the net-metering program. However, the information that project developers provide is not always correct, and no mechanisms are in place to monitor the accuracy or quality of their services. Misinformation and the high number of project developers may undermine consumer trust and hinder current and future program adoption.
- **Limited reach and appeal of the net-metering program**
  BESCOM's net-metering program is attractive and attainable to only a small, relatively wealthy, and motivated segment of the population, limiting its potential reach and growth.
- **Limited effect of the promotional net-metering rate**
  Investing in a rooftop solar PV system that provides a household's annual energy demand and does not take advantage of the promotional 9.56 INR rate yields a return comparable to putting money into a savings account.
- **Limited institutional capacity of the program administrator**
  Bengaluru's net-metering program is relatively new and is experiencing growing pains. As more consumers join the program, BESCOM's institutional capapcity will need to be strengthened in order to overcome challenges such as long wait times for interconnection appointments and confusion with meter-reading processes. Many of these limitations are acknowledged by BESCOM; the utility recognizes that it is learning as it gains more experience with the program.

Drawing on insights and suggestions from local industry experts, project developers, and customers, as well as the literature we reviewed, we offer initial recommendations[27] for how program administrators and others can address these barriers:

- To address limited understanding among prosumers, program administrators can increase publicity and frequency of newspaper advertisements, and provide more detail on rooftop solar PV technology through lengthier articles or television reports. They can also facilitate information exchange through open knowledge-sharing platforms, and provide detailed information about realistic system costs and payback periods.
- To address a lack of clarity on net-metering program specifications and processes, program administrators can facilitate information exchange about net-metering program application, installation, and interconnection processes and specifications through online platforms or frequent prosumer gatherings. They can also develop concise program guidelines that specify each process in a step-by-step, easy-to-follow format, as well as expected timelines. These guidelines should include clear, up-to-date information about what is and is not allowed under the net-metering program.
- To improve prosumer trust in project developers, program administrators can offer an open certification process for developers, and an accessible and up-to-date list of certified developers to prosumers. Furthermore, program administrators can offer training and education programs for project developers, specifically about BESCOM's net-metering program specifications. These trainings will be useful for ensuring that project developers pass along the correct information to customers.
- To expand the limited reach and appeal of the net-metering program, program administrators can undertake market research to understand why the program appeals to some population segments more than others, and to identify how the program can be redesigned to reach a larger share of the population. Administrators can better promote the benefits of solar PV by highlighting community champions and stories of successful systems. Government agencies can also better promote current subsidy and loan programs, and create stronger and simpler financial incentives to lower the upfront cost of rooftop solar PV systems and attract interest from a broader range of residential customers.
- To maximize the effectiveness of current incentives provided under the net-metering program, program administrators should research the effectiveness of the promotional rate in attracting program adoption among the current prosumer demographic and large potential prosumer demographics. If the promotional rate is found to be effective, program administrators should more clearly and explicitly promote its economic benefits. If the rate is found ineffective, the funds supporting it can be redirected elsewhere.
- To strengthen institutional capacity, program administrators can introduce short-term solutions, such as streamlining approval procedures, as well as longer-term solutions, such as creating a "one window" unit that manages the entire net-metering process and provide specialized training sessions for employees.

In the meantime, the KERC has announced the gross metering option for C & I consumers and residential consumers from May 2016. On opting for this scheme, consumers have to sell all the electricity that their panels generate to the grid. There is no way of meeting one's own consumption through solar and exporting the excess, if any. The reception of this scheme, among the relevant consumer categories, has so far been slow and will be better gauged after an year.

BESCOM (along with the other ESCOMs in the state) needs to rapidly update its communication channels with the new information and ensure that the recommendations suggested by WRI India in case of net metering are followed with suitable modifications for gross metering.

4 Conclusion

Long-term stability in policies (for e.g. regarding grid usage charges for off-site projects) may facilitate adoption of solar power by C & I consumers. Net-metering schemes help them to exploit their rooftop solar PV potential to the fullest, by monetizing excess power generated. Making the new gross-metering scheme succeed for all categories of consumers must be a priority for BESCOM. Towards this WRI India has identified a few steps that could have potentially made the net metering scheme a success. We believe the same steps could be adopted to popularize solar installations under the gross metering scheme and contribute to increased solar installations in the city.

Acknowledgement

The authors would like to thank Ms K Sumathy (Executive Director, TIDE) and Ms Sarah Martin (Associate, WRI) for being very generous with their time and advice in reviewing this paper.

Key portions of this paper is based on the publications brought out by WRI in the recent past. The authors would also like to thank all the people associated with those publications, for their active participation and valuable inputs. We would like to thank Stephen M. Ross Philanthropies for their support to some of the underlying WRI publications used here.

The authors would also like to thank Shakti Sustainable Energy Foundation (SSEF); Department of Energy, Government of United States (DOE) and the Caterpillar

Foundation for their kind support to the Green Power Market Development Group (GPMDG) initiative. We would like to thank our partner in the GPMDG, Confederation of Indian Industry (CII) for helping build strong relationships with companies that are committed to integrating more green energy.

Special mention goes to Jaya Dhindaw for helping us in bringing out this publication.

References

[1] John C, Peter P, Jon C, *et al*., 2016, *Leadership by US Cities: Innovation in Climate Action*, Innovation Network for Communities; Bloomberg Philanthropies, viewed May 15, 2016. http://www.bloomberg.org/content/uploads/sites/2/2016/03/Innovation-in-Climate-Action.pdf

[2] CDP, 2015, *Can cities quit fossil fuels?*, viewed May 15, 2015, https://www.cdp.net/en-US/Pages/events/2015/cities/infographic-narrative.aspx

[3] Ramachandra T V and Aithal B H, 2016, Bengaluru's reality: Towards unlivable status with unplanned urban trajectory, *Current Science*, vol.110(12): 2207−2208. http://dx.doi.org/10.3141/2193-15

[4] Directorate of Economics and Statistics, Bangalore, *State and District Domestic Product of Karnataka 2014−15*, viewed November 11, 2016, http://des.kar.nic.in/docs/sip/State%20and%20District%20Domestic%20Product%20of%20Kar%2014-15.pdf

[5] The Times of India, *Karnataka contribution to India's GDP has increased*, viewed November 11, 2016, http://timesofindia.indiatimes.com/city/bengaluru/Karnataka-contribution-to-Indias-GDP-has-increased/articleshow/51466196.cms

[6] The Economic and Statistical Organization, Punjab, *State Wise Data*, viewed November 8, 2016, http://www.esopb.gov.in/static/PDF/GSDP/Statewise-Data/state%20wise%20data.pdf

[7] BESCOM, 2015, *MYT for 4th control period (FY19-FY21)*, viewed May 15, 2016, http://bescom.org/wp-content/uploads/2015/09/Chapter6-_Load_forecast-4th-control-period-1.docx

[8] BESCOM, 2015, *13th annual report of BESCOM for the financial year 2014−15*, viewed May 15, 2016, http://bescom.org/wp-content/uploads/2015/11/Annual-Report-2014-15.compressed.pdf

[9] Deccan Herald, *Widening power deficit causing longer outages*, viewed May 15, 2016, http://www.deccanherald.com/content/504022/widening power-deficit-causing-longer.html

[10] KREDL, *RE cumulative report*, viewed August 8, 2016, http://kredlinfo.in/General/RE%20cumulative%20report.pdf

[11] Deepak K and Ashok T, 2015, *Assessing the Impact of Karnataka Electric Regulatory Commission's Open Access Order for Solar Power Generators in Karnataka*, WRI India, viewed May 15, 2016, http://www.wri.org/publication/assessing-the-impact-of-kerc-order

[12] Government of Karnataka, *Solar Policy 2014−2021*, viewed May 15, 2016, http://www.gokenergy.gov.in/documents/Solar%20Policy%20English.pdf

[13] Government of Karnataka, *Solar Policy 2014−2021* (revised), viewed August 8, 2016, http://mnre.gov.in/file-manager/UserFiles/Grid-Connected-Solar-Rooftop-policy/Karnataka_Solar_Policy_2014-2021.pdf

[14] KERC, *Determination of tariff and other norms for Solar Rooftop and Small Photovoltaic Power Plants*, viewed August 08, 2016, https://www.karnataka.gov.in/kerc/Downloads/COURTORDERS-2016/TARIFF_FY-17/Solar_Tariff_2016/Solar_Rooftop_Photovoltaic_Tariff-ORDER-dated-02.05.2016.pdf

[15] Aruna Kumarankandath, *Karnataka launches gross metering for solar rooftop*, Down To Earth, viewed August 8, 2016 http://www.downtoearth.org.in/blog/kerc-introduces-grossmetering-for-solar-rooftop-along-with-tariffs-54122

[16] KREDL, *RE progress report*, viewed August 8, 2016, http://kredlinfo.in/General/RE%20cumulative%20report.pdf

[17] KERC, *Karnataka Electricity Regulatory Commission (Terms and Conditions for Open Access) Regulations, 2004*, viewed on July 23, 2016, https://www.karnataka.gov.in/kerc/Regulations/Regulations/openaccessregulation/finalopenaccess2004.pdf

[18] KPMG 2016, Union Budget 2016: Energy and Natural Resources, viewed on July 23, 2016, https://www.kpmg.com/IN/en/services/Tax/unionbudget2016/Documents/ENR.pdf

[19] KERC, *Determination of Tariff for grid interactive solar power plants including rooftop and small solar Photo voltaic power plants*, viewed on August 8, 2016, http://www.karnataka.gov.in/kerc/Downloads/COURT-ORDERS-2013/Final_Order-09.10.2013.pdf

[20] KERC, *Retail Supply Tariff approved by K.E.R.C. in Tariff Order for the year 2013−14 For BESCOM*, viewed on August 8, 2016, http://www.karnataka.gov.in/kerc/Downloads/COURT-ORDERS-2013/Tariff_Order_2013/TAG_ENGLISH_BESCOM.pdf

[21] BESCOM, 2015, *Tariff booklet 2015−16*, viewed on May 15, 2016, http://www.bescom.org/wpcontent/uploads/2015/03/Tariffbooklet-2015-16.docx

[22] Ashok T and Deepak K, 2016, *Corporate Renewable Energy (RE) Procurement Guide: Why and how?*, WRI India, viewed on May 23, 2016, http://www.slideshare.net/sachiaggarwal/corporate-renewable-energy-procurement-why-and-how

[23] Deepak K, 2015, *India's Supreme Court Reinforces Re-*

newable Energy Targets for Industry, World Resources Institute, viewed on May 15, 2016, http://www.wri.org/blog/2015/06/india%E2%80%99s-supreme-court-reinforces-renewable-energy-targets-industry

[24] Ashok T and Deepak K, 2015, *Aggregating Demand for Corporate Rooftop Solar Installations: Lessons from the Collaborative Solar PV Procurement Project*, WRI India, viewed on May 15, 2016, http://www.wri.org/publication/aggregating-demand-forcorporate-rooftop-solar-installations

[25] KERC 2014, *Wheeling charges, Banking charges & Cross Subsidy Surcharge for Solar Power Generators*, viewed May 15, 2016, http://www.karnataka.gov.in/kerc/Downloads/COURT-ORDERS-2014/Final_WB_CSS-18-08-2014.pdf

[26] KERC, 2013, *Determination of Tariff for grid interactive solar power plants including rooftop and small solar Photo voltaic power plants*, viewed May 15, 2016, http://kredlinfo.in/general/Final_Order-09.10.2013.pdf

[27] Sarah M and Joshua R, 2016, *Prosumers in Bengaluru: Lessons for scaling rooftop solar PV*, World Resources Institute, viewed May 15, 2016, http://www.wri.org/publication/prosumers-in-bengalarulessons-and-barriers