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PERFORMANCE ANALYSIS OF ENERGY AUDIT IN HVAC SYSTEM IN HOSPITAL

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Abstract-In this paper we have conducted brief study of present assessment of HVAC in AVBR hospital, Wardha by carrying out detailed energy audit in AVBRH premises with its systematic methodology specified as per Bureau of Energy efficiency (BEE). And it is being suggested that efficient devices should be installed in hospital cam-pus and within the premises to reduce overall energy consumption of HVAC, On the other hand proper handling of HVAC system for improving better performance of HVAC. Thereby our objective is to achieve energy conservation through replacing and arranging earlier HVAC system by some new efficient one and proper recommendation given so as to improve the performance of HVAC system.

Keywords: Energy Audit, Systematic methodology, Bureau of Energy efficiency (BEE), Energy consumption of HVAC, Efficient Operator, Energy Conservation.

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INTRODUCTION

In India, Electrical energy consumption is more in private hospitals as compared to government hospital than the normal limit. So it's essential to find out those reasons which are responsible for high energy consumption. So here we have carried out study on the basis of practical implementation of energy audit in "**Acharya Vinoba Bhave Rural Hospital Sawangi (Meghe)"**, Wardha District of Maharashtra State (India). HVAC is an important loading on power system, along with pump & other loads; it constitutes 50% energy consumption out of total energy consumption. But mostly we have seen this energy consumption is not used efficiently as Watt consumption is more and maintenance of HVAC system is not done regularly. HVAC will recommend different types of air conditioner system for different application. The choice of which air conditioner system to be use which depends upon a number of factors including how long the area is to be cooled, the total heat generated inside the enclosed area, etc. Even though maintenance of HVAC was good solution earlier but nowadays proper handling is adopted by most of commercial institutions and therefore we have suggested whole procedure used for carrying out energy audit has given following with its different studied and analyzed aspect.

HVAC

It will recommend different types of air conditioner system for different application. The choice of which air conditioner system to be use which depends upon a number of factors including how long the area is to be cooled, the total heat generated inside the enclosed area etc. It would consider all the related parameter and suggest the system most suitable for your space.

Split AC

It is a ductless system. The evaporative unit is on the interior and condensing unit on exterior. The thermal distribution unit is required to circulate the media between the conditioned space and the AC plant and another main function is to introduce the required amount of fresh air into the conditioned space so that the required indoor air quality is to be maintained. Split typically produces 9000 to 36000 Btu per hr of cooling.

Centralize AC

Air conditioner basically working principal is the same as split ac the difference is that their location and it contain duct to provide thermal comfort and air conditioning.

AHU

It is the air handling unit. AHU is intended for central preparation of air. Construction layout and the physical location of the installed air handling unit means that it is extremely difficult to adjust at a later date to conditions much different from that established during the original selection process.

METHODOLOGY

The methodology adopted focuses on understanding the present energy baseline that identifies energy saving opportunities and achievability to implement the potential energy saving measures. In order to identify the energy saving opportunities, the energy use Pattern has to be analyzed. Also a complete understanding of the electricity billing system is necessary for the audit. Though traditionally energy audit targets the active energy

consumption and power factor improvement, this project gives special prominence to reduction of maximum power demand. This is done by smart energy conservation.

- Systematic Approach.
- Data Identification And Quantification
- Measurement And Monitoring with Instruments
- Analysis the performance of each equipment by certified BEE experts using most advance instruments and equipment
- Identification of Energy conservation factors and area
- Benchmarking
- Recommendation on objectives setting for energy conservation

In all over process we used instrument for energy audit such as identification and quantification of energy necessitates measurements. The monitors are monitored during energy audit included basic electrical parameter such as voltage, current, KVA, frequency, KW, etc. and importance parameter except electrical such as temperature, relative humidity, air flow, etc. The equipment which are used for identification and quantification are as follow.

Digital Temprature And *Humidity Meter*

It is used for the measurement of temperature and relative humidity of interior area. Which contain the temperature and relative humidity sensor in the plastic box picture. It has to just put in the room and it shows the result. The upper reading shows temperature and lower shows Humidity Meter.

Digital Flow Meter

It is used for measurement of flow of AC, cooler, etc. It contain the fan gauge which is connected to the digital meter. When we keep meter in front of the low of AC's it shows the speed of the air at output of the AC's or coolers.

Data logger

It is used for data collection of all electrical parameter with respect to the time. It show in digital manner. And all data we can store in computer for analyzing through USB port.

Clamp Meter

It is used for the measurement of current in live condition of equipment through clamp the connected wire.

Temprature Sensor

It is devised which we used for measurement of Temperature in degree Celsius as we keep it to the equipment.

OBSERVATION

A. *Air Coolers*

- Normal Indian Air Coolers: 36 – 1 = 35
- Chinese Air Coolers: 47 – 17 = 30
- Total Air Coolers: 83 – 18 = 65

- Approximate Loading each: 1.12 Kw each
- Total loading due to coolers: 73Kw
- Total Energy Consumed by coolers is 73 Kwhr

B. Air Conditioners:

- 197.75 tonnes of Packaged Air conditioners and 159 Window and Split Air conditioners are installed.
- Total approximate tonnage is around 525 TR
- Total loading due to Air Conditioners is 630 KW
- Total Energy Consumed by Air Conditioners is 367 Kwhr

TABLE I. AIR CONDITIONERS

- One 1.5 Ton AC working continuous for a year consumes 7560 Kwhr

Location	Type	Tonne	No of AC	Flow m/s	Vent Temp	Room temp	Rh %
Dept Of Pediatric	Spilt	1630W	1	3.4	20.5	34.1	45
Blood Bank TTD	Windo w	2500W	1	3.3	16.6	29.8	54
CT Scan	Central ize	8000W	2	0.6	16.60	29.8	39
EDP Room	Split	1630W	1	1.3	12.7	30.3	35
Reportin g Area	Split	1630W	1	2.4	12.9	26.7	38
ICU Room	Windo w	2500W	1	1.8	12.1	30.2	37 %

- *Notes on Air Coolers and Air Conditioning*

1. Air Coolers

- Most of them have the wood wool missing / broken / panel missing etc.
- Many of the air coolers run DRY. This causes hot air to be circulated in the hospital area, outing a load on other cooling equipments.

- All the coolers have no controls on the operation. This causes a constant load of 73 KW on the system grid.
- In case water pipe is connected to the air coolers, then many places overflow is noted. This causes heavy wastage of water.
- Because of the inefficient working of these air coolers, temporary air coolers were fitted in the rooms. These consume more electricity and water, and create high humidity in the room.

2. Air Conditioners

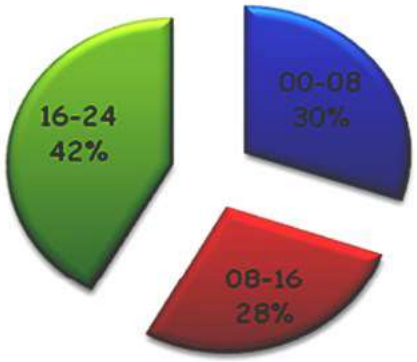
- Most Window and Split Air Conditioners are ill maintained.
- Doors at most rooms are left open, thereby increasing the load on the AC.
- Centralized AC's / Package AC's / Laminar AC's have no local operators, and hence they work in total in-efficient manner: Example, in the Ortho Building, First floor, two 7.5 ton AC are in parallel, supplying to the same duct. One AC was sending cold air at 7.5 degree C, whereas the other AC was working at 18 degree C. This was creating a high temperature of return air, and hence both the AC's did not get cut off.
- Water logging and high humidity was noticed in most Centralized AC rooms. This causes water condensation in the duct, and consequently dripping in the rooms.
- Excepting for few AC's, most of the AC compressors work for all the time, this causes high power consumption and frequent breakdown of AC.
- GRAPH/ PERFORMANCE

Here we have carried out a detailed energy audit in AVBRH, especially of HVAC premises with its systematic methodology. In AVBRH we analyzed that in Ortho Building, Neuro Department of AC's was not working properly. So we only concentrate on Neuro Department AC's. In which we connect data logger to panel of centralize AC to get all premises data along with AC's with respect to time. According to which performance of AC's are given below. During total energy audit we studied many AC panels in which we found a undesirable parameter in Neuro AC Panel which is detailed analyzed on dated 3rd and 4thJuly as follow.

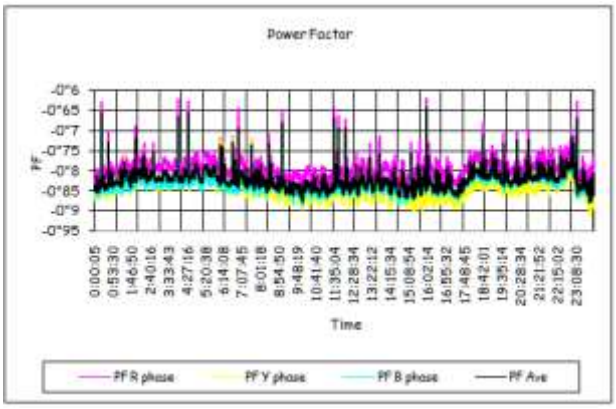
- *Total Energy Consumption along with time:*

From above we observed the energy consumption is 30% during night hours till 8 am. And consumption of energy is 28% during 8 am to 4 pm which is unacceptable. From 4 pm till midnight it raised up to 42%. Which shows the consumption of energy is peak at night period rather than day period that shows continuous wastage of energy during night hours.

Total Energy Consumption along with time



- *Power Factor:*

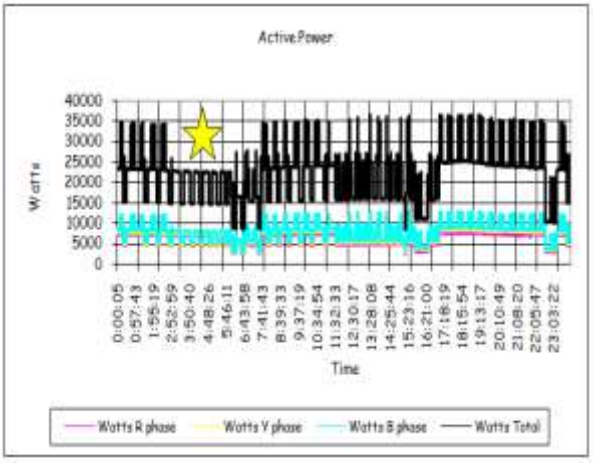


Power Factor

In which we observed that power factor is extremely poor in night hours. It goes up to 0.7 and then it improved in working hours in the day. The different power factor on different phases is shown in the graph. The power factor of R phase is extremely poor during noon period of time and it fluctuating from 0.85 to 0.7. That would dangerous for the system. And power factor on Y and B phase are quite similar and it's fluctuating from 0.8 to 0.88 that is acceptable for the system. Main thing is that we observed that the capacitor bank not worked properly. It can be improved to 0.85.

- *Active Power:*

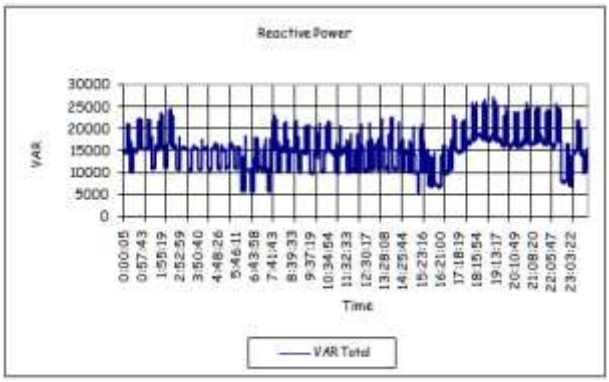
Active Power



Here AC's take constant load of 25Kw at starting interval. In which it shows active power on R, Y and B phases. On B phase we can see 13Kw during time 2:223pm and goes down to 7.5Kw at 2:46pm to 4:03pm, again sudden falls down to 2Kw. And again rose up to 11Kw as shown in the above graph. In first graph Star check point shows acceptable active power and in another graph star check point shows which is not acceptable yet for the system. This shows that the load on B phase higher than other two phases and total active power is 35Kw on time 14:23pm. This is constant for two hours.

- *Reactive Power:*

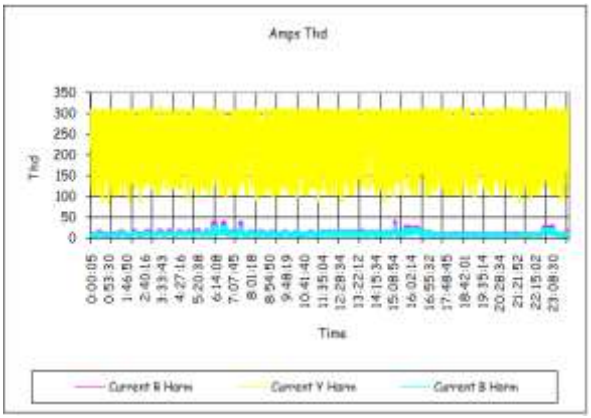
Reactive Power



Above graph shows the reactive power is varying during 2:23pm to 2:46pm between range of 15KVAr to 23KVAr and suddenly falls down to 2.5KAVr and then constant for 7.5KVAr till 3:03pm. It raised upto 23KVAr and continuously fluctuating between range of 15KVAr to 24KVAr. Relative compensation of 15KVAr can be given

- *Total Harmonic Distortion:*

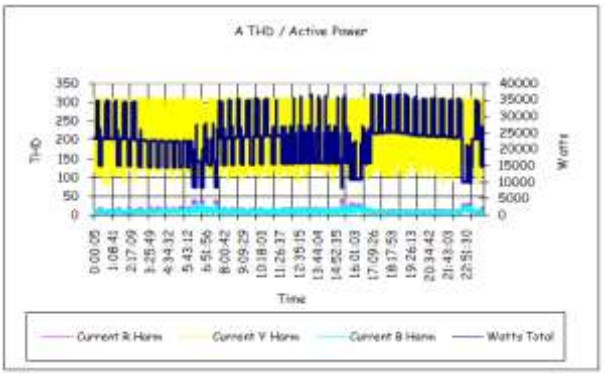
Total Harmonic Distortion



Above graph shows that current (THd) on y phase is extremely high around 300% with respect to other to phases which is not acceptable at all. This current total harmonic distortion (THd) causes unbalancing in phases and causes losses.

- *Current THd Vs Active power:*

Current THd Vs Active power



This graph shows that the current THd on Y phase is extremely high (300%) with respect to other two phases that is R phase and B phase. The current THd on B phase and Y phase is near about 10 % that is acceptable but current THd on Y phase is not acceptable. This is because of the excessive loading on Y phase and due to excessive loading on Y phase there is unbalancing and losses. This is remarkable. Power factor on Y phase is poor. The harmonic contain on Y phase is third harmonic that is creating a high current THd on Y phase. Due to heavy single phase load on Y phase is connected and this heavy single phase load draws heavy current from supply through Y phase and creating unbalance. Due to this unbalancing the phase shift between all three phases are different, so the magnitude of current is different for three phases. Air conditioner is the major load of AVBRH, which consume

power 24 hours that affect the electricity bill and reducing the life of air conditioners and increasing the cost of maintenance with respect to the output of air conditioners. That means the air conditioners are consuming more electric power with respect to output of AC

- Recommendation
- Switching off the unused electrical appliances is the best energy conservation one can do.
- Setting timers for HVAC system and installing automated sensor like computer based EMS data to track the temperature, Programmable Thermostat and Install Relative Humidity detector
- Maintenance of both Air Coolers and Air Conditioners are very bad. They need to be regularly maintained.
- At each location, there should be a person responsible for running of the AC and Coolers. He / She will observe the working of the equipment, and shut them off whenever required.
- Data loggers for temperature / humidity control should be purchased which can log readings every 1 minute and sends the output in Excel graph through the USB port. This can be used both for pin pointing to the outsource agency, and keep a check on the local operator. This data logger can store data for more than 20 days at a stretch, and battery life is more than 3 years.
- Install a Temperature/Humidity Display in each Ward / ICU for the local operator to control the AC/ Coolers.
- In case the AC is not working, then the Electrical Maintenance Dept should be notified. They will follow up with the Out-source team, who will repair it and take consent of the local operator.
- Each door of ICU / Ward where AC's are used should have a door closer and door opening delay alarm, like in the lift. This is a small device, which can give an audio beep, to make sure the door is kept closed.
- Duct must be insulate properly to maintain thermal comfort and avoid leakage of condense water.

CONCLUSION

Conducting an energy audit is one of the main objectives in identifying the potential areas of the unit for energy conservation. A simple and minor change in the system can conserve energy and bring down the utility of energy to a greater extent and also addressed several problems which can result in over-optimistic savings projections, and suggested ways to prevent mistakes. It is also reported that the audit was aimed at conservation of energy in Hospital only. If energy audit for the entire institute is conducted the quantitative energy conservation will be more.

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