FUTURE OF HVAC INDUSTRY WITH EMERGENCE OF GREEN BUILDING IN INDIA

It seems the era of "Green Building" has brought with it a trend in HVAC design, where the new technologies and strategies are adopted to achieve higher energy performance. Our definition of green buildings inevitably extends beyond the concerns of HVAC designers alone since the very concept places an emphasis on the integration of mechanical, electrical architectureal,public health engineering, and other systems. Green building is one that achieves high performance, over the full life cycle, in the following areas:

- Minimal consumption of energy – due to reduction of need and more efficient utilization- of non renewable natural resources, land, water, and other materials as well.
- Minimal atmospheric emissions having negative environmental impacts, especially those related to greenhouse gases (GHG), global warming, particulates, or acid rain.
- Minimal discharge of harmful liquid effluents and solid wastes, including those resulting from the ultimate demolition of the building itself at the end of its useful life.
- Minimal negative impacts on site ecosystems.
- Maximum quality of indoor environment, including air quality, thermal regime, illumination, acoustics/noise, and visual aspects.

HVAC designer plays an important role in the functionality of a green building. The HVAC system for green building shall be designed to reduce energy consumption while maintaining the interior conditions at a comfortable level to keep occupants health & productivity. The designer should ensure the HVAC system design NOT only meet the standard on energy front but beat the standard codes like Energy Conservation Building Codes (ECBC), India& American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) standards to achieve higher level of green building LEED (Leadership in Energy and Environmental Design) rating.

Noticeable Changes in the recent and future HVAC Industry due to Green Building Construction:

(1) Chiller Selection: All the major HVAC equipments like Chillers and Packaged AC units are procured based on their energy performance rating to beat the energy rating specified in ECBC and ASHRAE standard. This is inorder to score more points under Green Building LEED Rating – Energy & Atmosphere Credit 1.1. As it has become mandatory to achieve 14% (2 points) under Energy category in LEED – Green Building Rating System for Core & Shell project to meet the certification eligibility. For Example: Table -1 & Table – 2 explains under normal circumstances, the chiller would have been selected to meet the energy performance as per standards, due to green building construction, the chiller energy performance opted for more efficient than specified in the standard to achieve better building energy performance.

Table - 1

Sr.No.	Typical Commercial Building of 8.75Lakh BUSFT aspiring for Gold Rating under - C&S IGBC	Minimum COP of Chillers as per ECBC Code	Proposed COP of the High Efficiency Chiller	% of increased Energy Efficiency as against the Standard
1	700 Tr Water Cooled Centrifugal Chiller - 1No.	6.3	6.53	4%
2	350 Tr Air Cooled Screw Chillers -5 Nos.	3.05	3.2	5%

Table - 2

Sr.No.	Typical Commercial Building of 8.75Lakh BUSFT aspiring for Gold Rating under - C&S IGBC	Minimum COP of Chillers as per ASHRAE 90.1-04 Standard	Proposed COP of the High Efficiency Chiller	% of increased Energy Efficiency as against the Standard
1	700 Tr Water Cooled Centrifugal Chiller - 1No.	6.1	6.53	7%
2	350 Tr Air Cooled Screw Chillers -5 Nos.	2.8	3.2	14%

(2) Ancillary HVAC Equipment Selection: Pump and fan capacities can be reduced and energy saved by using variable speed drives to control their speed. Reductions in both peak and off-peak energy costs can be obtained by using variable speed drives on pumps, fans and compressors that operate at varying loads.

(3) **Outdoor Air Delivery System:** Optimization on fresh air supply to the occupied space as per ASHRAE 62.1-2004 to ensure the system neither over ventilates nor under ventilates the building. The concept of implementing Dedicated Outdoor Ventilation (DOAS) & Demand Control Ventilation (DCV) system are becoming popular to ensure the right amount building ventilation to strike a balance between human discomfort due to under ventilation and energy loss due to over ventilation.

(4) **Supply Air System Control:** Using Variable Air Volume boxes and dedicated individual control for 50% of the occupied people / all closed cabins in the occupied area will become mandatory to ensure human comfort & energy saving benefit.

(5) **Indoor Air Quality (IAQ) Monitoring:** In order to maintain the IAQ of the occupied area, it is required to install a Fresh air system which Controls, Measures, Monitors continuously the flow of fresh air (Outdoor air) supplied to the occupied area. The CO2 Sensors installed in the occupied areas to ensure proper Indoor Air Quality. The fresh are flow & CO2 level information is fed to Building Automation System (BAS) to trigger corrective action, if applicable.

(6) **Energy Conservation Measure (ECM) Strategies in HVAC System:** Adopting various energy conservation measures on HVAC system after conducting thorough Life Cycle Cost Analysis (LCCS) of ECM strategies to save energy. The following strategies can be adopted in the HVAC system:

ECM – 1: Demand Control Ventilation (DCV) using CO2 Sensors:

A significant component of indoor environmental quality is the indoor air quality (IAQ), ASHRAE Standard 62-2001 describes in detail the ventilation required to provide a healthy environment. However, providing ventilation based strictly on the peak occupancy using the Ventilation Rate Procedure will result in over ventilation during periods. Any positive impact on IAQ brought on by over ventilation will be outweighed by the costs associated with the energy required to condition the ventilation air. CO2 sensor can be used to measure or control the per person ventilation rate and, in turn, allow the designer to introduce a ventilation demand control strategy.

ECM – 2: Dedicated Outdoor Air Systems (DOAS):

A DOAS uses a separate air handler to condition the outdoor air before delivering it directly to the occupied spaces. While a DOAS can be applied in any design, it is most beneficial in a facility with multiple spaces with differing ventilation needs. A DOAS ensures compliance with ASHRAE 62-1999 for proper multiple space ventilation and adequate IAQ. It reduces a building's energy use when compared to mixed air systems that requires over ventilation of some spaces. It allows the designer to decouple the latent load from the sensible load, hence providing more accurate space humidity control. It allows easy airflow measurement and balance, and keeps ventilation lads off main HVAC units.

ECM – 3: Air to Air Heat Recovery System:

A heat exchange enthalpy wheels can be used in comfort application, where energy in the exhaust stream would otherwise be wasted. Energy recovery is most economical when there are large temperature differences between the airstreams, the source of supply is close to the exhaust, and they are both relatively constant throughout the year. With a total energy wheel, the humidification costs may be reduced in cold weather and dehumidification costs may be lowered in warm weather.

ECM – 4: Consider Variable Speed Drives for Pumps, Fans & Compressors:

Pump and fan capacities can be reduced and energy saved by using variable speed drives to control their speed. Reductions in both peak and off-peak energy costs can be obtained by using variable speed drives on pumps, fans and compressors that operate at varying loads. They pay off better if the systems they are applied to operate at part load for relatively long hours. Variable speed pumping can dramatically increase energy savings, particularly when it is combined with demand-based pressure resent controls. Variable speed drives on pumps/fans provide a "Soft" start, extending equipment life. Variable speed systems are quieter than constant speed systems.

ECM – 5: Chilled Beams:

Chilled beams do not require a secondary fan so they are inherently more energy efficient than fan coil units, their main air terminal device rivals. On top of this, chilled beams use higher chilled water flow temperatures than fan coil units (around 14ºC), which means there is a significant part of the year when chillers do not need to be working and free cooling is available. The net result of the above, the chilled beam systems is always **lower energy consumption and operating costs.**

ECM – 6: Night Pre Cooling:

Night precooling involves the circulation of cool air within a building during the nighttime hours with the intent of cooling the structure. The cooled structure is then able to serve as a heat sink during the daytime hours, reducing the mechanical cooling required. Night cooling would be applicable when the ambient nighttime temperatures are low enough to provided sufficient opportunity to cool the building structure through ventilation air. It is mainly applicable, a hot, dry environment area. This reduces the energy required to operate a chilled water plant.

ECM – 7: Thermal Storage System for Cooling:

Consider a thermal storage system when designing your chiller plant. With a thermal storage system, the idea is to run chiller equipment off-peak and store cooled water or ice, then draw on this cooling during the peak times of the day. These systems take one of three forms: chilled water, ice or a salt-water hybrid of both—called a eutectic system. Specifying which system is based on the availability of space for storage media, cooling load profile, rate schedule and current equipment.

ECM – 8: Displacement Ventilation:

With a ceiling supply and return air system, the ventilation effectiveness may be compromised if sufficient mixing does not take place. In this case the ventilation effectiveness will approach 80% or less. In displacement ventilation, conditioned air with a temperature slightly lower than the desired room temperature is supplied horizontally a low velocity at or near the floor. Returns are located at or near the ceiling. The supply air is spread over the floor and then rises by convection as it picks up the load in the room. Displacement ventilation does not depend on mixing. Instead, you are literally displacing the stale polluted air and forcing it up and out the return or exhaust grille. In this system, the ventilation effectiveness may actually exceed 100%, and ASHRAE 62-1, 6.2 addendum n, indicates a ventilation effectiveness of 1.2 shall be used.

ECM – 9: Gas Fired Chillers:

Chilled water systems that use fuel types other than electricity can help offset high electricity prices, whether those high prices are caused by consumption or demand charges. Absorption chillers use thermal energy (rather than electricity) to produce chilled water. This type of system can be thought of when natural gas prices are significantly lower than electric prices. The other option is to go for gas based captive power engine to produce electricity and the waste heat from the gas engine can be used to generate chilled water through heat recovery VAM chillers.

ECM – 10: Control Cooling Tower Fans by Sensing Ambient Wet Bulb Temperature: Control cooling tower fans by sensing ambient wet bulb (wb) temperature. Adjust the set point for an approach of about 2°F (controller will measure outside wb and adjust set point to 2°F warmer).

(7) **<u>Effect of other Building material on HVAC System:</u>** The overall installed capacity of HVAC plant for the building will become greatly influenced by the Energy Conservation Measure (ECM) adopted for the building. Other than the above mentioned changes in HVAC, the following strategies in the construction improves the overall energy performance of the building

- ❖ Providing High Performance Glass Façades by going for SHGC < 0.19
- ❖ Providing adequate insulation on building Wall & Roof to beat ECBC & ASHRAE Standard.
- ❖ Adopting Lower Power Density (LPD) for lighting as compared to the recommendation from ECBC & ASHRAE standard.
- ❖ Efficient Lighting system & using Solar Energy System - Photovoltaic
- ❖ Optimizing the orientation of building
- ❖ Providing external & internal Solar shading devices.
- ❖ Restricting the Glass Facades to meet the Window to Wall Ratio (WWR) not exceeding 60%
- ❖ Water conserving plumbing fixtures
- ❖ Grey water Systems
- ❖ Rainwater Harvesting
- ❖ Daylight harvesting

CONCLUSION:

It is important to use the right – size HVAC cooling and heating equipment. The old rule of thumb of 200-250 gross ft2/ton cooling load MAY NOT apply to sustainable / Green buildings. Recent high – performance building projects operate between 600 and 1000 GSF/ton. Set cooling equipment and system performance targets in terms of kW/ton, such as:

Chiller (Water Cooled)	0.51 kW/ton
Cooling Tower	0.011 kW/ton
Chilled water pump	0.026 kW/ton
Condenser water pump	0.021 kW/ton
Air Handling Unit	0.05 kW/ton

Industry standards such as ECBC & ASHRAE (90.1) give minimum requirements for equipment efficiencies and system design and installation. Understand that these represent the least efficient end of the spectrum of energy – conserving buildings that should be built! To be considered green, a building must exceed these standards. GO GREEN …. GREEN MAKES ECONOMIC SENSE.