

Demand Side Management Potential at the Bharati Hospital and Research Centre

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ABSTRACT

The present paper has the main aim of illustrating some main results obtained from a walk through preliminary energy audit performed on The Bharati Hospitals and Research centre, Pune, India. These results are analyzed in order to determine an optimum consumption pattern and potential of saving in terms of expenditure towards energy cost.

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1. INTRODUCTION (10 PT)

The demand of electricity has increased with the new developments in the world. This has put the pressure on the power utilities to meet the increasing demand of the customers. One simple way for them to meet this demand is to install more generating units. But the induction of additional generating units, especially thermal not only increase the cost per for the consumers but also contribute in pollution to the environment which is a global concern. In such a scenario the best solution is to go for load management and make best use of the available generating capabilities of a power utility [1].

Some of the important factors that highlighted the importance of load management after 1970 are:

1. The oil embargo, in 1973, brought as a consequence skyrocketing of oil prices. This incident increase the fuel cost to utilities and thus customers suffered directly as energy charges were increased by utilities.
2. The increase of capital cost and licensing requirements for utilities in the construction of new power plants, in some cases, construction lead-times increased from 5-8 years to 15 years or more.
3. The 1977 amendment of clean air act which required a state to develop a state implementation plan (SIP) to control air pollution that would meet national ambient air quality standards.

These series of events forced utilities to consider load management techniques to improve their system resources utilization and to control peak load growth [2, 3].

Load management is defined as sets of objectives designed to control and modify the patterns of demands of various consumers of a power utility. Thus control and modification enables the supply system to meet the demand at all times in most economic manner. Load management can be applied to all the loads experienced by a power utility including Industrial loads, cooling loads, heating loads and lighting loads. The annual load curve informs utilities during which time of the year they need effective load management techniques. The time of implementation of load management techniques may be different for different power utilities depending on the weather conditions and available megawatts of the utility in a particular country.

2. DEMAND SIDE MANAGEMENT

Demand Side Management (DSM) was introduced by Electric Power Research Institute (EPRI) as a concept that consists of series of activities which government and utilities perform to increase social welfare and decrease the needed investment in electricity industry in 1980s. The application of DSM has got the remarkable benefit, in the United States, 459 large electricity utilities with DSM programs saved the large utilities 50.6 billion kilowatt hours (kWh) of energy generation in 1999. This represented 1.5 per cent of the annual electricity sales of that year. The Smart Grid is a promising concept to cope with increasing energy demand and environmental concerns. As the main feature and construction goal of the smart grid, intelligent interaction includes two-way interaction of information and energy, to encourage electricity consumers to change the traditional usage styles and participate in the network operation actively (such as adjustment of energy consumption patterns according to real-time price), and to achieve the plug-and-play Grid-connection of the distributed generation. Thus, demand side management technology is one of the most important parts of the smart grid. Based on the traditional functions, the smart grid DSM has new contents, including automation demand response, smart consume sequence, remote energy efficiency monitor & control, energy efficient power generation, and so on. DSM and the smart grid will complement each other. The demand-side management techniques, such as smart meters, communication and control systems, and other load control technologies, will play key roles to determine the future success of the implementation of smart grid. The operation and development of the independent system operator (ISO) / regional transmission organization (RTO), power generation companies, system integrators, IT companies need DSM, too.

3. CUSTOMER'S PARTICIPATION IN DSM

Many utilities will benefit if their customers buy less energy - especially if that energy subtracts from peak demand. Energy conservation can help greatly both to conserve energy and reduce peak demand. Controller is to allow consumer to decide freely when they want to use their appliances. A Digital Tele-wattmeter System (DTS) provides a continuous real time display for both utilities and consumer's energy consumption. The DTS is a device that measures electrical energy consumption and reports via telephone. At a remote location, a microprocessor controlled wattmeter will sense current, voltage and time and convert this into kilowatt hours. For customer convenience, this information is displayed continuously. The consumer receives a typical monthly load curve showing peak hours and different time-of-day rates of kilowatt-hours. It is the consumer's decision whether to save energy and operate at off peaks [4, 5].

4. NEED OF DSM IN HOSPITAL COMPLEX

Both private and public hospitals and hospital buildings in a Country spend billions of money per year on energy by consuming energy in different forms and ways on a very large scale. Hospitals are 2-3 times more energy intensive than other institutional buildings since they are functioning 24 hours a day, all throughout the year. They are generally large building complexes incorporating most types of technical systems encountered in other types of buildings with a high level of heat being generated internally. However increasing healthcare facilitation costs leave little or no space to incorporate further investments for energy savings in a hospital budget. Moreover, patient comfort and quality patient care is of great importance in a modern hospital and cannot be compromised by cost-cutting measures that may affect the quality of service. Therefore, an effective measure seems to encourage energy management aimed at improving energy efficiency, which can reduce monthly energy bills even significantly. Effective energy management actions should ensure that energy use and costs are as low as possible while maintaining high standards of comfort, service and productivity. It is well known that a good starting point for creating an energy management plan is to develop a baseline of the facility's energy consumption. This usually involves identifying where and at what rate energy is used, areas of energy waste and potential energy-saving measures. Furthermore, when conducting an energy use analysis, it is useful to understand facility trends, patterns and superior performance values. But since it is well known that anything not measured cannot be controlled, a wide energy auditing stage has to be planned and organized providing that efficiency and energy consumption of every appliance, medical instruments, and other utilities are measured [6].

5. CASE OF BHARATI HOSPITAL AND RESEARCH CENTRE

The Bharati hospital and research centre is located at Katraj, Pune, Maharashtra, India. The centre stands a total area of 3.5 lakh square feet and is equipped with 850 beds and all necessary divisions such as X-Ray, Sonography, Blood Bank, Intensive care unit, Pathology Laboratory, Radiological Diagnostics with CT scan, MRI, Mammography and a ultra-modern Operation Theatre complex of International standard,

efficient cardiac Ambulance services and all-hours-all-days emergency services. All divisions are replete with most modern infrastructure required to take optimum care of patients.

Apart from this, the hospital is attached with Homeopathic Hospital, Ayurvedic Hospital, P.G Hostel & Working Women's Hostel for the doctors and staff members in the hospital, Nursing College Building & Nursing Hostel Building making it a super specialised teaching hospital institute.

6. BHARATI HOSPITAL ELECTRICAL POWER SYSTEM

The Bharati hospital and Research centre is supplied from a 22KV line of the MSEB (Maharashtra State Electricity Board) through a distribution transformer 22KV/433V. Apart from this, there are two diesel generators (415V, 380KVA) installed inside the complex to supplement any power failure. And also certain UPS are provided for each important biomedical instrument.

As of present, The Bharati Hospital and Research centre is monthly billed HT-II N I consumer of MSIEDCL (Maharashtra State Electricity Distribution Co. Ltd). The technical specifications of the consumer contract demand are as follows:

- Connected load: 662 KW
- Contract demand: 500 KVA
- Sanctioned demand: 500 KVA

7. MAJOR LOADS AT BHARATI HOSPITAL & RESEARCH CENTRE

The Bharati hospital and research centre is attached with Homeopathic Hospital, Ayurvedic Hospital, P.G Hostel & Working Women's Hostel for the doctors and staff members in the hospital, Nursing College Building & Nursing Hostel Building.

The major loads in the hospitals includes centralized sterilization department, Centralized AC system, split AC system, water pumps, lifts, biomedical instruments and machines like MRI and CT scan, lighting and other section such as mortuary & blood bank . The percentage wise load classification is given as a pie chart in figure below.

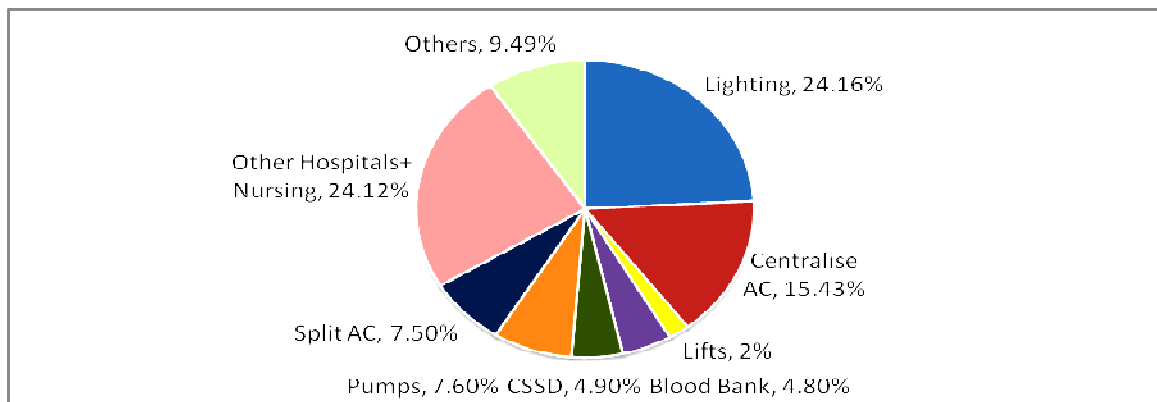


Figure 1. Pie Chart of Load Distribution at Bharati Hospital & Research Centre:

8. CONSUMPTION PATTERN AT BHARATI HOSPITAL & RESEARCH CENTRE

The electrical bills for a period of 13 months, January 2011- January 2012 are collected and analyzed. Analysis results are used to check efficient utilization of electricity and saving potential.

As shown in the Figure 2, the maximum demand varies from a minimum of 333KW towards a maximum value of 455KW with an average value of 406KW. The maximum demand is within the contract demand.

The variation in demand is from 126710KVAh to 204490KVAh with a difference of 77780KVAh. The maximum consumption occurred in the month of September and the minimum occurred in the month of February. The average consumption of energy accounts to 176226.15KVAh and an annual consumption of 2291330KVAh.

MAX DEMAND (KW) VS MONTH

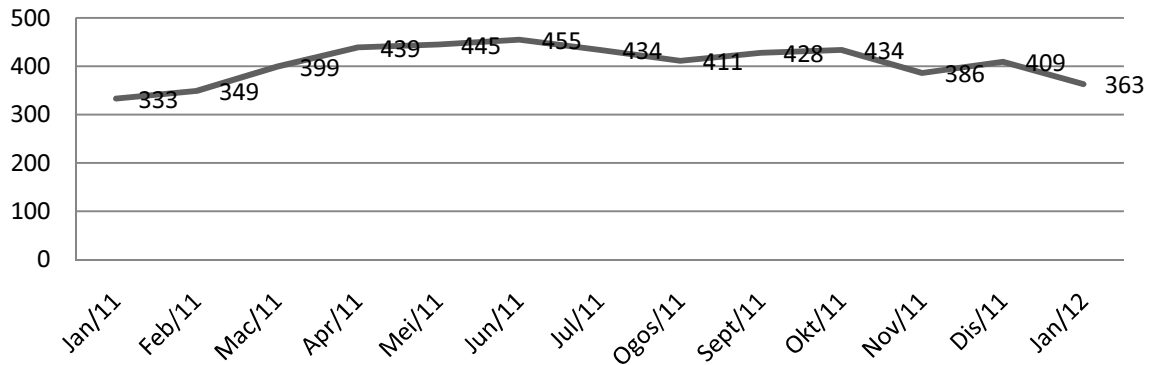


Figure 2. Max Demand for each month

LOAD CURVE

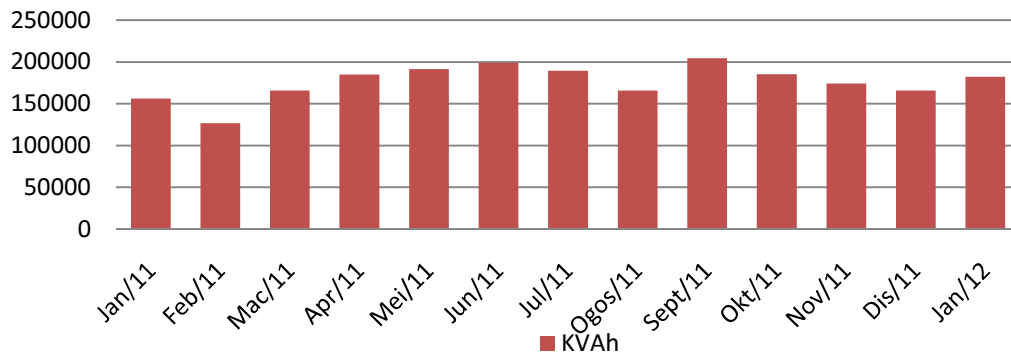


Figure 3. Load curve from Jan 2011-Jan 2012

MONTHLY BILL



Figure 4. Monthly Bill from Jan 2011-Jan 2012

The Bharati hospital and research centre pays an average monthly bill around Rs 16,65,210 to the MSEDCL. The annual expenditure of the centre amounts to the tune of Rs2 crores. This has caused a great concern for the management and has indicated the need of energy management strategies in the complex. Furthermore the consumption pattern can be analyzed on the basis of “time of day” usage pattern according to MSEDCL norms which will be discussed in the next section. The graph below shows the usage of energy

in each time zone. The average consumption in each zone is A Zone-49005 units, B Zone-68641 units, C Zone-26852 units and D Zone-31408 units.

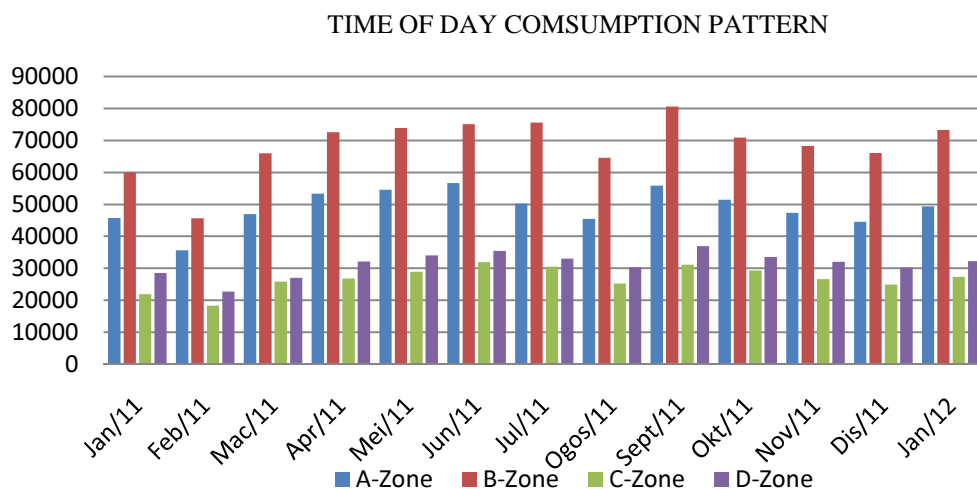


Figure 5. TOD consumption pattern in KWh from Jan 2011- Jan 2012

9. TARIFF STRUCTURE OF BHARATI HOSPITAL AND RESEARCH CENTRE

As of present, The Bharati Hospital and Research centre is monthly billed HT-II N I consumer of MSEDCL. In industries two part tariff is used to charge against energy consumption. The energy charges are based on unit consumption and demand charges. The energy consumption in KWh is charged as per the type of tariff (eg: HT-I, HT-II). The demand charges are charged based on maximum demand recorded by the energy meter (KVA). Every industrial consumer has a sanction or contract maximum demand. If the demand exceeds the contract demand, the utility charges penalty for exceeding contract demand as per tariff.

This is High Tension Tariff Structure of Maharashtra State Electricity Distribution Co. Ltd with effect from 14th September, 2010, for HT-11 N 1 consumers [7].

Table 1. High tension tariff structure of MSEDCL

Consumer category	Fixed / Demand Charge	Energy Charge Rs. / kWh
HT II – Commercial		
Express Feeder		
Educational Institutions & Hospitals	Rs. 150 / kVA / Month	7.65
Others		7.95

10. TOD TARIFF (IN ADDITION TO BASE TARIFF)

In addition to above demand and energy base charge, TOD tariffs are charged for HT – I, HT – II and HT – IV categories of consumers as under [7].

Table 2. TOD Tariff Structure of MSEDCL

Zone	Consumption during following hours of the day	Energy charge paise/unit
A-Zone	22 00 to 06 00 Hours	-85
B-Zone	06 00 to 09 00 Hours	0
C-Zone	09 00 to 12 00 Hours	80
B-Zone	12 00 to 18 00 Hours	0
D-Zone	18 00 to 22 00 Hours	110

With reference to the above mentioned TOD tariff The Bharati Hospital and Research centre has paid an amount of Rs 2 Lakhs as TOD extra charge to MSEDCL for 2011. The monthly expenditure on TOD EC is tabulated as under for the period of 13 months. On an average the expenditure is about Rs 15000/month. This can be taken under consideration for load management criteria in order to reduce the expenditure by shifting the flexible loads (like laundry, CSSD) from costly time zone (C &D) to non costly zone (A&B).

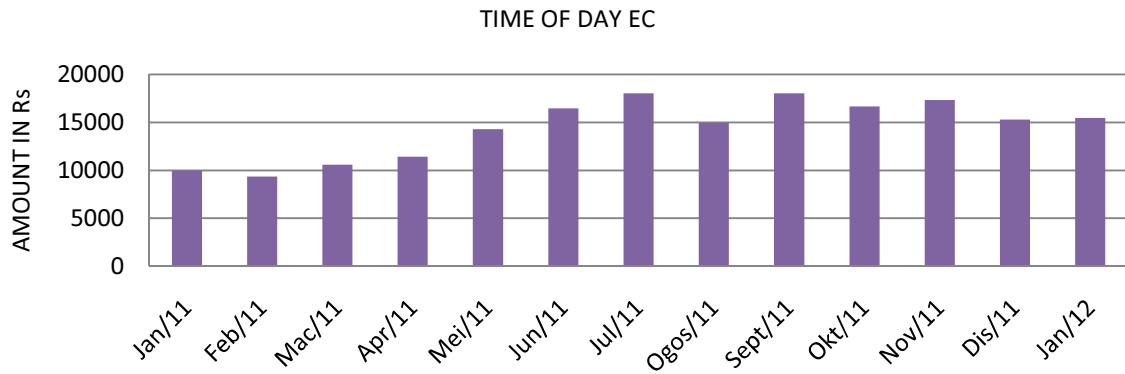


Figure 6. Time of Day Consumption pattern from Jan 2011- Jan2012

11. PENALTY AND INCENTIVES FOR BHARATI HOSPITAL AND RESEARCH CENTRE

Certain penalties and incentives are enforced by the MSEDCL toward its customers to ascertain its power quality and reliability. Power Factor, Load Factor Incentive and Penalty for exceeding Contract Demand are the different types enforced by the MSEDCL on its customers [7]. The analysis of these penalties and incentives for The Bharati Hospital and Research centre is done below, and comparison is done for the year 2006-2007 and 2011-2012.

A. Penalty for exceeding Contract Demand

The MSEDCL has the following norms for exceeding contract demand.

- 1) In case, a High Tension consumer exceeds his Contract Demand, he will be billed at the appropriate Demand charges for the Demand actually recorded and will be charged at the rate of 150% of the prevailing Demand Charges for the excess Demand over the Contract Demand.
- 2) In case, such occasions takes place three times in a calendar year, then the treatment would be governed by the Supply Code.

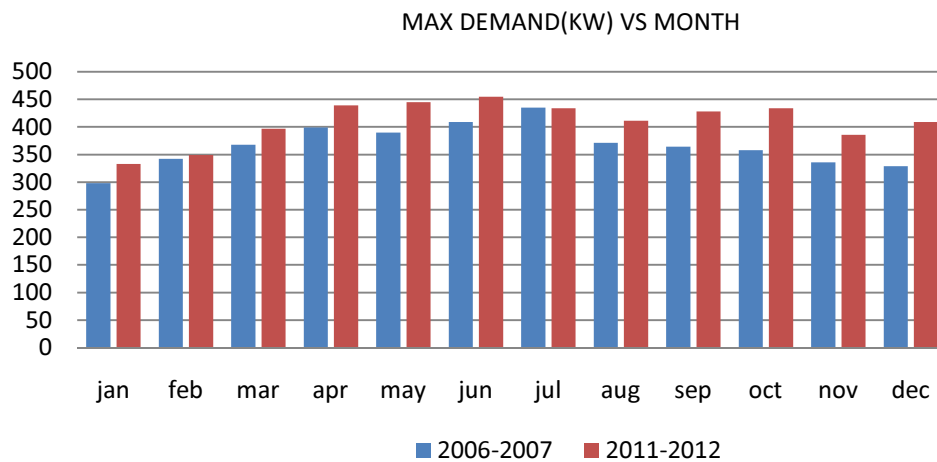


Figure 7. Comparison of Max Demand for 2006-2007 & 2011-2012

The contract demand for The Bharati Hospital and Research centre was increased from 200KVA (in 2006-2007) to 500 (KVA) in 2008. The institute was levied penalties for exceeding the contract demand as per the MSEDCL norms till 2008. The excess demand in 2007 was due to the construction of new ladies hostel in the complex. With the increase in contract demand, the maximum demand has been under the allowed value since 2008 as expressed in the graph above.

B. Power Factor Penalty and Incentives

According to MSEDCL whenever the average PF is less than 0.9, penal charges shall be levied @ of 2% of the amount of the monthly bill including energy charges, ASC, FAC, and Fixed/Demand charges, but excluding taxes and duties for the first 1% fall in the power factor below 0.9, beyond which the penal charges shall be levied @ 1% for each percentage point fall in the PF below 0.89.

Whenever the average PF is more than 0.95, and incentive shall be given @ of 1% of the amount the monthly bill including energy charges, ASC, FAC & Fixed /Demand charges, but excluding taxes and duties for the first 1% improvement in the PF above 0.95. For PF of 0.99 the effective incentive will amount to 5% reduction in the monthly bill and for unity PF, the effective incentive will amount to 7% reduction in the monthly bill.

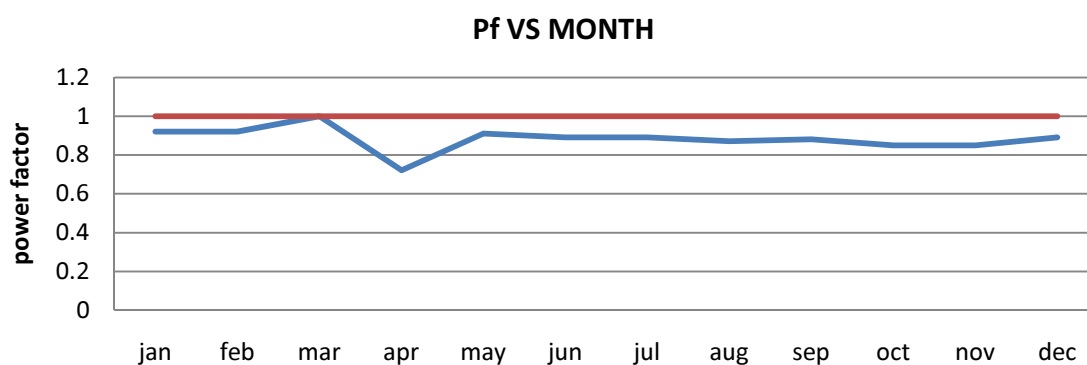


Figure 8. Comparison of Power Factor for 2006-2007 & 2011-2012

In 2007 the PF was drastically reduced from 1 in March to 0.72 in April, this was due to the construction work carried out in new ladies hostel and hence penalty charges for low power factor was Rs. 91526.72. After April the hospital has been operating on low PF, penalties were charged.

With the Installation of Automatic Power Factor controller (50 KVAR fixed & 175 KVAR switching), the hospital has maintained unity PF throughout till date. The hospital has got Incentives amounting to an average value of Rs 1 lakh/month.

C. Load Factor Incentive

The MSEDCL has the following norms for Load Factor

- 1) The Commission has retained the Load Factor incentive for consumers having Load Factor above 75% based on contract demand. Consumers having load factor over 75% up to 85 % will be entitled to a rebate of 0.75 % on the energy charges for every percentage point increase in load factor from 75% to 85%. Consumers having a load factor over 85 % will be entitled to rebate of 1% on the energy including ASC charges for every percentage point increase in load factor from 85 %. The total rebate under this head will be subject to a ceiling of 15% of the energy charges for that consumer. This incentive is limited to HT-I categories only. Further, the load factor rebate will be available only if the consumer has no arrears with the MSEDCL, and payment is made within seven days from the date of the bill or within 5 days of the receipt of the bill, whichever is later. However, this incentive will be applicable to consumers where payment of arrears in installments has been granted by the MSEDCL, and the same is being made as scheduled.
- 2) The billing demand definition excludes the demand recorded during the non-peak hours i.e. 22.00 hrs to 06.00 hrs and therefore even if the maximum demand exceeds the contract demand in that duration, load factor incentives would be applicable.
- 3) However, the consumer would be subjected to the penal charges for exceeding the contract demand and has to pay the applicable penal charges.

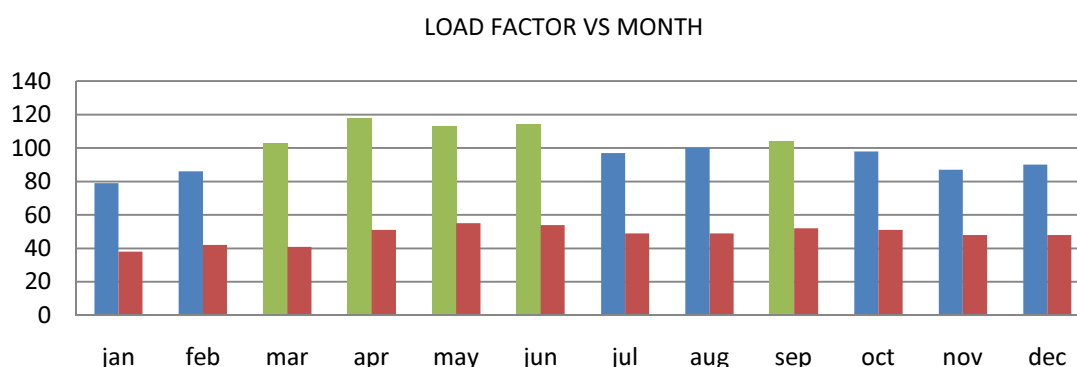


Figure 9. Comparison of Load Factor for 2006-2007 & 2011-2012

The load factor was above 85% until the contract demand was increased to 500KVA. Then it was reduced drastically to an average of 48% till date. This shows the possibilities of operating the system to a level nearer to the contract demand to get a higher overall efficiency. On five occasions in 2006-2007 the load factor was above 100%, the institute was levied penalties for exceeding contract demand on these occasions even though it had achieved load factor incentives.

12. CONCLUSION

A walk through preliminary energy audit was conducted at The Bharati Hospital and Research centre. The understanding from this analysis can be used to determine an optimum consumption pattern and minimization of energy bill for the institute. The demand side management potential is analyzed for the complex and certain results were drawn like 1) increasing the load on the distribution transformer (transformer rating is 1000KVA against a contract demand of 500KVA), 2) shifting the flexible loads from costly time zone (C &D) to non costly zone (A&B), 3) increasing the load factor of the system. This technique and results can be applied to other hospitals spread all over India. As a continuation detailed energy audit can be conducted in order to analyze the consumption pattern of each individual loads. The load diagrams thus obtained can be processed in order to identify typical load patterns of the whole hospital.

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