# Energy Consumption Patterns among and the Challenges in deploying Renewable Energy and Energy Efficiency in commercial buildings in the cities of Tamil Nadu and Karnataka

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*New Ventures India would like to acknowledge the support provided by the members of the various groups (commercial buildings, builders, architects, Energy Efficiency and Renewable Energy solution providers, energy services consultants) whom we interviewed and who provided inputs for the work. We deeply respect the efforts of both user organizations and vendors in the work they do in implementing environmentally and economically sustainable solutions. In many ways, our aim in New Ventures is to celebrate those efforts and smoothen their paths. We do hope that we have been able to capture the issues that would help in achieving these objectives.*

*We also express our gratitude to Dr. Ashok Das who has helped with introductions to his formidable network.*

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# INTRODUCTION TO THE SURVEY

The aim of the Survey was to identify the issues faced by commercial building owners, operators and managers in their energy consumption. The survey further aimed at gathering specific quantitative data that would help determine the scope and potential of these organizations to adopt Renewable Energy (RE) and Energy Efficiency (EE) solutions in their premises. Key technologies addressed are LED lighting, solar water heaters, solar PV and green power purchase.

## Target Audience of the Survey

The Survey covered a limited number of commercial buildings in the cities of Tamil Nadu (TN) (Chennai – 15 organizations, Madurai – 5 organizations), Karnataka (Ka) (Bangalore – 15 organizations). We started with the assumption (validated in the Survey findings) that the deployment of EE and RE solutions is not widespread so our Survey size was a random mix of large and small organizations, professionally managed and family run businesses.

The Survey covered the following five sectors of commercial buildings: office buildings, retail, hotels, hospitals and private educational institutions. The Survey included a mix of Indian owned organizations and Multi-national organizations. Within these organizations we talked to a variety of people: facilities managers (both in-house and outsourced), owners, and senior managers. There was no prior information available on the deployment of any EE and RE solutions in these organizations prior to them being contacted for the Survey.

## Methodology of Survey

The questions were designed to seek quantitative data about the capacity and energy consumption details of the organizations. The Survey questionnaire is enclosed in Annexure 1. The main questions were asked in the category of analysing energy units and price available from the Grid versus diesel generator sets, split between various components of electricity usage (lighting, HVAC, any other equipment), increase in the costs of electricity from the Grid, number of hours of outage and hot water requirement. These questions were chosen based on our understanding of the various RE/EE technologies available and the key drivers (electricity cost and supply) which make these technologies viable.

The questions were sent to the target audience after a one-on-meeting. During this meeting, the overall aim of the project was explained and the customer was exhorted to collect and share data. The process of data collection required multiple follow ups as customers did not have all the data available in one place and were often reluctant to share what they considered as confidential data. Some customers also expressed the view that they had shared data with other agencies before and were unable to see the benefit in doing so. The team was aware of some of these challenges and to address them, the team selected companies in which they had personal contacts or could leverage other contacts.

We started with the aim of getting 15 Survey responses from Chennai and 15 Survey responses from Bangalore. In the end, we were able to achieve this objective, even though it was very difficult for companies to share quantitative data with researchers. We believe that the following factors were important in helping us achieve our target:

- We were able to exhibit credibility emanating from the reputation of World Resources Institute as well as other partners in the work Indian Institute of Science, Bangalore and Madras School of Economics.

- We also actively reached out to Survey respondents with our own contacts and the contacts of alumni, colleagues and even family and friends. These personal networks further addressed the issue of credibility.
- We were upfront that individual company data would not be shared.
- We ensured value for respondents by sharing data on the various technologies involved.

*Survey size:*
*Chennai – 15 responded out of 23 targeted; response ratio of 65%*
*Madurai – 5 responded out of 6 targeted; response ratio of 83%*
*Bangalore–15 responded out of 40 approached for the Survey; response ratio of 38%*

The higher response ratio in Chennai and Madurai was on account of the power situation in TN: the high costs and the high number of hours of "load shedding" which meant that customers were interested to learn about new technologies. 5 of the 15 respondents in Chennai were located outside the main city premises.

The Surveys were conducted between September 2012 and November 2012.

## Methodology of analysis of Survey data

Along with the stand-alone data collected from the Survey, we have run some basic mathematical calculations on the available data. We have analysed the dependence on DG sets versus availability of power from the Grid. DG usage comes with annual maintenance and operational expenditure along with the cost of fuel (diesel). We have measured the cost of electricity from DG sets versus cost of electricity from the Grid and the average cost (DG+Grid) of electricity incurred by commercial buildings. Finally, we have measured the performance (Energy Performance Index) of the buildings based on the total energy consumed (DG+Grid) and the area of the building. This analysis will aid in understanding the future potential of EE and RE products in commercial buildings by city and by type of buildings.

### Key assumptions and calculations used in analysis

The final results, as presented in this report are based on the analysis conducted by New Ventures India. Where data is not available, New Ventures India has made estimates based on publicly available information and guidelines given by the Survey participants. We will explain the methodology for these calculations before analysing the Survey findings.

**DG usage vs. Grid usage:** All the buildings we interviewed have a back up DG set. The total energy consumed by a building is summation of the units produced by the DG set and the power drawn from the Grid.

*Total units produced by the DG set = Load connected to DG X Power factor of DG X hours of DG operation*

We collected data on the installed DG capacity and the DG capacity which is utilized in case of load shedding. The DG sets are not separately metered. Therefore, we use the utilized capacity where available or the actual load (power drawn from the Grid when supply is available) as a proxy for load connected to DG. We should note that this would err on the higher side since the entire connected load may not be turned on or the DG may be running at lower capacity based on the lower demand during outage.

Commercial buildings have provided the rated kVA capacity of DG. To calculate the equivalent kW capacity of the DG sets, we have used a power factor of 0.75. Where the building has provided the power factor, we have used the available power factor.

For hours of DG operation, we have used the average number of outage hours during operational hours. We enquired about the "average" number of hours to balance out the variation between summer and winter months. But since we conducted the survey in between September and November, the average hours may be on the lower side. The kW capacity multiplied by the hours of outage gives us the total units produced by the DG set or consumed by the building.

**Unit cost of electricity from DG set**

$$\text{Unit Cost of electricity generated by DG set} = \frac{\text{(Cost of diesel + Operations \& Maintenance cost)}}{\text{Total units produced by the DG set}}$$

We have collected data on the diesel consumed per hour from the commercial buildings. Where not available, we have assumed the cost per liter to be Rs.50 which is lower in some cases (SEZ's).

The commercial buildings have provided the Operations & Maintenance cost in some cases. Where not available, we have made assumptions based on unit O&M cost of running DG sets of given capacity.

**Cost of electricity from DG + Grid**

$$\text{Unit Cost of electricity generated from DG+Grid} = \frac{\text{(Cost of electricity generated by DG set + Cost of electricity from Grid)}}{\text{Total units produced by the DG set + Total units consumed from Grid}}$$

We have collected data on the average number of units consumed per month and the average tariff of electricity for the building. This gives us the total units consumed and cost of electricity from Grid.

**Energy Performance Index (EPI)**

$$\text{EPI} = \frac{\text{(Total units produced by the DG set + Total units consumed from Grid)}}{\text{Area of the building}}$$

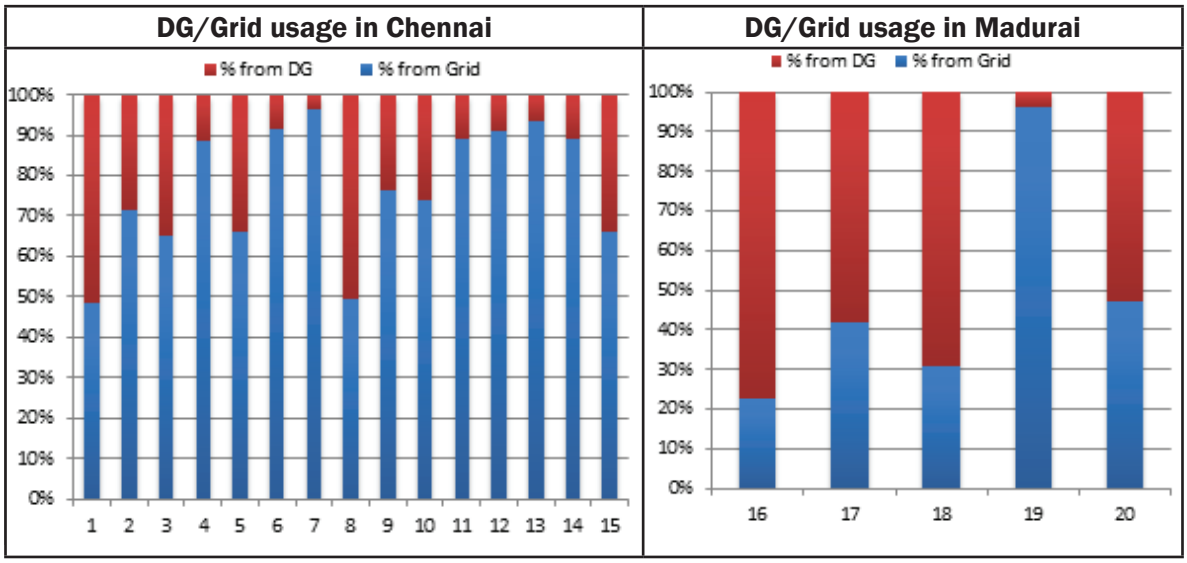
The commercial buildings have provided us with the area of their premises. This includes the area occupied by parking spaces, hallways, pantries, conference rooms and other public spaces. The area we use may be larger than the actual area that should be considered for EPI calculations. As a result, the EPI might err on the lower side since the lighting and cooling load is not equally distributed between the public spaces and working areas.

# SURVEY FINDINGS IN TN

## Power shortage is a serious issue with customers in TN.

Electricity users in TN have been suffering from severe power shortage since August 2012. Customers are relying heavily on DG sets. To understand the reliance on DG sets, we have calculated the split between units produced by DG and that consumed from the Grid.

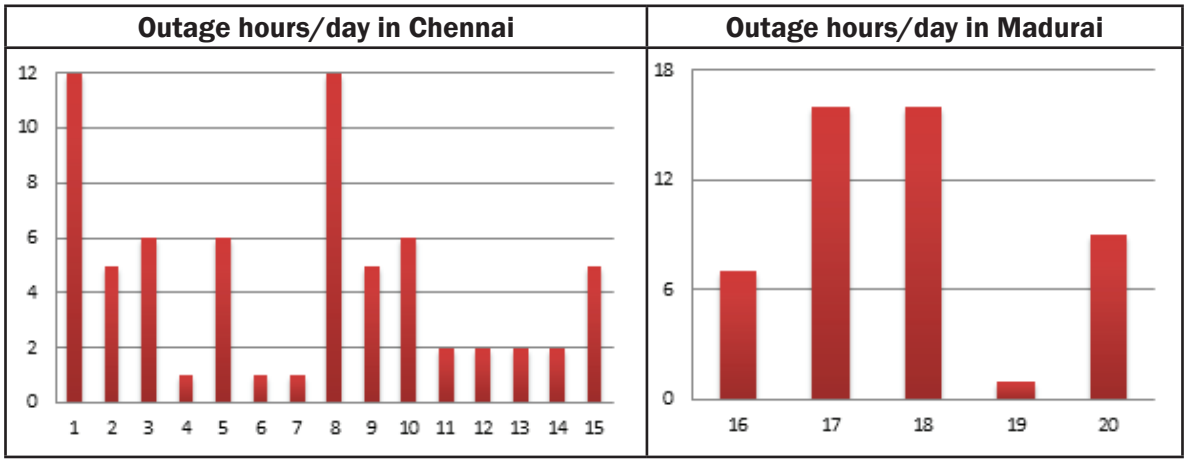
Figure 1: Units consumed from DG set and Grid in TN




**Source:** New Ventures India Surveys – The 15 data sets for Chennai above include offices, educational institutes, hotels, hospitals and retail malls. The 5 data sets in Madurai include educational institute, hospital, retail mall and hotels. Surveys conducted between September to November 2012. Sample calculations in Annexure

Outage during operating hours when DG sets have to be used is considered – referred to as outage hours below. Hotels operate for 24hrs while educational Institutes operate for 9 hrs. As seen in figures 1 and 2, longer hours of power cuts translate into greater DG usage.

Figure 2: Number of Grid Outage Hours

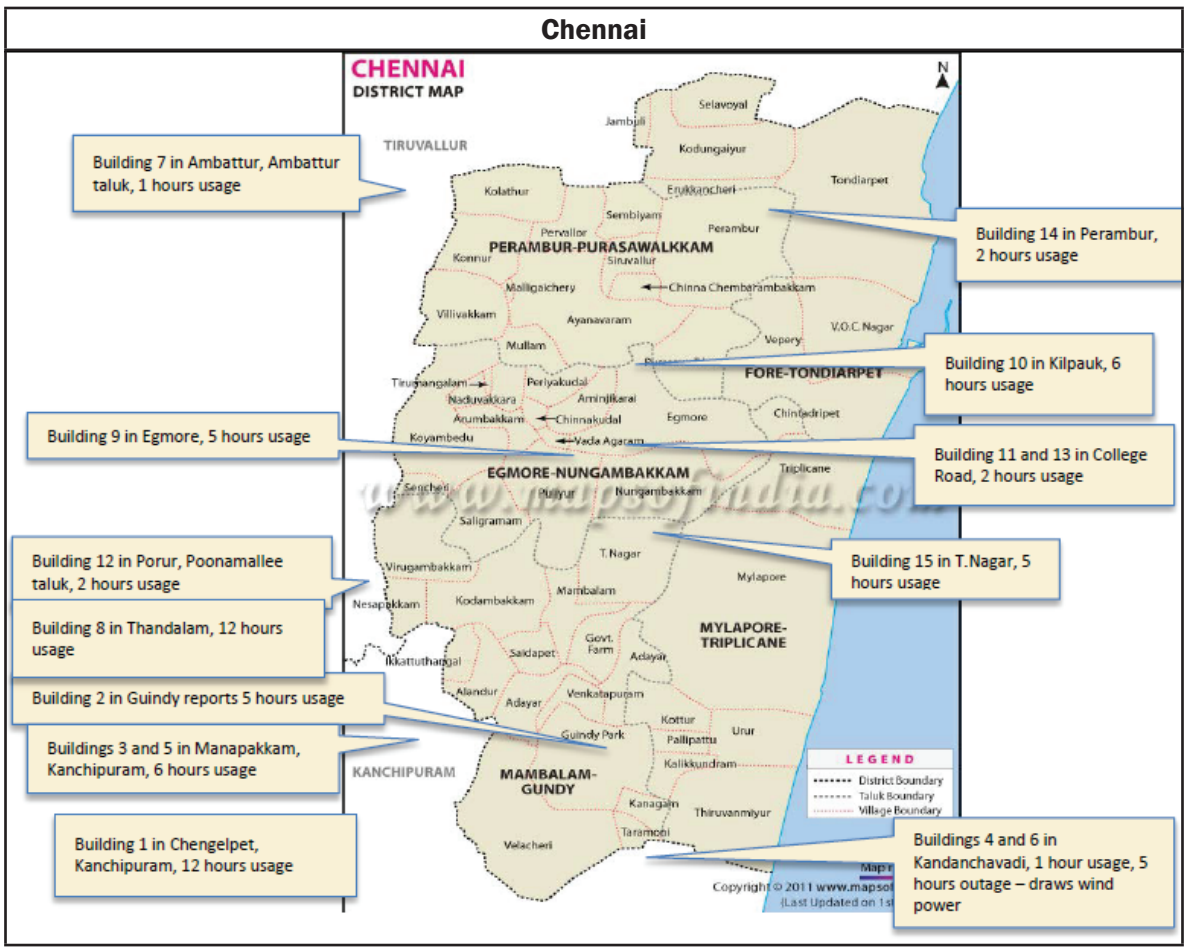



**Source:** New Ventures India Surveys – The 15 data sets for Chennai above include offices, educational institutes , hotels, hospitals and retail malls. The 5 data sets in Madurai include educational institute, hospital, retail mall and hotels. Surveys conducted between September to November 2012

Also, in Chennai, based on location, duration of power cut varies. In Chennai, the buildings 1 and 8 are an office and an educational institute respectively, each of which have 12 hours of load shedding per day. They operate for 24 hours and the office is located 50kms from the main city and the educational institute is located 35kms from Egmore area in the main city. Hotels, buildings 9,10 and 11 also operate for 24 hours. Further information on the location of the buildings can found in figure 3. Buildings 4 and 6 have 5 hours of load shedding, but they use the DG for only 1 hour as they draw wind power, reducing the hours of outage to 1 hour only.

The building 19 in Madurai is an exception due to the continuous access to power, which indicates that even within a city there could be differences in power availability patterns. Buildings 17,18 and 19 are located in the main Madurai city. DG set usage is higher in 17 and 18 as they are hotels with 24 hours of operation. Building 16 is located in the outskirts. While buildings 16 and 20 have the average 9-12 hours of operation in a day.

**Figure 3: Building Locations and hours of DG usage**




**Source:** Map from Maps of India. New Ventures India Surveys – The 15 data sets for Chennai above include offices, educational institutes, hotels, hospitals and retail malls. The 5 data sets in Madurai include educational institute, hospital, retail mall and hotels. Surveys conducted between September to November 2012

The high use of DG set is due to the power cuts, peak hour restrictions and peak hour and maximum demand restrictions imposed by TNEB.

**Table 1: Issues resulting in DG usage**

| Issues | Resulting in heavy usage of DG |
|---|---|
| Power cut duration | • Minimum outage of 2 hours on an average in Chennai<br>• Outage of 13-16 hours on an average in Madurai |
| Peak hour restrictions | • Only 20-40% of peak hour load (as defined by TNEB) between 6pm -10pm is supported by TNEB<br>• Remaining load is being supported by DG sets |
| Maximum demand restrictions | • Only 80% of the load during operating hours is supported by TNEB<br>• At all times, remaining load is being supported by DG sets |

**Source:** New Ventures India Surveys. Surveys conducted between September to November 2012

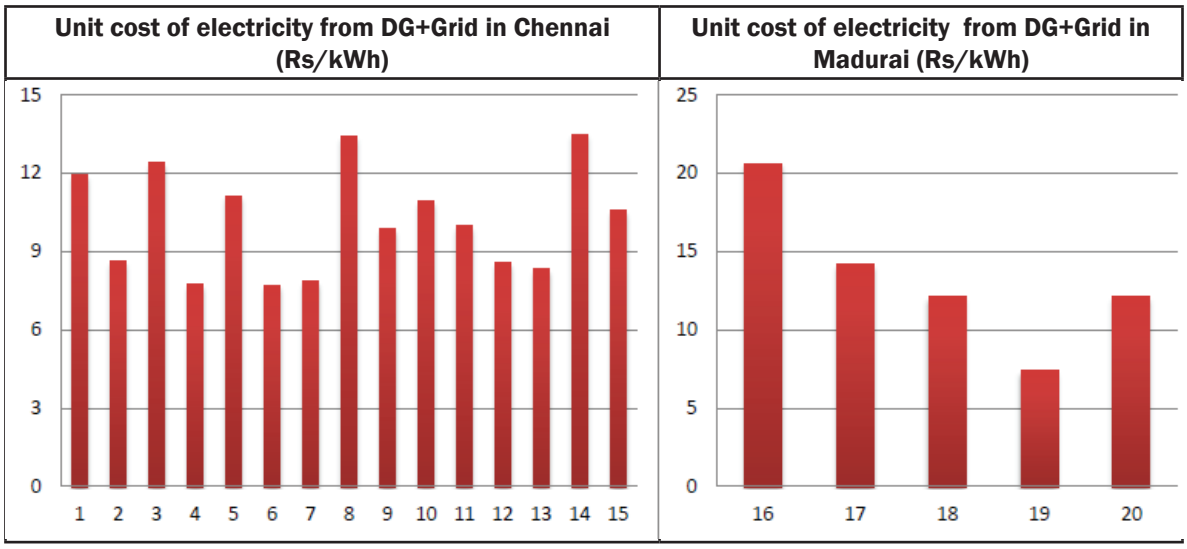
We observed that our target audience was paralyzed by the power situation in the state. Office spaces have reported productivity losses. Students in educational institutes suffer because of the fewer functioning hours of scientific and engineering laboratories and due to rescheduling of examinations and classes.

The losses are significant from what we have observed. For instance, an educational institute in Chennai – building 7 faces only an hour of power outage during operating hours. But, they cannot operate the labs and kitchen during this one hour of outage since they do not have enough DG back up. Major machines in the labs cannot be supported by their DG sets; as a result, students suffer.

Hotels have reported electronic equipment failure due to frequent trips and complaints from occupants due to inability of the hotels to meet all pantry and laundry requests. Hospital patients and staff complain about the temperatures when air conditioning has to be switched off.

Low DG efficiency and under-utilized DG sets along with increasing diesel prices have driven up the total electricity expense (learn more about DG costs below). We observed that the average electricity cost has gone up due to the extensive DG use.

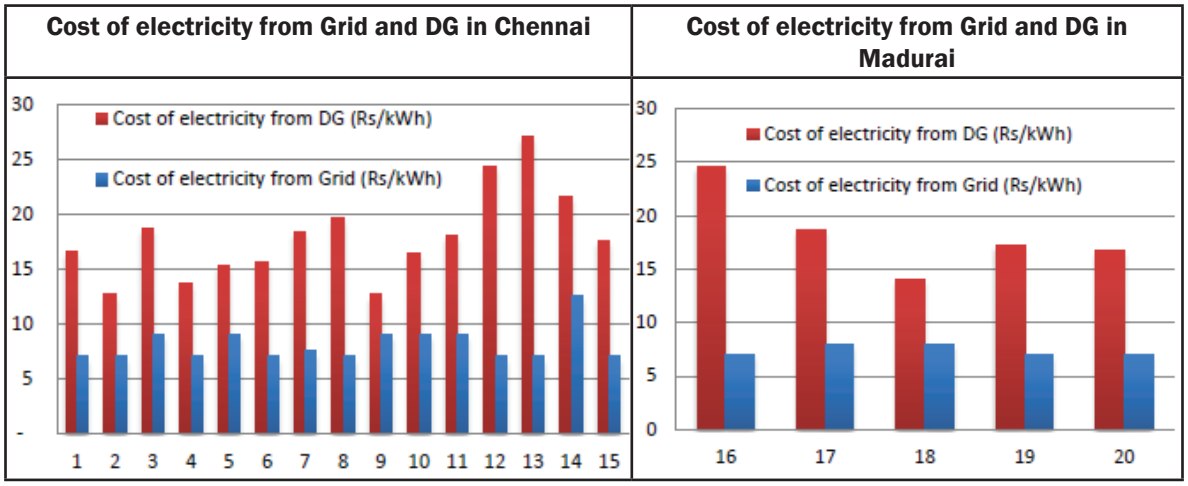
**Figure 4: Weighted average cost of electricity**




**Source:** New Ventures India Surveys – The 15 data sets for Chennai above include offices, educational institutes , hotels, hospitals and retail malls. The 5 data sets in Madurai include educational institute, hospital, retail mall and hotels. Surveys conducted between September to November 2012

The above analysis is based on the average unit costs of electricity from the Grid and DG. Cost of electricity from DG is more than double that of the cost of electricity from Grid as we can see below:

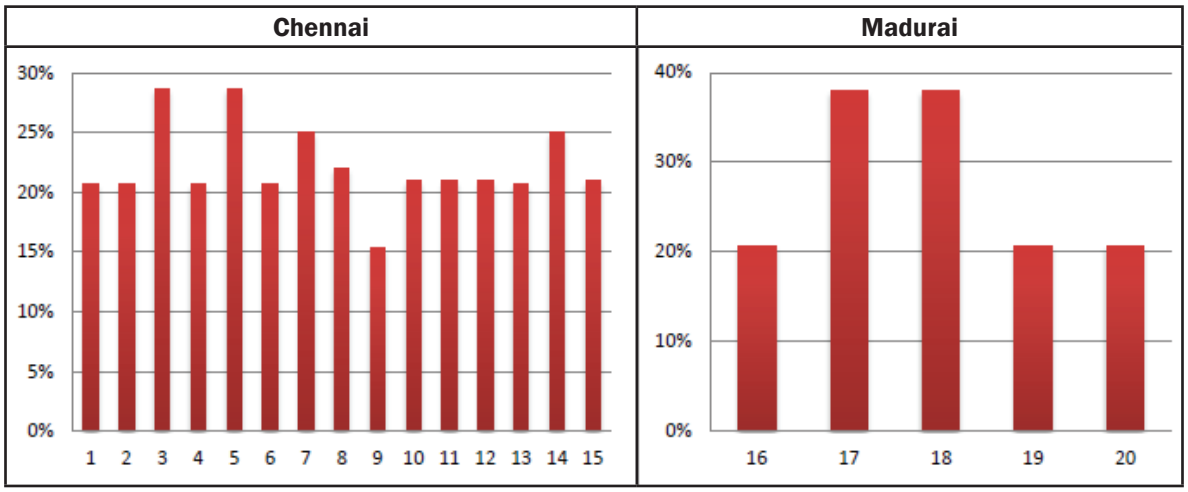
**Figure 5: Grid and DG electricity cost**




**Source:** New Ventures India Surveys – The 15 data sets for Chennai above include offices, educational institutes , hotels, hospitals and retail malls. The 5 data sets in Madurai include educational institute, hospital, retail mall and hotels. Surveys conducted between September to November 2012

Cost/unit from the Grid is defined for respective slabs. However, cost/unit in the above figures is the average cost incurred by the commercial organization based on number of units consumed per month across the slabs.

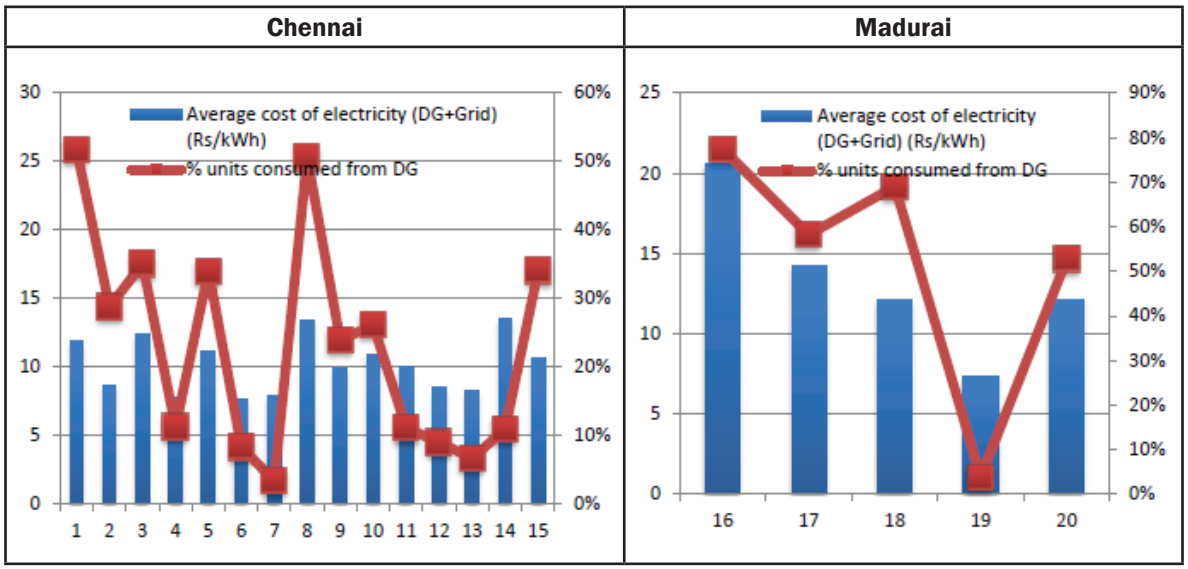
**Figure 6: Increase in cost of electricity from the Grid due to a price revision within the last six-eight months**




**Source:** New Ventures India Surveys – The 15 data sets for Chennai above include offices, educational institutes, hotels, hospitals and retail malls. The 5 data sets in Madurai include educational institute, hospital, retail mall and hotels. Surveys conducted between September to November 2012.

There is a clear co-relation between the high DG usage and the average cost of electricity from DG+Grid. Buildings with high DG usage pay a relatively higher price for their electricity.

**Figure 7: Correlation between DG usage and average cost of electricity paid by the commercial building**



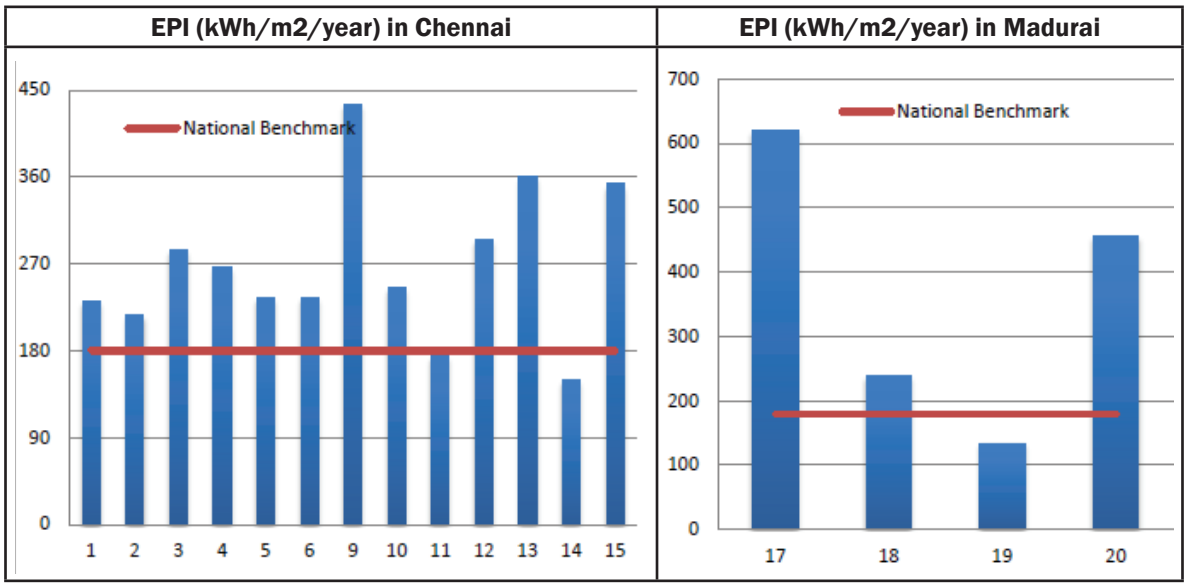

**Source:** New Ventures India Surveys – The 15 data sets for Chennai above include offices, educational institutes, hotels, hospitals and retail malls. The 5 data sets in Madurai include educational institute, hospital, retail mall and hotels. Surveys conducted between September to November 2012

The variation between the buildings is primarily due to the difference in the average cost of electricity from DG sets. This is a result of varying DG set efficiencies and different O&M and annual maintenance expenses for each DG set. In Chennai, building 14 is an exception to the trend. Despite the relatively lower rate of DG usage (11%), it pays a higher rate for electricity. This is driven by the high average cost of electricity from the Grid.

*Based on the data on the energy consumption, we observe that the energy performance of buildings we interviewed in TN is much higher than the national benchmark.*

We calculated the basic Energy Performance Index (EPI) for all the organizations we Surveyed (Sample calculation in Annexure). The national benchmark is set at 180 kWh/m2/year (please see “Browse by End User Segment” in nvindia.biz/energy/). However, the heavy usage of DG in TN has resulted in relatively higher EPIs as below (a high Energy Performance Index means that buildings are poor in energy performance).

Figure 8: Energy Performance Index (EPI) of buildings




**Source:** New Ventures India Surveys – The 15 data sets for Chennai above include offices, educational institutes , hotels, hospitals and retail malls. Surveys conducted between September to November 2012.

In Chennai, the buildings 7 and 8 correspond to educational institutes. In Madurai the missing building 16 corresponds to an educational institute. The area for each of these units is not available; they have been excluded from the EPI charts.

## Power Consumption patterns

HVAC forms the major share of the total load across all segments. In hospitals and malls, HVAC accounts for 60-70% of the total load. In office buildings and IT complexes, HVAC accounts for around 40% of the total load, rest split between lighting and other loads (lifts, UPS, computers). In educational institutions, lighting has a higher share of around 30%.

## RE and EE technology penetration

LED and Solar water heaters are the only technologies that have some awareness amongst the commercial buildings. Commercial buildings are aware of the purpose served by these technologies. In the case of LEDs, we have seen that people have a general idea that LEDs can achieve savings but they are not cognizant of the % savings that can be achieved. But even they do not have high penetration.

Despite awareness, in the two cities, LED lighting and solar water heaters were deployed by only some of the customers we interviewed. Of all the places that we interviewed who had hot water requirements, only about 30% actually use solar water heaters in Chennai and 25% in Madurai use solar water heaters.

**Table 2: LED and Solar water heater penetration**

| Usage amongst Surveyed organizations in | LED | Solar water heater |
|---|---|---|
| Chennai | None of the 15 places have 100% replacement. 4 had partially replaced their lights with LEDs. Remaining 11 had no LEDs | 2 of the 7 places which had hot water requirements used solar water heaters |
| Madurai | None of the 5 places have 100% replacement. 1 had partially replaced the lights with LEDs and remaining 4 had no LEDs | 1 of the 4 places which had hot water requirements used solar water heaters |

**Source:** New Ventures India Surveys. Surveys conducted between September to November 2012

In Chennai, buildings 1 and 10 that report the highest outage (12hours/day) have not installed LEDs. Building 10 has hot water requirement but does not have solar water heaters. The buildings that have invested in LEDs, have 2-6 hours of power outage. While the ones with hot water requirements that have solar water heaters have the average 2 hours of power outage only.

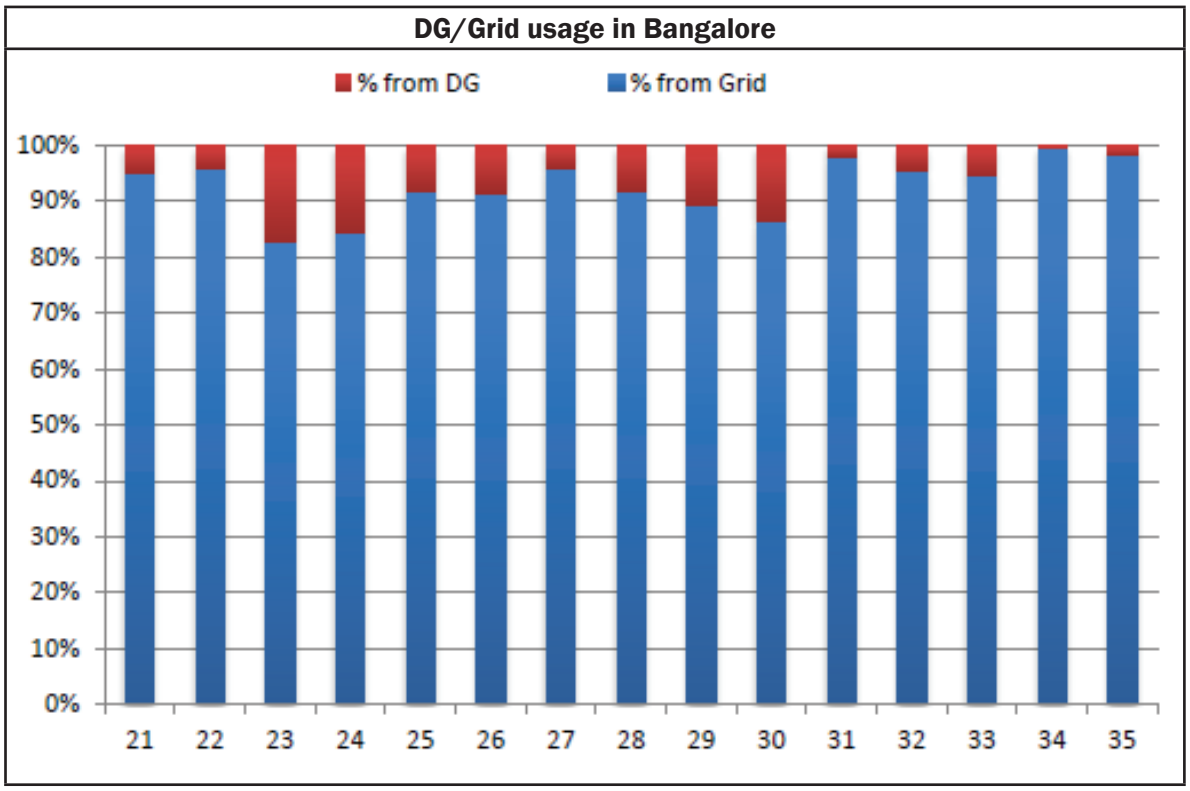
In Madurai, buildings 17 and 18 are hotels. Each of these hotels have reported 16 hours of power outage during over the 24 hours of operation. Building 17 also has the highest EPI within the Madurai Survey set. 17 has partially replaced its existing lights with LEDs. However, they have not yet used solar water heaters. Building 19 that has lowest DG consumption and the lowest EPI within Madurai Survey set has invested in solar water heaters.

# SURVEY FINDINGS IN KA

## Power outage is not a serious issue with customers in Bangalore.

Survey takers in Bangalore did not have major issues with the Grid connection. On an average, more power cuts have been observed across the summer months (March – June) compared to the monsoon/winter months (July – January). Unlike cities in TN, in Bangalore the use of DG is limited.

**Figure 9: Units consumed from Grid and DG set**

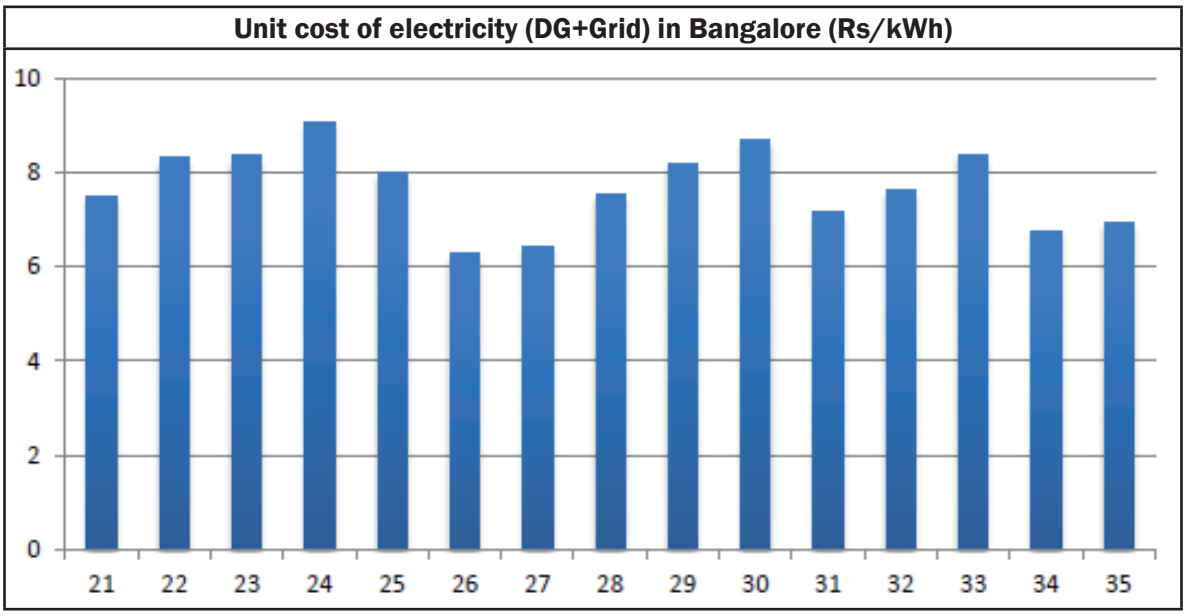



**Source:** New Ventures India Surveys – The 15 data sets for Bangalore above include offices, educational institutes, hotels and hospitals. Surveys conducted between September to November 2012. Sample calculations in Annexure

When compared to TN, the number of hours of outage is much lower in Bangalore. Based on Survey across sample space of offices, educational institutes, hotels and hospitals, the outage was intermittent and varied from a minimum of 10 hours in a month to 90 hours a month. The variation is also a function of the location of the organization. Longer hours of power cuts translate into greater DG usage. Buildings 24 and 30 report the highest number of outage hours per month – 90 and 56 hours respectively. Building 23 on the other hand reports only 38 hours of outage, but has one of the highest DG consumption. For building 23, due to absence of information, we have used the sanctioned load as a proxy for load connected to DG when DG is run. This may be on the higher side as the load connected to DG is generally lower than the total sanctioned load.

Due to the limited DG usage, we observed that the average electricity cost has only gone up nominally from the cost of electricity purchased from the Grid.

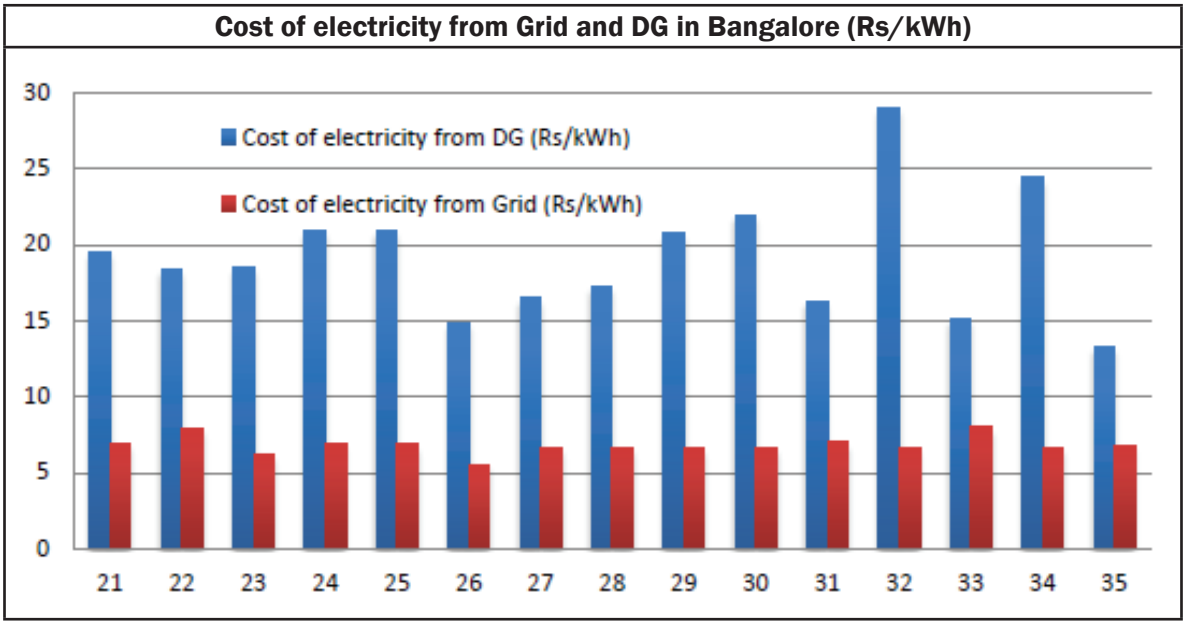
Figure 10: Weighted average cost of electricity




**Source:** New Ventures India Surveys – The 15 data sets for Bangalore above include offices, educational institutes, hotels and hospitals. Surveys conducted between September to November 2012. Sample calculations in Annexure

The above analysis is based on the average unit costs of electricity from the Grid and DG. Cost of electricity from DG is more than double that of the cost of electricity from Grid as we can see below. However, due to the below 20% DG usage, the average cost of electricity from Grid+DG is only nominally higher than the cost of electricity from the Grid.

Figure 11: Grid electricity cost




**Source:** New Ventures India Surveys – The 15 data sets for Bangalore above include offices, educational institutes, hotels and hospitals. Surveys conducted between September to November 2012. Sample calculations in Annexure

Cost/unit from the Grid is defined for respective slabs. However, cost/unit in the above figures is the average cost incurred by the commercial organization based on number of units consumed per month across the slabs.

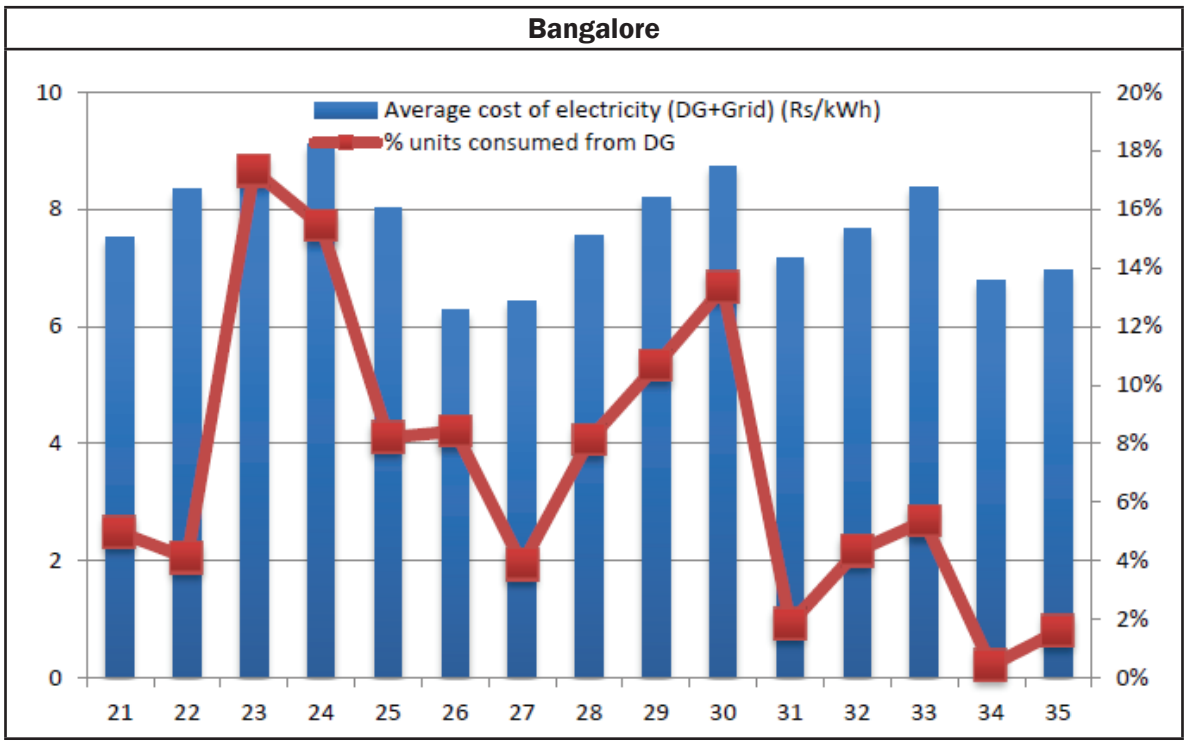
Units 32 and 34 incur high diesel and O&M expense per kWh which increases the unit cost of electricity from DG. Lower cost of electricity from DG has helped in reducing the unit cost of electricity from DG for 33 and 35.

In Bangalore, the unit price electricity from Grid is Rs6.5/unit for consumption below 2,00,000 units/month. Any consumption above 2,00,000 units/month is priced at Rs7/unit. In May 2012, the unit price of electricity had gone up by 30% from Rs6.5/unit to Rs6.7/unit for the first slab and from Rs6.8/unit to Rs7.0/unit for the next slab. This applies to all but one data point which pays a lower price and also has a much higher monthly consumption rate.

Our survey respondents could not report data around split between HVAC, lighting and other equipment in Bangalore.

As in Chennai and Madurai, there is a co-relation between the high DG usage and the average cost of electricity from DG+Grid.

**Figure 12: Correlation between DG usage and average cost of electricity paid by the commercial building**

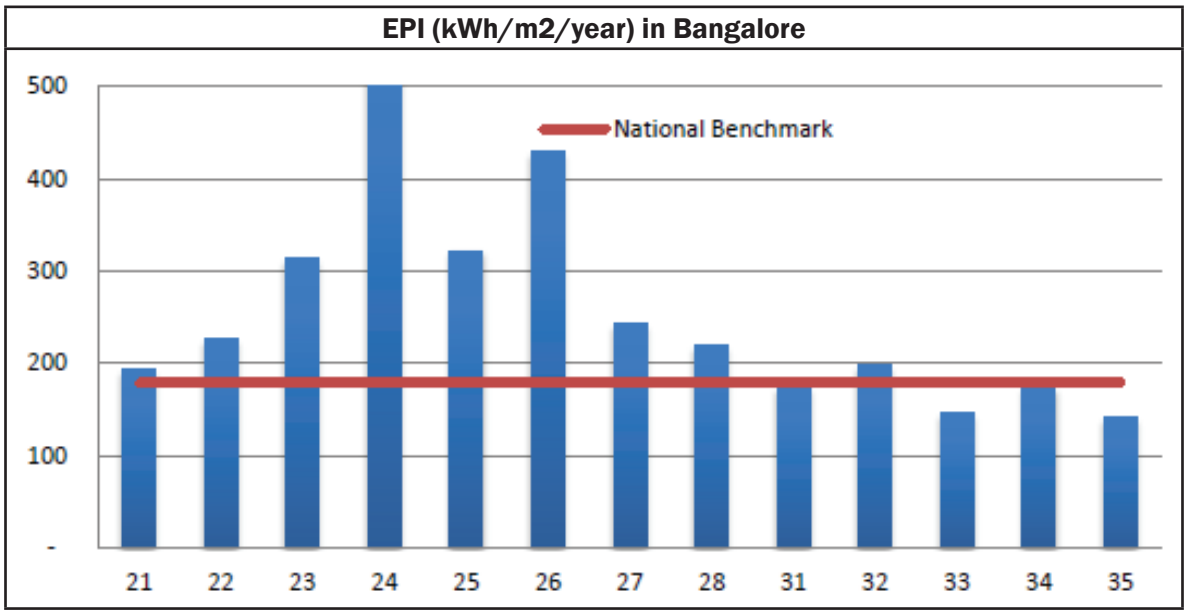



**Source:** New Ventures India Surveys – The 15 data sets for Bangalore above include offices, educational institutes, hotels and hospitals. Surveys conducted between September to November 2012

*The energy performance of buildings in Bangalore is still high.*

We calculated the basic Energy Performance Index (EPI) for all theorganizations we Surveyed. The national benchmark is set at 180 kWh/m2/year (please see End User Segment). Even though the use of DG sets is not high in Bangalore, the EPI of the buildings in our sample is very close to the national benchmark (three buildings) or higher (seven buildings), thus exposing the possibilities of efficiency in energy usage.

Figure 13: Energy Performance Index (EPI) of buildings




**Source:** New Ventures India Surveys – The 15 data sets for Bangalore above include offices, educational institutes, hotels and hospitals. Surveys conducted between September to November 2012. Sample calculations in Annexure

Building 24 has the highest average hours of monthly outage of 90 hours. Building 26 has to support its operations in the summer months by running DG sets along with the Grid.

## RE and EE technology penetration

LED, Solar water heaters and Solar PV that have some awareness. But they do not have high penetration.

Solar PV has very limited installations in Bangalore. However, despite awareness, LED lighting and solar water heaters were deployed by only some of the customers we interviewed. Of all the places that could use solar water heaters that we interviewed, 4 out of the 9 places use solar water heaters.

Table 3: LED and Solar Water Heater penetration

| Usage amongst Surveyed organizations in | LED | Solar water heater |
|---|---|---|
| Bangalore | None of the 15 places have 100% replacement. 5 had partially replaced their lights with LEDs and remaining 10 had no LEDs | 4 of the 9 places which had hot water requirements used solar water heaters |

**Source:** New Ventures India Surveys – The 15 data sets for Bangalore above include offices, educational institutes, hotels and hospitals. Surveys conducted between September to November 2012

Buildings 24, 25 and 30 have the maximum power outage within our Bangalore Survey set. None of them have invested in LEDs. Hotels in Bangalore (in our dataset) do not have solar water heaters. The two medical buildings and two of the offices which require hot water in their pantry's have installed solar water heaters.

# FEEDBACK ON PERCEPTIONS, ISSUES AND BENEFITS OF RE AND EE TECHNOLOGIES FROM CUSTOMERS

As discussed earlier, there was no attempt to choose members of the target audience who had already deployed RE and EE solutions. However, during the course of our interactions, potential and actual customers freely shared their opinions.

Customers do have perceptions about RE and EE technologies that have acted as a deterrent for deployment of RE and EE technologies. While others who have installed these technologies have faced issues with the technology, installation and after service.

## Perception related issues of RE and EE technologies

We asked customers, who are not using specific technologies, and here are their top reasons for their hesitation:

**Table 4: Perceptions of customers in Chennai, Madurai and Bangalore**

| RE /EE | Top reasons why customers have not used these technologies in Chennai and Madurai | Top reasons why customers have not used these technologies in Bangalore |
|---|---|---|
| LED lights | • LEDs always have to supplemented with sensors to increase the efficiency which additionally increases the project cost | • LEDs cannot be used in areas where aesthetics or lux levels are important<br>• The technology is still evolving and has not stabilised. The products available in India are not reliable |
| Solar Water Heaters | • There is not enough space for a solar installation on the roof top | • There is not enough space for a solar installation on the roof top<br>• The sky is often overcast solar water heaters do not perform reliably |
| Green Power Purchase from wind farms | • Green power from wind is not reliable<br>• Subsidies are limited or not available due to demand outstripping supplies | • There is no awareness of this option as a practical one |
| Solar PV | • Though weighted average cost of electricity is high the awareness of solar PV as a practical option does not exist | • The technology is too costly, unreliable and does not have strong vendors<br>• The technology will not work in the overcast skies of Bangalore<br>• There is not enough space for a solar installation on the roof top |

**Source:** New Ventures India Surveys. Surveys conducted between September to November 2012

There is no awareness of energy efficient air conditioning like geothermal air conditioning and comfort cooling in any of the cities that we surveyed.

## Usage related issues of RE and EE technologies

We asked customers, who are using specific technologies, and here are the top usage issues they have experienced:

**Table 5: Usage related issues reported by customers in Chennai, Madurai and Bangalore**

| RE /EE | Top issues that customers have faced in Chennai and Madurai | Top issues that customers have faced in Bangalore |
|---|---|---|
| LED lighting | • There are high failure rates of auxiliary electronic unit like the rectifier unit, heat sinks and sensors. Frequent power cuts creates surge which results in these failures<br>• Quality of installed product does not meet required lumen requirement<br>• The right type of fixtures is not available for retrofits and retrofit installations require more time to break even | • It takes a long time to install (often over a month involving repeated assessments)<br>• It does not provide the same "warm lights" and cannot provide lux levels of 300 and above<br>• There are cases of multiple images<br>• There are high failure rates for certain types of LED products<br>• The right type of fixtures is not available for retrofits |
| Solar water heater | • There are space constraints as the roof tops of commercial buildings are used for utilities or other purposes. The projects are often not able to move beyond pilot stage | • Solar water heaters were not able to meet the morning peak hot water requirement.<br>• The temperature of the water in tap outlets varies widely (temperature increases if a tap has not been utilised for some time)<br>• Vendors do not provide turnkey and guaranteed solutions (integrating pumping and plumbing) |
| Green Power Purchase from wind farms | • It is difficult to identify the right supplier and suppliers are not reliable<br>• There is no fixed price for this model. Demand exceeds supply causing PPA prices to escalate<br>• Have limited or no subject knowledge, with few suppliers, have low negotiating power on pricing<br>• Wind power is not reliable. DG sets have to be kept as back up despite signing a PPA | • Not used in Bangalore |

**Source:** New Ventures India Surveys. Surveys conducted between September to November 2012

## Benefits derived from RE and EE technologies

At the same time some customers have started experiencing real benefits. The few customers who have installed LEDs (2 in Chennai and 5 in Bangalore) have benefited from the partial replacments. Similarly, the users of solar water heaters in Chennai, Madurai and Bangalore have found the performance of solar water heaters satisfactory.

We asked customers, who are using specific technologies, and here is what they had to say:

**Table 6: Benefits derived from use of RE and EE technologies**

| RE/EE | Top benefits customers are deriving in all cities |
|---|---|
| LED lighting | • Helps in reducing the operating cost |
| Solar water heater | • Performance is satisfactory and as per expectations |
| Green Power Purchase from wind farms | • Helps in handling scheduled power cuts and in meeting demand during peak hours |

**Source:** New Ventures India Surveys. Surveys conducted between September to November 2012

We noticed some promising steps. Customers are implementing LED technology by partial replacement of existing lights so that they don't feel the entire financial burden at one go. Model LED projects are run in newly planned properties that will be replicated if successful. Most importantly, people are looking out for alternatives and for solution providers.

# SUMMARIZING THE KEY SURVEY FINDINGS

We can conclude from our Survey that the energy situation is very different across the three cities. In the cities of TN (Chennai and Madurai) the number of outage hours was high and the number of units consumed from DG sets increased the weighted average cost of electricity. In the city of Bangalore, on the other hand, there is a far lower reliance on DG sets and therefore, a lower weighted average cost of electricity. The EPI of the buildings in Chennai and Madurai is much higher compared to the buildings in Bangalore. The EPI of buildings in Bangalore is still high, **thus exposing the possibilities of efficiency in energy usage.**

The above situation leads to the applicability of various technologies in the various cities. In Chennai and Madurai, the high usage of DG sets makes the use of Solar PV cost effective while Bangalore has a greater market for EE devices. But even in these cities, other RE/ EE measures in buildings like daylighting, insulation and energy management systems have not yet been addressed due to lack of awareness.

One key finding is that the energy consumption patterns and prices even within individual cities may vary widely. This is on account of many local issues. **There is thus, a significant need/ market for companies to provide tailored customized services.**

We observed greater appetite for these **measures in owned premises versus rented ones.** Also, where **commercial spaces are occupied by one organization,** such spaces have seen more investment. Larger and professionally managed offices have exhibited more interest in EE and RE measures.

**Three key conclusions stand out from the Survey:**

- The most serious matter with deployment of RE and EE technologies is that customers who had invested in these solutions expressed issues about using these technologies. These issues ranged from product quality in actual operations and lack of an end-to-end delivery model from vendors.

- Amongst the users and non-users, most customers (across all three cities) were only aware of solar water heaters and LED lighting. The awareness of other technologies (such as efficient air conditioning, solar PV and Green Power Purchase) was very low in Chennai and Madurai along with Bangalore, among members of our target audience.

- Even when there is awareness, there was significant hesitation in using even technologies such as solar water heaters and LED lights. The penetration of these technologies was low within our target audience. The main issue that our target audience shared were doubts about the technology and perceived lack of benefits. Customers, in general, seemed to be interested in experimenting specific pilots with these technologies. The customers we interviewed did identify the capital cost (and therefore the need for financing) but not as the top barrier.

This is an important finding. A lot of anecdotal evidence and discussions on the EE and RE market is focussed around the issue of financing (and how the lack of it is putting brakes on the market). Our conclusion is that vendors need to do far better job in making customers aware of the benefits, make it easy for them to purchase and install products and finally address issues around product quality. In our opinion, confidence in vendor solutions and service would also help NBFC (Non Banking Finance Companies) and Banks to provide specific project/asset finance for RE or EE.

# RECOMMENDATIONS

We have the following set of recommendations for vendors:

- Vendors must address the issue of product and service quality. Vendors must show how they are addressing specific concerns that customers have expressed in our Survey and meeting the needs of customers in various segments. We believe that satisfied customers are the most successful product evangelists and vendors are not doing enough to create delighted customers.
- Vendors must include customer service monitoring as a key process in their own organizations. Customer service monitoring should include processes by which customers can escalate concerns, tracking the resolution of issues and independent Survey of customer satisfaction.
- In addressing customer issues and putting customer service at the center of their offering,vendors would also address issues of perception and lack of awareness among customers. There is sometimes a tendency to brush these aside. However, the market will expand if customers feel more empowered. This is an opportunity for more established vendors to come together and jointly create an awareness campaign, fund an independent customer Surveys and so on.
- Vendors must form consortiums that will comprise of customers – both existing and potential. Such consortiums can get together through workshops to discuss the issues/ perceptions and benefits of using RE and EE technology.

We strongly recommend that this consortia of vendors and customers come together in focussed workshops with a focus on improving the efficiency of commercial buildings. These workshops should discuss real issues in usage about technologies and products and the potential savings. Such workshops should include other key players - in particular architects, civil and electricity consultants.

We have the following set of recommendations for all key stakeholders in the field:

- Similar Surveys should be conducted regularly over various time periods to arrive at the key data points that will allow vendors and customers to adopt appropriate technology solutions.
- Surveys should be expanded to include other cities of commercial importance in the states of TN and Ka.
- The Survey should be followed by regular customer-vendor days where customers can express their pain points and requirements and vendors their solutions.

We have presented this information along with a comprehensive data base on vendors and EE and RE solutions for commercial buildings in the NVI website - http://nvindia.biz/energy/. This can serve as a platform to support knowledge transfer and initiate dialogue between the key stakeholders. We intend to take the Survey results to the vendors through this website to kick-start the dialogue between the stakeholders.

# ANNEXURE

## 1. Questionnaire for commercial buildings Survey takers

| | | |
|---|---|---|
| **Location** | | Bangalore/Chennai/Madurai |
| **Address** | | Office address |
| **Commercial Building** | | Office/Hotel/Hospital/Educational/Mall |
| **Building ownership status** | | Owned/Leased |
| **Building Type** | | Office park, 4/5 star hotel, multi speciality hospital, eng-med-gen college |
| **Sources of energy** | | DG/Grid/Biomass/Solar/Wind |
| **Building data** | | |
| Buildings | | |
| Floors | | |
| Area (sq ft) | | |
| Staff | | Applicable to offices |
| Students | | Applicable to educational institutes |
| Rooms | | Applicable to hotels,hospitals |
| Beds | | Applicable to hotels, hospitals |
| Occupancy rates | | Applicable to hotels, hospitals |
| Hours of operation | | |
| Do you have residential campus | | Applicable to educational institutes |
| Number of Units Consumed per month from the gird (average) (units) | | Averaging over the year |
| Number of Units Consumed per month from the Grid (maximum) (units) | | Maximum over the year |
| Per unit cost of electricity (average) from the Grid (Rs/unit) | | Current cost |
| Any increment in unit cost of electricity observed over the last one, two, three years? | | |
| Connected Load (kVA) | | |
| Average actual Load (kVA) | | |
| Do you see any need of expansion of current load and by how much? | | If there are expansion plans |
| | | |
| Do you have sub-metering for electricity consumption? | | Yes/No |
| Split of electricity consumption between HVAC,Lighting, others? | | In % |
| Connected HVAC load? (kVA) | | |
| Connected lighting load? (kVA) | | |
| Other connected load? (kVA) | | |
| Do you have LED lights? | | Yes/No |
| Are your LED lights fitted with sensors to switch off/on based on room occupancy? | | Yes/No |
| Is there a need for low pressure steam ? If yes, what is the requirement/day? | | |

| | | |
|---|---|---|
| Hot water requirement/day? (liters/day) | | Hotels, hospitals, residential institutes, pantry |
| Do you have solar water heaters? | | Yes/No |
| Capacity of AC/chiller system? | | |
| Is your chiller water cooled or air cooled? | | |
| Are you split ACs energy star rated? | | Yes/No and rating |
| | | |
| Capacity of DG Set (kVA) | | |
| Power factor | | |
| Utilized capacity (kVA) | | |
| Have you purchased or leased your DG set? | | |
| Monthly lease for DG set? | | |
| Other operations and maintenance cost on the DG set per month? (Rs) | | |
| Does the monthly cost include AMC (Annual Maintenance Cost)? | | Yes/No |
| If not, please provide the total AMC (Rs) | | |
| Total unit expense figures on DG Set per month? (Rs/kWh) | | Seen in the range of 13-20 |
| Rate of diesel purchased for DG set (Rs/liter) | | |
| Number of litres of diesel used per hour | | Averaging over the year |
| Hours of electricity outage/day on an average | | Averaging over the year |
| Number of Days of DG set operation per month | | Averaging over the year |
| Average outage hours per month – when DG set has to be used | | Averaging over the year |
| Available roof area or other possible areas for installing solar panel? | | |
| Could you share the pain points, issues with existing energy sources | | |

## 2. Sample calculations for units consumed from DG set

| **Commercial Building** | **Hotel** | Data point 11 in the Chennai Data |
|---|---|---|
| **Hours of operation** | 24 | |
| Connected Load (kVA) | 1000 | |
| Average actual Load (kVA) | 750 | |
| Capacity of DG Set (kVA) | 1500 | 2 sets of 750kVA |
| Power factor | 0.75 | Assumed as 0.75 since it is not available |
| Utilized capacity (kVA) | 750 | kVA – using the average actual load |
| Hours of electricity outage/day on an average | 2 | Averaging over the year |
| Number of Days of DG set operation per month (days) | 30 | |
| Average outage hours per month | 60 | Averaging over the year |
| Capacity of DG Set (kW) | 562.5 | 750kVA X 0.75 |
| Average outage hours per year | 720 | 60 X 12 hours |
| Average units consumed from DG set in a year (kWh) | **4,05,000** | 562.5kW X 720 hours |

We have shaded the data provided by the hotel in yellow. The remaining data comes from our assumptions and calculations.

## 3. Sample calculations for unit cost of electricity from DG

| **Commercial Building** | **Hotel** | Data point 11 in the Chennai Data |
|---|---|---|
| Average outage hours per year | 720 | 60 X 12 hours, from table above |
| Average units consumed from DG set in a year (kWh) | 4,05,000 | 562.5kW X 720 hours |
| Annual O&M cost on DG set (Rs) | 1,00,000 | |
| Rate of diesel (Rs/liter) purchased for DG set? | 50 | |
| Number of litres of diesel used per hour/day (liters) | 200 | |
| Diesel consumption cost per year (Rs) | 72,00,000 | Average outage hours per year X Rate of diesel per liter X liters used per hour |
| Annual cost on DG set (Rs) | 73,00,000 | Annual O&M cost + Diesel consumption cost per year |
| Cost of electricity from DG set (Rs/kWh) | **18.02** | Total annual cost / Average units consumed from DG set in a year |

We have shaded the data provided by the hotel in yellow. The remaining data comes from our assumptions and calculations.

## 4. Sample for EPI calculation

| **Commercial Building** | **Hotel** | Data point 11 in the Chennai Data |
|---|---|---|
| **Hours of operation** | 24 | |
| Connected Load (kVA) | 1000 | |
| Average actual Load (kVA) | 750 | |
| Average units consumed from DG set in a year (kWh) | 4,05,000 | From table in Annexure 2 |
| Average units consumed from Grid in a month (kWh) | 2,70,000 | 9,000 daily |
| Average units consumed from Grid in a year (kWh) | 32,40,000 | 2,70,000 X 12 |
| Total average units consumed from DG+Grid in a year (kWh) | 36,45,000 | Units consumed from DG+Grid |
| Area of the premises (sq mt.) | 19,500 | |
| EPI (kWh/sq. mt.) | **175** | Total average units consumed from DG+Grid / Area of the premises |

We have shaded the data provided by the hotel in yellow. The remaining data comes from our assumptions and calculations.

## 5. Sample calculation for unit cost of electricity from DG + Grid

| **Commercial Building** | **Hotel** | Data point 11 in the Chennai Data |
|---|---|---|
| Total average units consumed from DG+Grid in a year (kWh) | 36,45,000 | From the table in Annexure 4 |
| Annual cost on DG set (Rs) | 73,00,000 | From table in Annexure 3 |
| Average units consumed from Grid in a year (kWh) | 32,40,000 | |
| Per unit cost of electricity from the Grid (Rs/kWh) | 9 | |
| Annual electricity cost from Grid (Rs) | 2,91,60,000 | Average units consumed from Grid in an year X Per unit cost of electricity from Grid |
| Total annual electricity cost from DG+Grid | 3,64,60,000 | Annual cost on DG set + Annual cost from Grid |
| Average cost of electricity from DG+Grid | **10.0** | Total electricity cost from DG+Grid/Total average units consumed from DG+Grid in a year |

We have shaded the data provided by the hotel in yellow. The remaining data comes from our assumptions and calculations.

# ABOUT THE AUTHORS

## SANJOY SANYAL

*Sanjoy has over 20 years of experience in finance and entrepreneurship, with a particular focus on the education and green infrastructure. He is concurrently the Director of New Ventures India, Under his leadership, New Ventures has developed a strong network of institutional investors and also been able to help early stage green entrepreneurs raise US$ 10 million in funding. Previously, Sanjoy was part of the management team at SumTotal Systems, a global leader in Talent Management software, where he managed services delivery out of India. As an entrepreneur, he has co-founded and run Aesthetic Technologies, which had major Indian and international firms as its clients and received venture capital funding from Indian investors. In addition, Sanjoy has worked at ITC Classic Finance Ltd. and ICICI Ltd. where he evaluated credit risk and managed debt and equity syndication for project financing. He also provides mentoring to early stage entrepreneurs in his capacity as a Charter Member of TiE. Sanjoy has a Post Graduate Diploma in Management from the Indian Institute of Management, Calcutta and a Bachelor of Technology degree from the Indian Institute of Technology, Kharagpur.*

## PAMLI DEKA

*Pamli brings more than six years of experience in the Energy Industry. She has worked in the oil fields, conducted research for clean technology companies and held consulting roles. With New Ventures India, she is working on a project to assess the potential of energy efficiency and renewable energy products for the commercial, residential and industrial sectors.*

*Prior to this she was a consultant in firms like Shell and BCG (Boston Consulting Group) with major focus on energy projects. As an Equity Research Analyst, she has authored broker reports for the carbon credit and solar sector for UK market. Pamli has an MBA from INSEAD and a Bachelor of Technology degree in the department of Chemical Engineering from Indian Institute of Technology, Roorkee.*

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