HVAC system performance and operational strategies in Green buildings - A Simulation approach

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Abstract - Heating, ventilation and air conditioning (HVAC) systems in buildings will plays a crucial role to address the thermal comfort of the buildings. Most of the buildings are consuming unnecessary energy usage to a tune of 30 to 40 % with bad practices of HVAC maintenance. With a good practice of technologies in HVAC; will save enormous energy savings and also without compromising the comforts of the consumer. Buildings HVAC design with basic operational strategies like control of indoor climatic conditions, day lighting optimization, natural air cross flow ventilation will minimizes the burden on Air- conditioners.

In this paper, an approach has given to minimize the energy consumption of HVAC system by considering the thermal comfort of the building with a certain levels of occupancy levels. A thermal model for one building has been analyzed in an Engineering college campus by using RETSCREEN software with saving reports on energy conservation.

Key Words: HVAC, Simulation, Thermal Comfort, RETSCREEN, Green buildings

1. INTRODUCTION

Energy efficient buildings also known as green construction or sustainable building refers to a building which can maintain sustainable technologies and environmentally supporting clean technologies in all aspects throughout the life span of the building. By maintaining sustainability with good financial viability is also one of the major criteria in Green buildings.

Many new technologies are coming and emerging with best practices to upgrade the existing technologies into green technologies to reduce the overall energy consumption of the building keeping in view of the environmental and carbon neutral technologies.

HVAC technologies has to adopt the local climatic conditions and also by using natural materials that are available in local premises.

Hence in an overall concept, energy efficient buildings which will leads to green buildings has to adopt HVAC technologies to its full potential with all modern best practices clubbed with technical advancements will gives an optimal solution for HVAC parameters.

2. Indoor environmental quality enhancement

While designing best system of HVAC in a building, indoor air quality is one of the important parameter to get better results. Sometimes HVAC system design may lead to bad design and causes to poor indoor air quality

Integrating natural day lighting with artificial daylighting also are features in HVAC system design. Hence, a careful monitoring and adopting these technologies leads to lighting quality of the building and less energy consumption.

2.1 Energy conservation Building Code

Energy conservation building code (ECBC) means the rules and regulations to set some benchmark parameters to decrease the energy consumption of the building depending upon climatic condition of the area. A unit will be derived as EPI (energy performance index) in kwh/m² will decides the performance of the building in period of yearly analysis.

A building consumes different EPI values in different locations with same HVAC benchmark parameters. Hence, validating HVAC design features in different locations is an uphill task for the designer to design HVAC system integration with a building.

The various factors which will influence ECBC with HVAC are detail of the following:

Building orientation: Building direction, insulation materials, air leakage levels, local weather conditions, coordinating the solar heat gain values with building, active and passive technologies.

HVAC design: Equipment sizes, their capacity to suit the room size, location, height of the installation, equipment efficiencies, meeting the standards of regulations of governing bodies.
Passive technologies: Solar hot water system, solar cooking, Earth air tunnel system, solar chimney.

Lighting: energy efficient lighting, sensor based lighting, scheduled lighting, natural day lighting, DC power based lighting

While planning an energy conservation building with HVAC as main feature for energy conservation a range should be planned between 30 to 40% reduction in EPI. Hence, in practical implementation

Standard regulations are framed to test the technical feasibility of a HVAC design. Some of the regulations are ECBC, GRIHA and LEED.

These regulations have been prepared to make sure that:
- The fulfillment process are user friendly, easy to adopt, easy to implement, accessibility
- The techniques and best practices are practically implantable to suit the various climatic conditions.

2.2 HVAC role in Building energy analysis

A building with proper sizing of facades, walls, roofs, wall to window ratio, with proper cross ventilation without and air leakages are some of the parameters in HVAC role in building energy analysis.

The main objective is to identify the exact matching of all these constraints which is not only a technical solution which leads to economical solution.

3. SIMULATION RESULTS

RETScreen 4 is a free Excel-based clean energy project analysis software tool that helps decision makers quickly and inexpensively determine the technical and financial viability of potential renewable energy, energy efficiency and cogeneration projects. The energy performance of a building envelope is influenced by a number of factors.

Case study with simulation results

An analysis has been carried out for GIET campus to analyze the Energy efficient buildings with HVAC parameters and the procedure is as follows:

Step 1: Starting worksheet

The project type is of Energy efficient Measures, this is of institutional facility type and the analysis method is considered as method 1. The Heating value reference is considered as LHV (lower heating values).
This is the extension of fig 3.2 and 3.2(A) window which show the data of climatic conditions of the considered location. While the latitude and longitude values are entered, the values of Air temperature, Relative humidity, Daily radiation-horizontal, Atmospheric, wind speed, Earth temperature, Heating Degree days, Cooling degree days are obtained for monthly basis. The data obtained is only for reference purpose not to run the model

Step 2: Energy Model:

The fuel type is of Electricity at a unit rate of 6.0 Rs/Kwh. The scheduled working days are of 24 days on an average for a month. The base case and proposed cases have working hours of 8 per a day. Therefore, out of 100%, 33% occupancy is utilized. The climatic conditions are always hotter as described in the previous worksheet; hence the cooling temperatures are required for 365 days.

Step 3: Facility characteristics

In this section, enter the information about the facility characteristics, for the base case and the proposed case facilities. The user clicks on the blue hyperlinks (e.g. Heating system, Cooling system, Building envelope, ventilation, lighting etc.) to access the data entry forms used to describe the facility.
5 Conclusion

In most of the countries, buildings represent 30-40% of the countries primary energy use, including fuel input for production. Furthermore, buildings today are almost exclusively dependent on energy supplied from outside, even though they have significant potential for self-support using renewable energy. Buildings have the physical potential to harness diluted and sometimes unpredictable renewable energy. The building envelope and the ground constitute the basic resources for energy autonomous buildings.

The key objective of this project is to produce new, innovative and non conventional scientific knowledge in sustained, clean and efficient energy technologies to give a better solution for rooftop PV assisted buildings and achieving energy efficient buildings. The present work will be analyzed through simulation by using RETSCEEN software and compared with measured values and to arrive at certain general design rules for such systems.

References:


2. Thermal energy savings in buildings with PCM-enhanced envelope: Influence of occupancy pattern and ventilation; Bogdan M. Diaconua,b,*, Energy and Buildings 43 (2011) 101–107; Elsevier journals, August 2010

3. Relationship between construction characteristics and carbon emissions from urban household operational energy usage Hong Ye, Kai Wang, Xiaofeng Zhao, Feng Chen, Xuanqi Li, Lingyang Pan; Energy and Buildings 43 (2011) 147–152; Elsevier journals, September 2010

4. Room air temperature affects occupants' physiology, perceptions and mental alertness Kwok Wai Tham*, Henry Cahyadi Willem Department of Building, School of Design and Environment, National University of Singapore, Architecture Drive, Singapore 117566, Singapore

5. Optimization of distributed generation capacities in buildings under uncertainty in load demand A. Taghipour Rezvana, N. Shams Gharneha,*; G.B. Gharehpetianb

6. An hourly modelling framework for the assessment of energy sources exploitation and energy converters selection and sizing in buildings Enrico Fabrizio a, Marco Filippi b, seph Virgon

7. A life cycle energy analysis of social housing in Brazil: Case study for the program “MY HOUSE MY LIFE” Jacob Silva Paulsen*, Rosa Maria Sposto Department of Civil and Environmental Engineering, University of Brasilia, 70910-900 DF, Brazil