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Optimizing **HVAC** through **Green design**

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HVAC with its vast usage in most of the buildings and increased focus on thermal comfort for the occupants, has become the main contributor to building energy consumption. In a typical air-conditioned building, more than 50% of the electricity consumed will be from HVAC. Therefore, it is very critical to optimize this component to improve the energy performance of a building & reduce the operational costs.

The energy consumption from the HVAC is influenced by various factors which are both tangible and intangible. These factors are climatic conditions, heat loads in the building, efficiency of the HVAC system and building operation schedule. Understanding each can help in optimizing the building design and save energy in turn.

To further elaborate, the overall design of the building and its systems depend on the climatic conditions with respect to the location of the building. Hotter the climate, more is the cooling required, hence higher the electricity consumed and vice versa. The architectural and MEP design of the building should be in line with the climatic conditions of that location as the climatic condition directly influences the heat loads in the building.

Heat Loads

Heat loads are of two types, namely internal heat load and external heat load. The primary factors that contribute to external heat loads are climatic condition, location, building shape, building orientation, building materials and the interior layout. Also the façade design majorly contributes to the heat load. The secondary factors such as window to wall ratio, shading devices are all important parameters in determining the heat loads as well. The internal heat load comprises of heat generated from lights, equipment, human beings and other process and non-process loads.

Further, based on the heat loads & climate, the HVAC system type and the efficiency have to be chosen. The energy consumption of the HVAC system directly relates to its performance efficiency. Finally, the entire building operating hours also determine the energy usage.

Once the major contributors to the energy consumption in a building are identified, the areas of energy savings can be analysed. Factors like climatic conditions and operating schedules remain constant and no changes can be attributed to these parameters. Heat loads and HVAC system efficiency are the two main areas for improvement which can contribute greatly towards energy reduction.

Heat Load Reduction

M. SELVARASU, B.E., MBA LEED Accredited

External Heat loads in a building can be reduced with a good architectural design. A building in best orientation (longer façade in north and south orientation) with buffer spaces / no conditioned spaces in the west and east façade will reduce significant amount of heat ingress into the building. Reduced glazing in east and west, use of high efficient glazing system coupled with shading devices can be options for conditioned spaces in these orientations. Also, building shape which can contribute to self-shading should also be encouraged.

The choice of building materials is critical in curbing the heat ingress. Materials with low U values, use of insulation, double glazing with low solar heat gain, shading devices, landscape wall, double façade are all key features which can be part of the building design.

Internal loads can be reduced by using efficient light fixtures like CFL, T5, LEDs integrated with light shelves. Lighting controls like daylight and occupancy sensors can be integrated into the design along with use of efficient equipment with star ratings can be chosen.

Professional & Faculty Of USGBC,Director-LEAD Consultancy & Engineering services(India) Pvt Ltd

HVAC Optimization

The HVAC system selection has to be done wisely to match with the building type, loads and climatic conditions, accordingly the best efficiency should be selected. Even though the Capex is higher, the energy cost savings can compensate from the Opex. Measures like using Variable frequency drives, variable air volume boxes, heat recovery wheels, controls for VAV boxes, Separate air distribution system for solar exposed zones, Higher IPLV of chillers, Underflow air distribution system, etc. should be opted wherever there is an opportunity to enhance energy performance for long term sustainability. These technolgies shall be selected with the help of energy modeling softewares and based on the payback analysis.

System Maintanance

There is also the need for continuous monitoring and maintenance of all the installed systems. Regular health check & energy audits will help in identifying problem areas and timely resolution. Routine maintenance should be practiced to eliminate bigger problems later. Small steps like changing filters, sealing leaky duct etc. can have a good effect on the overall system efficiency. ASHRAE 90.1 and ECBC can provide guidance with respect to building envelope construction, lighting design and HVAC selection and efficiency.

New Technologies

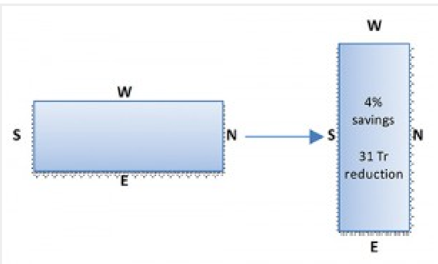
HVAC field is advancing in great momentum resulting in more and more energy efficient systems which are available in the market. Passive designs such as earth tunnel, radiant cooling, chilled beams, geothermal system, wind towers, etc., are all new technologies which can be explored to achieve increasing levels of energy efficiency.

RAthnashree P, Senior Manager-Sustainable Design LEAD Consultancy & Engineering services (India)Pvt Ltd

Variable Refrigerant flow system can be preferred for building with lesser conditioned areas. High capacity centrifugal chillers can be fitted with variable frequency drives for increased efficiency. Inverter based system DX system and Variable air volume system in place of constant speed can be opted. Constant Air Volume system should be phased out from the market. Primary variable pumping system can be a good option to implement. Demand Controlled Ventilation is a good measure to adopt to ensure the right ventilation to balance Indoor air quality & energy consumption. Wherever heating is required, heat pumps can be used instead of boilers and geysers.

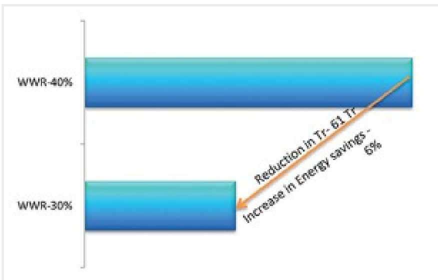
Implementation of complete system automation and avoiding manual operation will result in tremendous operational energy savings.

Case Studies

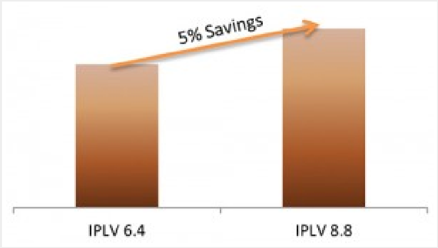


Focus on passive design measures will go a long way in energy efficiency. Reduction in HVAC energy consumption should be critically looked into in a building design. Few simple steps like setting higher temperature control as human comfort range can go as high as 28 degrees can result in enormous savings. In the end every available opportunity should always be looked into as an opportunity to save energy in an intelligent manner. With advancement in technologies, building can be easily designed with 500 to 600 sqft/TR.

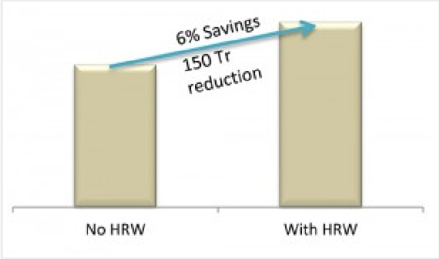
Impact of Orientation:A typical office building of 3.5lakhsqft. conditioned area located in Noida was oriented with longer façade towards east and west orientation. A change in orientation yielded 4% savings on annual energy which amounts to 31 Tr reduction in chiller tonnage.



Reduction in Window to Wall Ratio: A typical office building of 3.0lakhsqft. conditioned area located in New Delhi with longer façade oriented towards North and south is designed with 40% window to wall ratio (WWR). If the WWR is reduced from 40% to 30%, a saving in tonnage of 61 Tr can be achieved with a reduction of energy consumption upto 6%. There is no major impact on the daylight penetration.



Impact of chiller part load efficiency: A typical office building of 4 Lakh sq. ft. Conditioned area located in Chennai is simulated with chiller with high part load conditions. COP of 5.77 with IPLV of 8.8 is simulated as against conventional chillers COP 5.77 and IPLV 6.4. The project has achieved savings of 5% on HVAC.



Impact of Heat Recovery wheels: A typical office building of 4.0lakhsqft. conditioned area located in Chennai is simulated by adding Heat recovery wheels. The savings can increase by around 6% with chiller tonnage reduced by 150 tonnes.

Tagged with: heat loads | hvac | hvac optimization | impact of orientation | reduction in window to wall ratio | technology