Energy-Saving HVAC Tips for Green Buildings

An Online Continuing Education Course for Engineers

Course Number: HV-5018

Credit: 5 Hours / 5 PDH / 5 CPD

Energy-Saving HVAC Tips for Green Buildings

A. Bhatia, Mechanical Engineer

Introduction

Green buildings! Green technology!

We hear these catch-phrases quite frequently these days. What exactly does this mean? Incorporating excellent practices that result in environmental protection, water conservation, energy efficiency, usage of recycled products, and renewable energy is termed "green." A "Green Building" is one that is environmentally responsible, profitable, and a healthy place to live and work. Green Buildings ensure that waste is minimized at every stage during the construction and operation of the building, resulting in low costs.

Green Building applies to both existing and new constructions, from a simple commercial space to large development projects. The Leadership in Energy and Environmental Design (LEED) Green Building Rating System is used as a benchmark for evaluating the design, construction, and operation of high-performance green buildings. LEED is often used as a qualifying criterion for a growing array of state and local government initiatives. What many facility managers may not realize is that it is an easy list of steps worth adopting, even if LEED certification is not being pursued.

Green HVAC Design

Concerns about a healthy indoor environment, maximum energy-efficiency, and thoughtful use of natural resources/water – also happen to be the current concerns of the HVAC industry.

To improve a building's overall efficiency, it is helpful to understand what sources of heat gain/loss create the greatest cooling/heating load on the HVAC system. By reducing those loads, HVAC energy costs can be lowered, and comfort often can be improved. When designing a comfort system, it is not adequate to merely produce a heat loss/gain estimate and select high-efficiency equipment; much more is involved in the proper design and installation of a comfort system. Air handling and distribution system (ductwork, dampers, etc.), a hydronic distribution system (pumps, piping, fittings, etc.), delivery equipment (fan coil units, induction units, baseboard heaters, grilles, registers, etc.), and the control system make an important contribution to the performance and efficiency of the system as a whole.

The total performance of a building depends on a balance of envelope, mechanical systems, occupants, and external environment. All these parts of the building affect the flow of heat, air, and moisture into and out of the building. Every subsystem should be designed with these concepts in mind to minimize the flows of heat, air, and moisture through the building envelope. Heat flow leaking out of a building wastes precious fuel, air leaking out carries both heat and moisture, and moisture that escapes from the interior of a building can condense or freeze in the insulation, reducing the effectiveness of the insulation and causing damage by mold and rot. We will, in this course, look at some key elements related to HVAC and building design.

The green HVAC tips noted in this course are by no means exhaustive; keep in mind that the conservation strategies for greening may vary from region to region. Specific strategies should reflect the region's climate, material availability, and building practices. Keeping abreast of developments in real-time requires continuing education.

The content in this course is as follows:

Green Tip #1	Building Siting & Architectural Features
Green Tip #2	Building Envelope
Green Tip #3	Materials that Control Air & Vapor
Green Tip #4	Lighting & Appliances
Green Tip #5	Packaged & Ductless Split HVAC Systems (DX)
Green Tip #6	Central Cooling Plants Chillers
Green Tip #7	Absorption Chillers
Green Tip #8	Refrigerants
Green Tip #9	Cooling Towers
Green Tip #10	Cooling Water Treatment
Green Tip #11	Heat Recovery from Condenser Water
Green Tip #12	Pumping System
Green Tip #13	Variable Speed Pumping Systems
Green Tip #14	Chilled Water Distribution Schemes
Green Tip #15	Chilled Water & Condenser Water Piping

Green Tip #1: Building Siting & Architectural Features

An integrated approach to building design involves addressing several aspects of building design that influence the loads imposed on the HVAC system.

1. Building Siting

Following are some general guidelines for siting of building in different climatic conditions:

a. Cold: Exposure to morning sun is preferable, but shade should be provided to west and northwest in summer. Buildings should preferably be placed on south-facing slopes; north slopes should be avoided.

b. Temperate: Buildings should be accessible to winter sun and summer breezes, but sheltered from winter storm winds. Summer shading is important to the east, west, and over the roof.

c. Hot arid: Summer shading is very important, especially to the west and over the roof. Some access to winter sun and sheltering from winds are desirable.

d. Hot humid: Buildings should be opened up for natural ventilation. Shading and access to breezes are important. Some access to winter sun is desirable.

2. Solar control

Solar radiation contributes to heat, light, and glare to a site. Trees planted on the east, west, and south sides of a building can dramatically reduce cooling loads. To take advantage of the sun in the winter, the location selected must be free of obstructions to winter sunshine.

a. Vegetation: Apart from many aesthetic advantages, related benefits of vegetation include decreased air pollution, noise, and glare. In order to permit summer breezes, vegetation should not be very near to a building.

- External shading with natural deciduous trees is very effective at providing shade and cooling by evaporating water through their leaves: during winter, they are bare, allowing sunlight to pass through, but during summer, they shade the building. Studies have shown that when shaded by a single large tree in direct sunlight, a wall may experience a drop in temperature by 20° to 25°F. Even when there is no direct sunlight on the walls, shading by a large tree can reduce the wall temperature by 5° to 10°F.

- Excess glare from a nearby un-shaded ground, water bodies, etc. can be minimized by the use of ground cover such as grass or ivy, which absorbs a fair amount of light. Maximum local cooling occurs when grasses or ground covers are allowed to reach their maximum height.

- Vines have the potential to cover a large portion of a building in a very short period. They, however, require a supporting trellis away from the wall to ensure adequate air circulation and minimize the potential for root damage to the wall. Vines can provide temperature reductions up to about 15°F.

3. Wind control

Wind speed and direction can cause large pressure differences across the building envelope. Positive pressure on the windward side of the building drives air in through cracks and holes. At the same time, a negative pressure is created on the leeward side of the building, drawing air out through cracks and holes.
In contrast to the sun, wind should be utilized during summer to aid natural conditioning and blocked during winter. In designing for wind protection and wind use, directions and velocities of the wind should be known in relation to cool and warm periods of the day and year. Of all the climatic variables, wind is the most affected by individual site conditions.

a. **Sheltering**: It can be done by providing windbreaks: a wall, earth berm, or just another building. Velocity of wind striking a solid break can be reduced to about half at distances equivalent to 10 to 15 times the height of the break.

b. b **Channeling**: Site development can be utilized to channel cool breezes in order to carry unwanted heat and moisture from a building. Hedgerows and shrubbery can block cold winter winds or help channel cool summer breezes into the building.

Building Architectural Features

Adopting appropriate passive solar design strategies, e.g., orientation, shape, shading, area classification, fenestration sizing, and shading, landscaping, and day-lighting are few techniques in minimizing HVAC loads.

1. Building Shape, Form, and Orientation

The orientation of a building often is determined by siting considerations. However, for those sites where there is a choice, analyzing the effect of orientation on energy and equipment costs can lead to a more energy-efficient building.

Long, narrow buildings with their long axis running east/west will permit orienting more windows to the north and south. These have LOWER cooling loads and may be able to utilize smaller cooling equipment. Conversely, buildings facing east or west with their long axis running north/south will have higher peak cooling loads and electricity demand costs and may require larger cooling equipment.

For more northerly locations, only the south glass receives much sunlight during the cold winter months. If possible, maximize south-facing windows by elongating the floor plan in the east-west direction and relocate windows to the south face.

2. Shading

External overhangs or some type of internal shading device are desirable because they provide comfort for the occupants (overhangs provide shade without interfering with the view).

- Tropical regions need both vertical and horizontal shading throughout the year. In higher latitudes, horizontal and vertical shading is only needed during the summer on the south-facing sides of buildings.

- Any breeze in …neficial for most of the year, whereas, …as to be screened.

- In the arid zone… …vaporative cooling. In the tropical zone… …table.

3. Atrium

- In the tropical zo… …e ventilation within the built form.

- In the arid zone, t… …ilding for cooling and shading purpos…

- In cool and tempera… …the center of the building for heat and light.