Analysis of Power Situation in Pune – A model towards Decentralization in the Domestic Sector

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Summary

In India, many of the cities witnessed an unprecedented pace of urbanization after economic reform in the ninety's. Due to the rapid urbanization the electricity requirement in urban centres is growing with the increasing population. Pune city also portrays a similar picture. As per 2001 census, Pune city had a population of 25.38 lakhs[1] while in 2011 the population of Pune city is 31.15 lakhs. Along with the growth in population the geographical area of the city has also increased over the years as villages on the fringe of the city have been included in the PMC limits. So the population growth in the city has occurred due to three reasons *viz.* natural growth, villages added to the PMC limits and in-migration. Pune is the second largest city in Maharashtra and seventh largest in India. The city has grown in terms of its area as well as population.

This paper primarily analyses power "demand-supply- shortfall" pattern of Pune city and explores the growth of electricity for various categories of electricity usage. Secondly the paper highlights the various energy conservation schemes introduced by the Central and state government. It further explores various methods of sustainable use of electricity *viz.* energy efficient appliances, improving the energy efficiency of buildings, implementation of Energy Conservation Building Code (ECBC) and use of renewable energy. Such measures would ensure that electricity requirements of the city will reduce and building would be energy self sufficient.

[1] Environment Sustainability Report, Pune 2009-10

Abbreviations

BAU- Business as Usual

BEE – Bureau of Energy Efficiency

ADSM - Agricultural Demand Side Management

BLY – Bachat Lamp Yojana

CII – Confederation of Indian Industry

CPP – Captive Power Plant

DGBDF – Distribution Generation Based Distribution Franchisee

DSM – Demand Side Management

ECBC – Energy Conservation Building Code

GoI – Government of India

HSD - High Speed Diesel

HT – High Tension

kWh – Kilo Watt Hour

LDO - Light diesel oil

MDSM - Municipal Demand Side Management

MERC – Maharashtra Electricity Regulatory Commission

MoP – Ministry of Power

MSEDCL – Maharashtra State Electricity Distribution Company Ltd

MW – Mega Watt

PMC – Pune Municipal Corporation

PVC – Photovoltaics

S & L - Standards and Labeling

SMEs - Small and Medium Enterprises

STP – Science and Technology Park

TWh – Terawatt Hour

TPC – Tata Power Company

ZLS – Zero Load Shedding

Introduction

Pune is the second largest city in Maharashtra and seventh largest in India. The city has grown in terms of its area as well as population. Pune had a population of around 1.5 lakhs in the beginning of the century (1901). By 1931 it was 1.9 lakhs. After 1941, population started increasing significantly. During 1941-51, the growth was about 86.75% due to expansion. Up to 1991, the decadal growth was in the range of 30-40 %. Natural growth and moderate amount of migration were the main contributors. During 1991-2001, the decadal growth was 60 %. It was observed that out of the population growth of PMC during 1991-2001, *i.e*. out of 9.7 lakhs 21% was due to natural growth, 41% was due to the territorial expansion and remaining 38% was due to net in-migration[2].

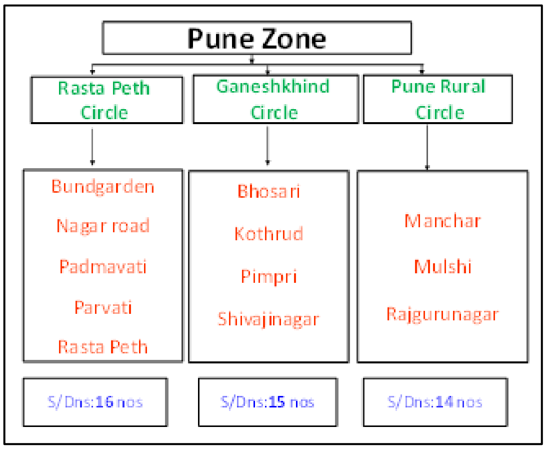
As per the 2001 census, Pune city had a population of 25.38 lakhs[3] while in 2011 the population of Pune city is 31.15, an increase of 23% in a decade.

This paper deals with the electricity requirements and solutions of the Pune Municipal Corporation limits. Rather than focusing on the distribution end, the paper focuses on the energy saving at the consumer end. This is due to the fact that there is a huge potential for energy conservation across different economic sectors.

Electricity supplied to the Pune city

In Pune electricity is provided by Maharashtra State Electricity Distribution Company Ltd (MSEDCL). As far as electricity distribution is concerned MSEDCL has divided the areas for distribution into zones, circles, divisions and sub-divisions.

MSEDCL has 14 Zones, 43 Circles and 629 Sub Divisions. Pune zone is divided into three circles *viz* Rasta Peth, Ganeshkhind and Pune rural circle. The circles are further divided into divisions and sub divisions. The administrative structure of the Pune zone for distribution of electricity is represented below. For the present study Rasta Peth and Ganeshkhind circles are considered.



2 http://government.wikia.com/wiki/Projections_from_Pune_Demographic_Survey and census data
3 Environment Sustainability Report, Pune 2009-10

Pune's energy requirement

Electricity demand has grown consistently in the city. In five years time (from 2005 to 2010) electricity demand in the city has increased by 27%. Rapid urbanization, population growth and industrial growth have placed enormous strain on the city's infrastructure. This has led to the deterioration in the electricity supply, with demand being higher than the supply.

Power demand, availability and shortfall in the city from 2005-2010[4] is provided in the table below. The demand is given taking into consideration Pimpri and Bhosari divisions as well. The maximum demand in 2010– 11 for Pune (including Pimpri and Bhosari divisions) has been registered up to 1100 MW[5].

Table 1 –Power demand, availability and shortfall in Pune urban zone from 2005 to 2010

Year	Power Demand* (MW)	% increase	Power Availability (MW)	% increase	Power Shortfall (MW)	% Shortfall
2005	700		600		100	14.29
2006	750	7	650	8	100	13.33
2007	782	4	650	0	132	16.88
2008	832	6	624	-4	208	25.00
2009	893	7	730	17	163	18.25
2010	959	7	755	3	204	21.27

* Average power demand has been provided

Power demand has always been higher than the power that is available. Power shortfall was 14.29% in 2005 and around 21.27% in 2010 (up to December 2010). As can be seen MSEDCL has been unable to meet the demand of the city and on an average there was a shortfall of 18.17% from 2005 to 2010. The growing number of residential, industrial and commercial consumers has led to an increase in the demand which has kept on increasing steadily every year. The average demand from 2005 to 2010 has increased by 6.2%, while availability has increased by an average of 4.8% only, whereas shortfall has increased on an average by 18.6% in the same time period. This implies that though the demand was increasing the availability of power was not increasing at par with the rising demand which resulted in shortfall.

The average growth rate of 6.2 in five years (2005-2010) time has been considered to calculate the growth in Pune for the year 2020, which works out to be around 1750 MW.

Table 2 - Power demand from 2010 to 2020

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Power Demand* (MW)	959	1018	1081	1148	1219	1295	1375	1461	1551	1647	1750

* Calculated at the rate of 6.2

[4] As per data obtained by RTI to MSEDCL dated 14 March 2011, No.CE/PZ/T/RTI/ 01582

[5] MSEDCL's presentation at National Conference on Urban Planning and Policy: A case perspective of Pune

Pune city has 16.4 lakh consumers across various economic sectors such as residential, industrial, commercial, etc. The requirement of energy is increasing in the domestic sector at a rapid rate in the urban areas as the standards of living of people are improving. The electricity needs of the domestic sector have increased by 36% while that of commercial sector has increased by 47% in a span of five years time (2005-10). Together these two sectors constitute significantly to the increased demand.

In the same time period (2005-10) the residential consumers have increased by 42% and commercial consumers by 43%. Electricity powers most of the appliances that come with increasing wealth. The graph below represents the growth residential, commercial and industrial consumers' in the city.

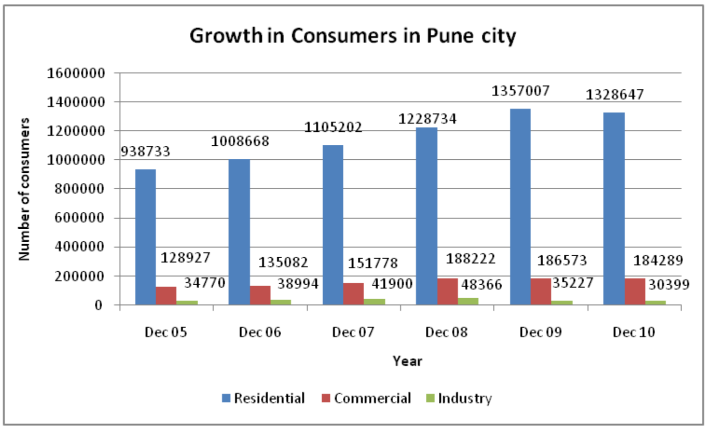


Figure 1 - Increase in number of consumers in Pune city

Among the three categories of consumers, residential consumers comprise 86%, commercial consumers are 12% while industrial consumers are 2% in the year 2010.

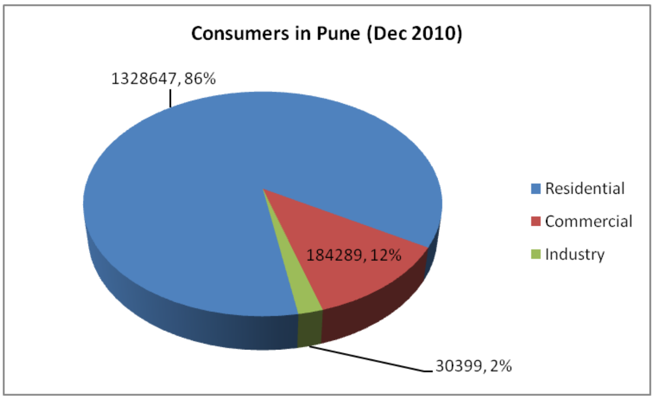


Figure 2 - Share of consumers in Pune city

This increasing electricity requirement by the city kept on increasing and the supply did not increase as per the demand. This resulted in power shortages and MSEDCL had to resort to load shedding. Due to long hours of load shedding several consumers were forced to invest in backup systems such as invertors and generators, without being aware of the extra premium they had to bear.

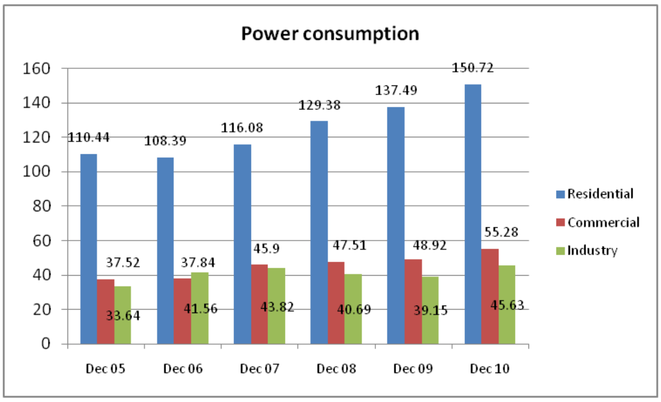


Figure 3 – Category wise Power consumption

Burden on consumers due to investments in backup systems

Load shedding is a major discomfort and has significant adverse impacts on overall economic development and standard of living.

The amount of electricity available for consumption has reduced over the years and the city has faced load shedding in the last decade. Consumers across all the sectors suffered due to load shedding. Though the city was given interim relief from load shedding it was at an extra cost that the Pune consumers had to pay from their pockets.

Apart from paying extra to get relief from load shedding, prior to the implementing various schemes for providing relief from load shedding, investments were made in inverters and diesel generators. This put an additional burden on the consumers. A study carried out by *Wartsila* is provided below shows the additional premium paid by the residential and commercial consumers due to use of inverters on varied hours of usage.

The premium paid by **residential consumers** varies widely across cities because this premium depends on the duration of usage of back-up power which in turn depends on the severity of the daily outage and the duration of the peak outage season in a given city. A consumer with a typical monthly consumption level of 400 units with an 800 VA Inverter back-up pays a premium of ~80% above the grid power cost when faced with a severe outage of 6 to 7 hours throughout the year. A similar consumer will pay a premium of ~17% above grid costs when facing a 1 hour daily outage for only 3 months a year and a less frequent lower duration outage for the rest of the year. With the use of an inverter of the above mentioned capacity, the consumer will be able to run only limited appliances in the house. The premium will increase if the consumer chooses to run all appliances; this will however require a shift from inverter to generator set.
Commercial consumers choosing to opt for back-up systems end up paying an even higher amount of premium as compared to residential consumers. For a commercial establishment with a typical consumption of 1500 units and a diesel generator power back up, faces a premium of ~150% above the grid power cost when faced with a severe outage of 6 to 7 hours throughout the year. A similar establishment will pay a premium of ~11% above grid costs when facing a 1 hour daily outage for only 3 months a year and a less frequent lower duration outage for the rest of the year[6].

[6]The Real Cost of Power, Wartsila, pp 15 & 17

As can be seen not only the commercial but also the domestic consumers also had to bear a premium for using backup systems.

In the wake of load shedding, the MSEDCL came up with a various load shedding models for the city. From 2006 till 2011, three load shedding models were implemented in the city. But this relief for the consumers did not come for free, but at an additional cost.

Load shedding in Pune

Load shedding is shutting off power supply during some parts of the day in a given area. It protects the grid from collapsing and has been adopted by power utilities to manage the power deficit.

By the year 2005-06, Maharashtra, which once boasted of surplus power availability, was reeling under an acute peak power deficit of 23% (i.e. 3700 MWs). Pune like many other cities in the state faced regular load shedding for about 2-4 hours a day[7] which in the months of summer increased to 4-6 hours a day[8]. This was because demand for power was higher than supply.

First load shedding model – The CPP model

To make Pune free of load shedding, Confederation of Indian Industries (CII) Pune Chapter made an innovative proposal to Maharashtra Electricity Regulatory Commission (MERC) for its approval. This model is called the CPP (Captive Power Project) model.

CII (Confederation of Indian Industry) Proposal

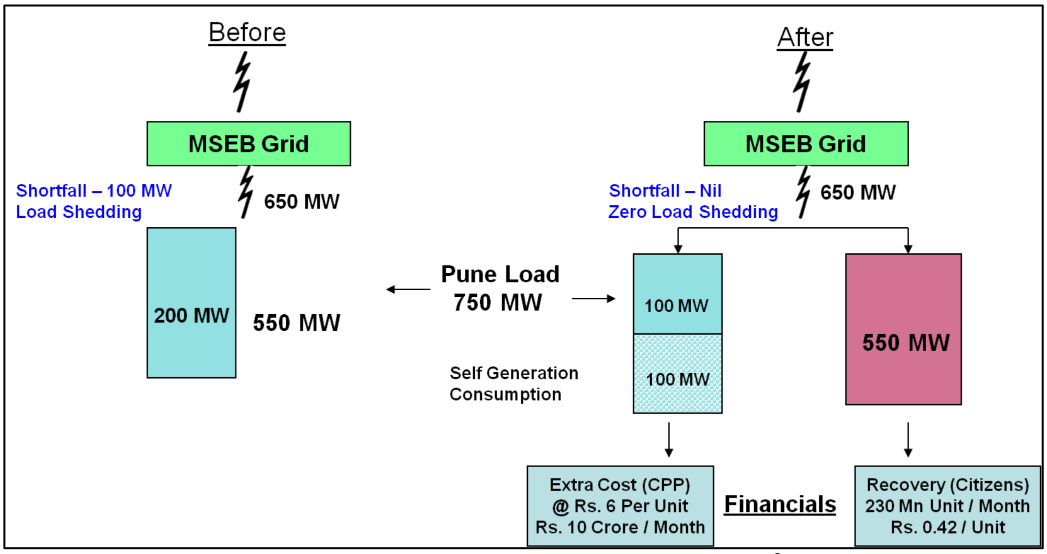


Figure 4 - Working of the Pune CPP model[9]

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[7] http://www.idfc.com/pdf/publications/policy_group_quarterly_2.pdf - Policy Group Quarterly, Dec' 2008
[8] http://www.thehindubusinessline.in/2010/06/21/stories/2010062150250300.htm- Business Line, June 21, 2010- Pune shows the way to tackle power deficit
[9] 14th Quality summit, Bangalore, Confederation of Indian Industries, Pradeep Bhargava

Power requirement of all categories of consumers in Pune – 750 MW
Power available with MSEDCL – 650 MW
Shortfall – 100 MW
Power available for consumers (other than industrial) of Pune from MSEDCL – 550 MW
Power required by industries -200 MW
Power available with industries (captive) - 100 MW
100 MW captive power available with industries, so power required by industries from MSEDCL– 100 MW
Total power available for industries now (captive + MSEDCL) – 200 MW
Total power available for other consumers – 550 MW
Charge borne by consumers – Rs 0.42/ unit
Benefit to consumers – Riddance from load shedding

CII, in consultation with Maharashtra State Electricity Distribution Company Ltd (MSEDCL), estimated a shortfall of 90 MW in the worst case scenario in Pune, while the top 30 industrial undertakings of Pune – which is home to major industries such as Tata Motors, Bajaj Auto, Bharat Forge, Kinetic Engineering and DaimlerChrysler India – had unutilized captive capacity in excess of ***100 MW***. CII proposed that these 30 undertakings would utilize their idle captive capacity to generate and consume power equivalent to the shortfall in Pune Urban Circle following the schedule of operation (*i.e* number of hours and capacity utilization) as directed by MSEDCL. By so doing, these industries would cut down their demand for grid power (equivalent to the shortage in the city), which would consequently be available to MSEDCL for distribution to other consumers, thereby eliminating the need for load shedding. The switch from grid supply to self supply for industries was not economically viable otherwise.

The CPPs in question were fired by liquid fuel (LDO and HSD) and had high generation costs (i.e. variable cost exceeding Rs.10/Kwh) in comparison to their purchase from the grid, making its exploitation uneconomical. To induce industries to switch from grid supply to self supply it was therefore proposed that these industries be compensated for the additional generation from captive capacity by an amount equivalent to the difference between the variable cost of generation by CPPs and the average HT tariff (grid supply). Finally, the compensation costs to the industries were proposed to be borne by the consumers of Pune Urban Circle in exchange for the benefit of no load shedding.

The CPP model proposed by the CII was implemented in the city for two years from 4th June 2006 till 15th July 2008 and the city had the privilege of uninterrupted power supply. The additional charge *i.e* reliability charge levied to the consumers was Rs. 0.42 /kWh. Domestic consumers consuming up to 300 units per month were exempted from the reliability charges. However, after 2008 since the power demand of the city went up by 12-14%, it was difficult to sustain this model[10].

[10] http://www.expressindia.com/latest-news/CII-moots-new-power-supply-model-for-city/256958/; January 3'08

Second load shedding model –The Franchisee Model

The franchisee model was implemented from 7th July 2008 till 9th December 2009. MSEDCL appointed a distribution generation based distribution franchisee (DGBDF) for the city through competitive bidding process. Tata Power Company (TPC) was appointed as the interim franchisee. TPC besides offering 40MW of power from its DG sets and also offered to procure the deficit through its trading arm TPC Trading Company. Thus, the interim franchisee would be procuring additional power for Pune over and above the usual supply mix of MSEDCL. Depending on the power available on daily basis from the franchisee, percentage relief in load shedding hours was given. The consumers had to pay reliability charge of Rs. 0.48/kWh. Domestic consumers consuming up to 300 units per month were exempted from the reliability charges.

Third load shedding model: The Zero Load Shedding (ZLS) model

After this the ZLS was implemented in the city from 10th December 2009. This model was initially valid till November 2010 but was later extended till July 2011. Consumers across all categories, except domestic consumers below poverty line, were levied a reliability charge of Rs. 0.21/kWh. In July 2011, MSEDCL withdrew the ZLS model claiming that the company was in a position to supply power for 24 hours. Withdrawal of the model meant that the consumers did not have to pay the reliability charge but would get assured power supply. However within three months load shedding started in the city for nearly 3 hours.

As can be seen, the consumers of Pune did not get the benefit of uninterrupted power supply free of cost, but had to pay extra charges per unit of power consumed other than the regular billed amount. However, power cuts for maintenance purposes still continued in the city.

So implementation of such models by sourcing costly power and putting the burden on the consumers is not a permanent solution. This is because the power demand will continue to rise with growing population and changing lifestyles as the city gets more urbanized. The need today is to implement demand side management measures and energy conservation.

Demand Side Management (DSM) measures

The importance of Demand Side Management (DSM) has been recognized by the Ministry of Power, Government of India. One unit of electricity saved results in reduced consumption of coal, which is a non renewable resource, by about 1kg[11].

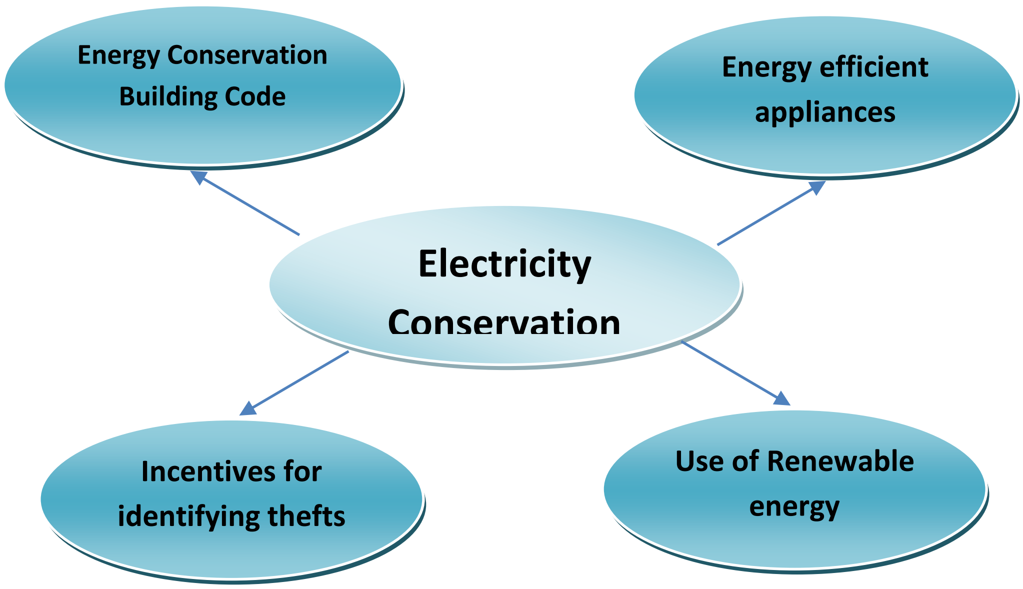
DSM is the implementation of policies and measures which serve to control, influence and generally reduce electricity demand. DSM aims to improve final electricity using systems, reduce consumption, while preserving the same level of service and comfort. Demand side management

[11] Demand-Side Management (DSM) in the Electricity Sector Urgent Need for Regulatory Action and Utility-Driven Programs Report by Prayas Energy Group (Pune) for Climate Change & Energy Program World Wide Fund for Nature-India, New Delhi, February – 2005

relies on a combination of using high efficiency equipment and efficient use of electricity through good operating practice[12].

To ensure continuous power supply, the consumers have to bear additional charges, wither through investments in generators/ invertors or by paying extra charges. The demand for electricity will continue to increase as the expected growth in electricity consumption is a result of demographic and economic changes. To generate electricity, large quantities of land and water are required. To meet the never ending demand for electricity, several power projects are proposed across the country. The power generation capacity in India is set to expand massively. In Maharashtra itself a total installed capacity of 79,000MW (concentrated in certain districts) is proposed by the state and central governments as well as private companies. A large capacity addition is of thermal (coal based) power generation plants. These power plants are in different phases of development. Power plants require vast tracts of land and water resources and agriculture land is usually diverted. Moreover to fulfill the water needs water for agriculture purposes is diverted for generation of electricity. This has created a stress on the land and water resources of the state and has also resulted in pollution of land and water resources in the regions where the power plants are located.

Following the business-as-usual trend of constructing more and more power plants to meet the ever increasing electricity demand is not the solution. There cannot be one solution to this problem, but a mix of solutions will be required. However, from the city point of view the most easily achievable solution would be to identifying and growing its own electricity generation potential. There are several ways to do this, one of them being increasing the energy efficiency in houses and buildings. Moreover buildings in the city should also generate their own power through renewable energy sources. This way every building would have its own decentralized power generation, relieving the burden from the grid. The extra power available can also be sold to the grid. By adopting such means the citizens would also contribute their bit in conserving energy.



[12] http://www.leonardo-energy.org/ - Efficiency and eco-design

Ongoing programs and initiatives by Government of India (GoI)

The Energy Conservation Act 2001 recognizes the importance of energy efficiency. The Bureau of Energy Efficiency (BEE) was set up under this Act due to which the implementation of energy efficiency programs has accelerated. The BEE functions under the aegis of Ministry of Power (MoP). The primary objective of BEE is to reduce energy intensity of the Indian economy with active participation of all stakeholders, resulting in accelerated and sustained adoption of energy efficiency in all 4th sectors. During the 11 Five Year Plan (2007-2012), BEE aims at reducing power consumption by 5% (equivalent to 10,000 MW of avoided capacity). Various schemes launched by the BEE to meet this target. The schemes are discussed below.

- BEE established a Standard and Labeling (S & L) program in 2006 for eleven household electronic appliances (refrigerators - Frost Free/No-Frost, Tubular Fluorescent Lamps, Room Air Conditioners, Direct Cool Refrigerator, Distribution Transformer, Induction Motors, Pump Sets, Ceiling Fans, LPG, Electric Geysers and Color TV) and is moving to gradually make them mandatory which would then become the *de facto* minimum efficiency performance standard (MEPS)[13].

- Energy Conservation Building Code (ECBC) launched in 2007- The Code defines norms and standards for the energy performance of buildings and their components based on the climate zone in which they are located. It covers building envelope, heating, ventilation and air conditioning system, interior and exterior lighting system, service hot water, electrical power systems and motors. The Indian government introduced an Energy Conservation Code for commercial buildings in 2007 aimed at cutting their energy consumption by 25 to 40%[14].

- BEE launched the star rating for office buildings on February 25, 2009. In order to further accelerate the energy efficiency activities in the commercial building sector, BEE developed a Star rating program for office buildings which is based on the actual performance of a building in terms of its specific energy usage in kwh/sqm/year. The program rates office buildings on a 1-5 Star scale, with a 5 Star labeled building being the most efficient. The Star rating Program provides public recognition to energy efficient buildings and creates a 'demand side' pull for such buildings. Buildings with a connected load of 100 KW and above are being considered under the BEE Star rating scheme. It will be subsequently extended to other building types and different climatic zones.

- Bachat Lamp Yojana (BLY) - It was on February 25, 2009 launched with an objective of replacing the incandescent lamps and cutting down the price of CFLs. The share of incandescent lamp lighting in both residential and commercial sector is 80%[15]. State level electricity distribution companies that join the program would distribute high quality CFLs at about Rs. 15 per piece to their consumers and in return take back a working incandescent lamp.

[13] Factsheet - Scaling-Up DSM to the National Level, Prayas Energy Group
[14] Fueling sustainable development: The energy productivity solution, McKinsey Global Institute, October 2008
[15] http://moef.nic.in/downloads/public-information/bachat-lamp-yojana.pdf

- Agricultural Demand Side Management (ADSM) - This scheme targets the replacement of inefficient pumps which will result in energy and cost saving
- Municipal Demand Side Management (MDSM) – This scheme targets replacement of equipment in street lighting and promoting energy efficiency in municipal water supply system.
- Energy Efficiency in Small and Medium Enterprises (SMEs) Scheme

The benefits of electricity efficiency have been recognized in the 10th and 11th Plans as they both emphasize its importance and outline measures for its implementation.

In this paper as discussed we would explore ways of promoting energy efficiency and conservation in the residential sector as more and more people are being added in the city.

Electricity consumption by the residential sector

Though domestic users represents only a part of the total electricity consumption in the city, the domestic electricity use accounts for a major impact on electricity demand because of complex attitudes towards the use of electricity. New appliances are being added every day in the market, but the efficiency of these appliances is not checked at the consumer end, due to lack of awareness and apathy towards of energy saving. Energy consumption by various household appliances is given below. It can be seen from the figure that the lighting requirements consume most of the electricity followed by refrigeration followed by air conditioners.

We have seen in figure 3, that the residential sector consumes more electricity. The graph presented below is based on the stock and consumption of nine different appliances in the country. The study was conducted by Prayas Energy Group in 2008. The study revealed that four end-uses lighting (incandescent bulbs and tube lights), fans, refrigerators and TVs make up 80% of household consumption.

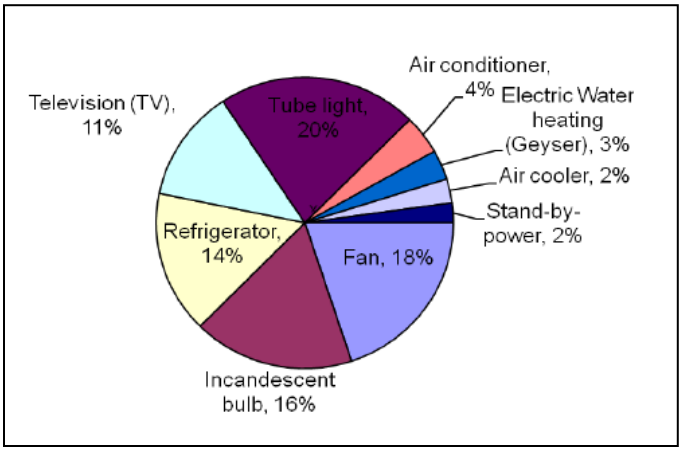


Figure 5 - Energy consumption by household appliances[16]

[16] Energy saving potential of Indian household appliances, Prayas Energy Group

The sale of electrical appliances in the residential sector has increased due to high economic growth, which has placed a heavy burden on the power sector. As discussed, resources (land, water, and fuel) are limited. This has posed a challenge to the construction of new power plants. The shortage of fuel (coal) has led to importing fuel at higher prices which has affected the tariff for the consumers. Energy efficiency measures have the advantage to meet demand with the help of existing capacity at costs lower than that required for construction of power plants. It would also provide relief to the pressure on existing resources due to construction of new power plants.

Since the appliances are being added in the market at a rapid pace and the life of some of these appliances is very long, it has to be ensured that the appliances that are being sold in the city market are efficient, thereby resulting in energy savings. The municipal administrative body can put in efforts to implement the energy efficiency program initiated by the MoP.

A study (India level) has been carried out by Prayas Energy Group which highlights the fact that if all new appliances added to the Indian market are the most efficient appliances that are available in India, then the energy saving potential in Indian households would be 55 TWh in 2013. This consumption would be the same as the consumption in the year 2008, even though many more appliances and consumers would be added. The study also pointed out that investment to the tune of Rs.120,000 crores for about 20,000 MW capacity addition could be avoided, thereby reducing CO_2 emissions by 50 Mt/ year.

Energy saving potential in the range of 23% - 46% has been identified through energy audits conducted in public buildings[17].

The average wattage of the cheapest model and the most efficient model is given below[18].

Table 1: Wattage of the cheapest model and energy efficient model

Appliance	Cheapest model (W)	Energy efficient model (W)	Savings (%)
Incandescent bulb to CFL	55	15	73
Direct Cool Refrigerator	350 kWh	179 kWh	49
Flat Screen TV	73	51	30
Fan	70	50	29
Tube light T12 to T8	49	36	27
Window AC	1892	1406	26
Air cooler	162	125	23

[17] Energy Efficiency in Buildings in India-An Overview; Dr. Ajay Mathur -Director General, Bureau of Energy Efficiency, Ministry of Power, Government of India at 2nd Meeting of the Indo-German Energy Forum 20th December 2007

[18] Energy saving potential in Indian households from improved appliance efficiency, Prayas Energy Group

Action program for Pune Municipal Corporation (PMC) for promoting energy efficiency and energy conservation

Make Pune self sufficient in its power needs, PMC in coordination with stakeholders should focus on promoting energy conservation and energy efficiency measures. Active participation should from individuals and government and private institutions such as MSEDCL, STP, builders, industries, traders of electrical appliances, NGOs, consumer groups, etc. Since the local authority and city decision makers, are the closest administration to the citizens, they understand their concerns and can influence the energy behavior of their citizens. PMC will be able to address the challenges in a comprehensive way. It could cater to both the public and private interests and also integrate sustainable energy in the overall developmental goals, be it promotion and development of renewable energy, promotion of energy efficient appliances, or changes in behavior.

Pune Municipal Corporation (PMC) should initiate through campaigning actively on creating awareness on energy conservation and energy efficient appliances in the city. PMC has taken a step in the direction by generating electricity from waste in certain wards which is used to light up street lights as the problem of waste and electricity shortages both problems get dealt with. These plants should be monitored to ensure that they do not become defunct in the years to come.

PMC should take efforts on a wider scale. Primarily PMC should coordinate with MSEDCL in order to implement demand side management measures in the city. The following action points are proposed to be taken up by PMC to deal with

Identification of Thefts

- PMC should identify and report thefts in the city to MSEDCL and gain the benefit of 10% of the total value of the theft as a reward from MSEDCL.
- PMC in coordination with MSEDCL should conduct drives to detect and cut off illegal connections in the city, and set up a mechanism so as to ensure there are no illegal connections in the city.

Energy Conservation Building Code

- PMC should begin by upgrading its administrative building as per ECBC norms and make the building energy self sufficient by adopting a blend of renewable energy generation systems such as roof top solar PV and wind. Once this is done PMC can promote such measures in all the other government buildings in the city.
- PMC should introduce ECBC norms on buildings in a phased manner. This could be done by offering concessions in duties and registration fees for all new constructions in the initial phase for a few years. At a later stage, it should be made mandatory for all new constructions to implement ECBC norms by declining permission for constructions that do not follow these norms. Building inefficient infrastructure should be avoided.

- PMC should establish a monitoring mechanism in coordination with Science and Technology Park (STP) Pune, to monitor the implementation of ECBC and DSM measures in new constructions in the city.

Energy Efficient Appliances

- PMC should allow only those appliances in the market which have star labels. This can be done by giving concessions in octroi, tax rebates, incentives, etc. An action plan should be formulated to phase out inefficient household appliances and lighting products from the market and promote use of energy efficient standard labeled appliances in the city.
- The city's development plan should also promote Pune as a green city, thereby along with reserving green pockets in the city, energy self sufficient buildings (residential as well as commercial *i.e.* not only malls and multiplexes but also hotels) should be promoted.

Use of Renewable energy

- PMC should make it mandatory for all hoardings to generate their own power through solar PV.
- Similarly PMC should use energy efficient lights for the street lights and should take them off the grid by powering the street lights with solar PV. Off grid power systems should also be used for water supply and for running sewage treatment plants.
- PMC should use energy efficient lighting such as LED in all the parks and playgrounds which should work on a hybrid system of solar and wind power.
- Captive power plants fired by diesel should need prior clearance from PMC and moreover such plants should be avoided. Instead, renewable energy should be opted for.
- All new constructions should have their own mechanism of hybrid renewable energy systems in place to generate their own electricity. Thus the city will be a prime centre for promoting decentralized renewable energy systems and soon reduce its power intake from MSEDCL. This would not only help in combating climate change but also get the city on the global map of renewable energy sector.

  The example of Orange County is a case in point. A residential building in Pune city named Orange County is self sufficient in its energy needs. 100% of its energy needs are fulfilled through a hybrid of wind and solar photovoltaic cells. Not only in terms of energy is the apartment self sufficient, but sewage generated is treated through root zone technology on site. The biodegradable waste is treated in a vermicompost unit set up in the building premises. These kinds of self sufficient buildings with decentralized renewable energy sources should be promoted in the city. (Case study attached as Annexure)

Conclusion

Given the manifold risks arising from increasing energy use such as insufficiency of resources, local pollution and climate change – there is an urgent need for speedy improvement in energy efficiency and promotion of decentralized renewable energy for commercial and residential buildings thereby making sustainable use of electricity. This paper suggests that PMC should promote energy efficiency, conservation and demand side management measures as the city planners and developers can play a key role in formulating these changes. Rather than opting the Business as Usual (BAU) scenario, PMC could integrate sustainable energy in the overall goals and lead in design, implementation, investment and monitoring of renewable energy and energy efficiency projects, thereby making the city self sufficient in its electricity needs. This would be a paradigm shift towards a sustainable urban electricity development. Pune would thus be a model city and this model would then be replicated across all the urban centres of the country.

Keywords: electricity, Pune, population, power demand-supply- shortfall, energy conservation, renewable energy, energy self sufficient.