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ANALYSIS OF ENERGY - EFFICIENT MEASURES FOR ARCHITECTURAL BUILDING

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Abstract - *In India, 50% of electricity is consumed in commercial buildings. It is due to fully air conditioned commercial buildings. The analysis of energy- effect has gone up by the air conditioned buildings. The energy efficient measures include electricity ballasts for fluorescent lamps; air to air energy recovers & control of identical chillers & variable spaced drives. Last two years, control of multiple identical chillers is the most useful & attractive measures. It leads to rapid economic improvement & growth in all sectors of the living standards. Major role in commercial buildings growth are observed to consume more energy. Two third of the imported coal & oil products are used for electricity generation. In India, there are four major areas, where the electricity is used are Industries, Commercial, Residential & Public areas.*

Key Words: (Size 10 & Bold) Key word1, Key word2, Key word3, etc (Minimum 5 to 8 key words)…

1. INTRODUCTION

The consumption of street light is merely 2.5 % of total consumption. It shows that the local economy has been shifted from manufacturing based to service oriented (e.g. finance, tourism etc). The major electricity end users are commercial sector overlooking industry. The govt. of India has passed the order & considered legislative controls of building envelop design of commercial buildings. However, it has been defined that commercial buildings grew at the net rate (e.g. new building minus demolition) of merely 15%-20% per annum during decay (1998 – 2007). By this way the energy consumption impact is to be controlled over the overall consumption.

Segregated the commercial buildings are in to four ways:

1. Office Buildings.
2. Hotels.
3. Shopping complexes or malls.
4. Industrial Buildings.

In survey, one of the main city of India revealed that the commercial buildings have been consuming 70% - 80% of electrical energy by HVAC (heating, ventilation & air conditioning). It has been observed that the life cycle costing analysis can give a good indication of the economic variable of energy efficient measures.

2. Measures of Energy Efficiency

All the existing buildings in India since then have different design features & operational systems of individual building to assess & positively of energy conservation measures. In survey & study lighting system & HVAC of selected buildings have been conducted.

In lighting systems: The common energy-saving products for existing buildings are energy-saving lamps and electronic ballasts for fluorescent lamps. The fluorescent lamps with conventional magnetic core-and-coil are installed in most commercial buildings. There are only small numbers of tungsten down lights used in places such as lobby lounges and reception counters. Therefore, replacement of conventional ballasts with electronic ballasts is selected for a cost-effectiveness study in energy-saving measures of lighting systems.

HVAC systems: The mass electricity consuming area in a building is divided into air side and water side. On the air side, air-to-air heat recovery system like thermal wheels could save energy by exchanging heat between intake fresh air and exhaust air from the air-conditioned spaces of a building, thus reducing cooling load on HVAC plant. In the water side, the chiller is the largest electricity consuming component. Similarly, through a study on modification of sequence control for multiple chillers is proposed instead of study on replacing old and less efficient chillers. This is because changing the control system on chillers is much simpler and will cause less interruption to the operation of a building. Variable speed drives have been used for energy savings in commercial and industrial installations for chillers, chilled and condenser water pumps, fans and heat rejection systems

A generic reference building is then developed for energy simulation and life cycle analysis for example. A building is 40-storey, 35mx35m plan with curtain-wall construction (single 6 mm reflective glass, 0.4 shading coefficient and a U-value of 5.6 W/m2K). U-values for external wall (spandrel) and the roof are 2 and 0.64 W/m2K, respectively.

The DOE-2 (Depends on Experience) energy simulation program was used to estimate energy consumption of the reference building. There are 4 major parts, namely LOADS SYSTEMS, PLANT AND ECONOMICS. The LOADS section calculates the heating and cooling loads within each space inside the building on an hourly basis. It then passes such loads data to the SYSTEMS section for system loads computation. After the loads in each HVAC system inside the building are computed, they are passed to the PLANT section to calculate the energy required for the cooling and heating. With the total amount of energy ascertained by the ECONOMICS section then calculates the energy costs incurred together with the life-cycle cost of the energy conservation measures in the building.

2.1 The Electronic Ballast

A fluorescent lamp with magnetic core and coil ballast is considered energy-efficient when compared with an incandescent filament lamp. However, the conventional magnetic ballast can incur power loss up to 26% approximate of the power rating of the lamp. Electronic ballast is more energy efficient. Energy performance of the reference building with conventional ballasts and electronic ballasts has been simulated to investigate the cost-effectiveness of this energy-saving product. It can be seen that building consumes 15% approximate less electricity for lighting. Moreover, due to less heat dissipation by electronic ballasts, the HVAC system consumes 3.0 % less electricity for cooling. Annual electricity cost for a building with electronic ballasts 3.3% less than that with conventional magnetic core. The coil ballasts payback period has been found to be 4 years which is within the average life time of 6 years for electronic ballast. In assessing the economic viability of an energy-saving measure. The life-cycle cost of a building in the life time of the energy-saving product is calculated. The difference between the life-cycle costs in NPV (Net Present Value) i.e. a building with conventional ballasts and a building with electronic ballasts) would be the financial benefit that resulted by the NPV of annual electricity cost over 6 years.

2.2 The Thermal Wheel

The thermal wheel is a rotator air-to-air heat exchanger in which exhaust air from the air conditioned space pre-cools outdoor and intake fresh air to reduce the cooling load of an HVAC system in summer and pre-heats outdoor air to reduce heating load in winter.

In India, during most of summer, the temperature and relative humidity of exhaust air from air-conditioned space are very close to the indoor condition and are very much lower than the outdoor hot humid air. Direct discharge of the exhaust air to outdoors would be a form of energy wastage. There is potential to pre-cool the intake fresh air with the exhaust air before discharging to outdoor. In India the cooling season for commercial buildings with central air-conditioning plants runs from March to November. The remaining months are taken as winter. Calculations are based on a 08 hour day and 5.5 day week with 10 l/s per person fresh air requirement.

Pre-cooling and preheating determined are 1, 153 and 37.5 MWh, respectively; the payback period is 8 years. NPVs of the accumulated electricity cost have been calculated for the expected life time of thermal wheel of 15 years.

2.3 The Sequence Control of Multiple Chillers

It is revealed that multiple identical chillers are designed and installed in most commercial buildings in India. This arrangement gives simplicity in Design and operation and also lowers the maintenance cost. However, very little work has been carried out to investigate energy-efficient mode of control for multiple identical chillers.

Two identical chillers are modeled for the reference building. Basically, there are 3 types of mode for controlling the operational sequence of multiple chillers. Information from building operators shows that sequence control of multiple identical chillers mode 1 is most commonly applied in commercial buildings in India.

Thus Mode 1 is taken as the base case. Annual electricity consumptions and the corresponding NPV of the accumulated annual electricity costs have been determined. Mode 2 sequence control consumes 13,500 MWh/ year which is 2.6% more than that in the base case of 12,750 MWh/yr. It is obvious that under control of mode 2, simultaneous part-load operation of two identical chillers occurs between 0% and 50% of total design cooling load which yields low energy efficiency. However, this situation only happens during mid-season, in early March and late November, so that the annual electricity consumption between these 2 cases is very close.

Mode 3 sequence control has been found to be the most energy-efficient with annual electricity consumption of 11,500 MWh, which is 9.5% less than the base case. This is mainly because this mode of control eliminates simultaneous part load operation of two identical chillers during part load condition between 0% and 50%.

From an HVAC control company, one cost of modification of sequence control is estimated life time of this control system is 25 years. NPV of electricity cost over the life time of the control system.

2.4 The Variable Speed Drives

The electric motor is the largest electricity consuming component in building services especially in HVAC systems. DOE-2 has been used to investigate the energy performance and cost-effectiveness of variable speed drives (VSD) for chillers, water pumps and fans in HVAC systems. This information are input into the DOE-2 program to replace the performance data of default constant speed drives. Analyses of energy consumption and financial implications have been performed. Pay back periods for chillers, water pumps and fans are 1.8, 1 and 4.3 years, respectively. VSDs for fans have the longest payback period mainly due to relatively high installation cost.

3. CONCLUSIONS

The study of energy saving measures has been selected for the cost effectiveness study. These include electronic ballasts for fluorescent lamps, thermal wheels, sequence control of multiple identical chillers and variable speed drives for chillers, water pumps and fans. A payback period of 2 to 3 years would be acceptable. Pay back periods for sequence control of chillers, VSD for chillers and VSD for water pumps are 2.7, 1.8 and 1 year, respectively. For assessing the viability and priority of energy saving measures in existing commercial buildings, 3 options should be considered.

Pay back periods for electronic ballasts and VSD for fans are 3.8 and 4.3 years, respectively. As technology improves and cost lowers. The thermal wheel has the longest payback period of 8 years. Moreover, space could be a problem in existing buildings even when major retrofit is carried out. This is considered not viable.

Life-cycle cost analyses indicate that financial benefits within the excepted life time of these measures is 6 years for electronic ballasts & 25 years for sequence control of chillers.

REFERENCES

[1] Hong Kong Energy Statistics 1979-1992. Census and Statistics Department, Hong Kong 1993.

[2] F.C. Winkel Mann and M. Lokmanhekim, “Sun-control options in a high-rise office building.” Energy and Buildings, Vol.8, 1985, pp. 1-13.

[3] J.C.LAM., “Energy-efficient measures and life cycle costing of a residential building in Hong Kong”, Architectural Science Review, Vol.36, 1993, pp. 157-162

[4] J.E.ETO and A.DE Almedia, “Saving electricity in commercial buildings with adjustable speed drives.” IEEE Transactions on Industry Applications, Vol. 24, 1988, pp. 439-443.

[5] B.P.Zell, “Design and evaluation of variable speed pumping systems.” ASHRA Technical Data Bulletin, 1985, pp. 40-49.

[6] G. Mcmahon, “Energy savings by the speed regulation of fans.” Australian Refrigeration, Air Conditioning and Heating, March 1993, pp.42-44.

[7] DOE-2 Reference Manual Parts 1 and 2, U.C. Department of Commerce, National Technical Information Service, Springfield, 1980.