Introduction to the ASHRAE GreenGuide for LEED

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ABSTRACT

This article introduces the concept of sustainability in building design, construction, and operation, and offers various "green tips" to aid the integrated design team in developing a green building. In 2002, the American Society of Refrigerating and Air-Conditioning Engineers, ASHRAE, and the United States Green Building Council, USGBC, entered into a partnering agreement to team together to promote green buildings. This GreenGuide was developed by ASHRAE to assist the USGBC in their efforts at promoting sustainable design.

INTRODUCTION

During the year 2000, the USGBC released its first green building rating system. Called "Leadership in Energy and Environmental Design for New Construction," LEED 2.0. USGBC released a revised version, LEED 2.1, also called NC. Although the LEED rating system incorporated many ASHRAE standards into the rating system, the architectural community, not the engineering community, was in the vanguard of LEED. ASHRAE recognized the potential value of LEED to the community and the building industry, and the value that ASHRAE could bring to the LEED program. Under then-president-elect Bill Coad, Tech Committee 1.10 Energy Resources was tasked with developing a handbook or guide for sustainable engineering design, specifically targeted for ASHRAE members. In addition, during this time, after dialog between both organizations, the USGBC and ASHRAE entered into a partnering agreement. The result of these efforts was the development of the ASHRAE GreenGuide, released in December 2003, to assist the USGBC in their efforts to promote sustainable design.

THE ASHRAE GREENGUIDE

The guide was developed to provide guidance on how to apply green design techniques. Its purpose is to help the designer of a "green design" with the question of "What do I do next?" It is organized to be relevant to the audience, useful, practical, and to encourage innovative ideas from the design team. A key component of the guide is the "green tips," which will be covered in some detail later in this article.

However, the guide is not a consensus document, and one does not have to agree with all elements of the guide for it to be helpful. It was not developed to motivate the use of green design.

Green Design, Sustainability and Good Design

"Green" has become one of those words that can have too many possible meanings. One of the USGBC's initial goals was to provide a definition of "green" through the development and release of the LEED rating system. It was here that we had a measurable, quantifiable way of determining how green a building was. It also addresses the "greenwashing" issue, wherein all types of green technologies and techniques could be employed, some valid and others questionable, all in the effort to label a building green. The conclusion is that green buildings are LEED buildings. This message is almost universally accepted, in the USA as well as internationally. But do be aware that there are other strong green rating systems that have been developed in Canada and Europe. For example, Canada has the green building challenge, GBC, and Britain has the building research establishment environmental assessment method, BREAM. According to the guide, the consensus on green buildings is that they achieve a high level of performance over the full life cycle in the following areas:

- Minimal consumption of nonrenewable, depletable resources such as water, energy, land, and materials.
- Minimal atmospheric emissions that have negative environmental effects.
- Minimal discharge of harmful liquid and solid materials, including demolition debris at the end of a building's life.
- Minimal negative impact on site ecosystems.

- Maximum quality of indoor environment including lighting, air quality, temperature, and humidity.

Sustainability Sample Definitions

Many have developed definitions of sustainability, such as:

The UN Brundtland Commission, "Development is sustainable if it meets the needs of the present without compromising the ability of future generations to meet their own needs."

The Design Ecology Project, "Sustainability is a state or process that can be maintained indefinitely. The principles of sustainability integrate three closely intertwined elements—the environment, the economy, and the social system—into a system that can be maintained in a healthy state indefinitely."

The ASHRAE GreenGuide, "Sustainability is providing for the needs of the present without detracting from the ability to fulfill the needs of the future."

"Good" Design

ASHRAE asks whether good design is intrinsically green design. The GreenGuide authors make the distinction between green and good. Good design includes:

- Meeting the purpose and needs of the building's owners and occupants.
- Meets the requirements of health and safety.
- Achieves a good indoor environment consisting of thermal comfort, indoor air quality, acoustical comfort, and is compatible with the surrounding buildings.
- Creates the intended emotional impact on building's occupants.

But this is not green design in the sense that it does not address energy conservation, environmental impact, low impact emissions, and waste disposal. Integrating good and green design, such as the LEED rating system, helps us achieve the optimum building for the owners' needs as well as the needs of society. Hence the authors of GreenGuide "strongly advocate that buildings should strive to achieve both."

The Design Process

The design process is the first crucial element in producing a green building. There needs to be an integrated design team created in the beginning. This team should include the owner, project manager, representative of the end user, architect, HVAC&R engineer, plumbing & fire protection engineer, electrical engineer, lighting designer, structural engineer, landscaping specialist, civil engineer, energy analyst, environmental consultant, commissioning authority, construction manager, cost estimator, building operator, and code enforcement representative.

Each individual professional works in a team environment to establish the building's goals and the manner in which these goals will be achieved. Each professional must be able to recognize the impacts of one another on others' designs and process.

For example, during conceptual design, the architect will determine the size and number of floors of the building. The building envelope will determine the size of HVAC&R equipment as well as the types of systems being evaluated. The energy analyst will advise the team on the energy cost implications of their selections. Everyone is interdependent upon the others. What should come at the end of this iterative process is a single integrated design that functions a unit and not as a collection of parts.

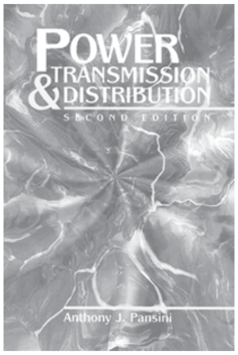
Integration and interdependency of the design team professionals are the keys to a successful green design.

Conceptual Engineering Design

The principle intent of the GreenGuide is to assist the design-engineering professionals in integrating their skills and bringing value into the green design. The guide discusses a number of design responsibilities and suggests a number of "green tips" to the design team. You may find that these suggestions are not new to you and many of these concepts have been in use or at least in consideration for years. However, with the advent of the desire to build green, which requires high performance systems, these techniques have a much better chance of being incorporated into the green building than in the past when first cost was possibly the primary concern of one owner and the design team. The tips are arranged so that they are listed after the design section responsibility that they are most closely linked to.

1) Load Determination

Loads are determined by summing up internal and external gains and losses. The HVAC&R engineer can assist the architect in determining necessary characteristics of the building envelope. Working together with the energy analyst and others, they will aid the architect in selecting building orientation, in-



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sulation, fenestration, roofing, lighting, day lighting, systems sizes and efficiencies, etc. A key element to strive for is the initial reduction of loads resulting from efficient building envelopes, lighting loads, power loads, and A/C tonnages.

Green Tip #1: Night Precooling

Involves the circulation of cool air during the nighttime hours with the intent of cooling the structure. There are two variations on this theme. First is the use of fans only to bring in cool ventilation air; this is a somewhat passive technique. The other is to actively run the HVAC&R plants to precool the facility, potentially below daytime occupied temperatures, to take advantage of the building's thermal mass. Parameters to consider when evaluating this strategy are local diurnal temperature variations, humidity levels, and thermal coupling of the circulated air to the building's thermal mass.

Some pros and cons of this strategy:

Pros include the potential for energy savings, and both variations can be added into a design at very little cost, primarily through the building automation system, BAS. This can also beneficially affect the indoor air quality, as the building will be purged of used air during this time.

Cons include the potential to overcool the building, making early occupants uncomfortable. There is also the potential to bring in large amounts of humidity if not closely controlled by enthalpy sensors in the BAS.

2) Space Thermal/Comfort Delivery Systems

Occupant comfort and health are important and the quality of the indoor environment promotes satisfied, productive workers within the building. Green buildings provide a more productive workplace environment.

Thermal comfort is concerned with satisfying ASHRAE Standard 55 for temperature and humidity requirements.

Indoor air quality is concerned with ASHRAE Standard 62 for fresh air and ventilation. However, both of these can negatively impact energy consumption, and thus the following related green tips:

Green Tip #2 Air-to-Air Heat Recovery—
Heat Exchange Enthalpy Wheels

This is a rotary cylinder filled with an air-permeable medium with a large internal surface area. Intake and exhaust air streams pass through opposite ends of the wheel in a reverse flow configuration. Latent and sensible heat are then transferred as desired from exhaust to inlet air, thereby recovering the conditioning energy that was invested in the exhaust air.

Pros and cons:

Pros include smaller HVAC equipment, as this energy recycling reduces loads. Humidity can also be recycled in winter months, and the wheels require relatively little maintenance.

Cons include some cross-contamination between exhaust and inlet air, added pressure drop to the system, and cost considerations require the exhausts and inlets are within close proximity.

**Green Tip #3 Air-to-Air Heat Recovery—
Heat Pipe Systems**

These are passive devices, usually configured as tubes with fins for maximum surface area. They contain a thermal fluid that transports sensible heat only between exhausts and inlets.

Pros and cons:

Pros include smaller HVAC equipment as loads are reduced through heat recovery. They require little maintenance, and cross-contamination is not an issue.

Cons include that exhausts and inlets need to be close together, added pressure drop, and the decomposition of the thermal fluid.

Green Tip #4 Air-to-Air Heat Recovery—Run-Around Systems

This consists of energy recovery coils in the exhaust and inlet air streams and a circulating loop containing a heat transfer fluid. Although these systems do not transfer latent energy, an option added to the systems is the use of an indirect evaporative water process that can reduce loads in addition to the heat recovery process.

Pros and cons:

Pros include smaller HVAC equipment, the loop accommodates remote exhaust and inlet locations well, and there is no cross-contamination potential.

Cons include the energy cost of running the loop circulating pump, added pressure drop to the system, and more maintenance and controls than Tips #2 and #3.

Green Tip #5 Displacement Ventilation

This technique supplies conditioned air at a slightly lower temperature than the desired room temperature at low velocities horizontally at the floor level. Returns are located in the ceiling. This supply air rises by convection, picks up the room load and exits through the ceiling returns.

Pros and cons:

Pros include better thermal comfort and IAQ due to increased ventilation effectiveness, and reduced energy usage due to the ability to use more hours of the airside economizer due to the relatively warmer supply air temperatures employed.

Cons include added complexity to the HVAC systems, more difficult high heating and cooling loads, and higher perceived costs.

Green Tip #6 Dedicated Outdoor Air Systems

This uses a dedicated, separate air handler to condition the outdoor air before delivering it directly to the occupants. The air delivered should be conditioned sufficiently to not adversely affect the thermal comfort of the occupants. The only absolute with this system is that the ventilation air must be delivered directly to the space from a separate system. Control strategy, energy recovery, and leaving air conditions are all variables that can be fixed by the designer.

Pros and cons:

Pros include ensurance that there is compliance with ASHRAE Std 62 for proper multiple space ventilation, generally reduced energy consumption, and allows the designer to decouple latent loads from sensible loads, providing more accurate space humidity control. It also eases air flow measurements and keeps the ventilation load off the main HVAC systems.

Cons include that it may add first cost to the overall project, may require additional materials, there may be more systems to maintain, there may not be a thorough mixing of air from the two systems within a space, and total airflow may exceed a single system.

Green Tip #7 Ventilation Demand Control Using CO_2

CO_2 concentrations are measured in a space and ventilation rates are automatically adjusted by the BAS to maintain CO_2 concentrations within predetermined limits. This system is best used in buildings and spaces with variable occupancies such as public spaces, theaters, meeting rooms, etc.

Pros and cons:

Pros include energy savings by optimizing the amount of ventilation air used versus fixed ventilation systems, and it maintains adequate ventilation regardless of occupancy levels within the limits of the ventilation system capacities.

Cons include added first cost for controls and sensors, additional materials, and CO_2 sensor technology is still evolving.

Green Tip #8 Hybrid Ventilation

Allows the controlled introduction of outside air ventilation into a building by both mechanical and passive means. It is sometimes called “mixed mode ventilation.” It has built-in strategies to allow the mechanical and passive portions to work with one another so as to not cause additional ventilation loads as would occur using mechanical ventilation alone. This is a nonconventional technique that has the promise of reducing operating expenses as well as providing a healthier stimulating environment.

Pros and cons:

Pros include an energy efficient form of ventilation, lower building life cycle costs, a healthier indoor environment, a sense of occupant satisfaction as they have control over the passive aspects of the operation such as operable windows, and it could extend the life of equipment as it may run fewer hours.

Cons may arise if the passive and active systems are not well integrated into an operating strategy. Additional first costs are a possibility, security could be compromised when using automatically opening windows if not locked out based on time of day. Also, open windows may introduce insects, animals, and birds into the space. Special training of occupants is required, and it is difficult to calculate the ventilation effectiveness of the mixed system.

3) ENERGY DISTRIBUTION SYSTEMS

These provide the heating, cooling, lighting, and electric power throughout the building. The most common media to distribute energy are steam, hydronics (water), air, and electricity. Steam supply, because of its pressure characteristics, does not need to be pumped, although generally the steam condensate is pumped back to the boilers. Water and air are the principle media that require mechanical intervention for distribution, and can be major consumers of electric power for pumps and fans.

Green Tip #9 Variable Flow/Variable Speed Pumping Systems

Pumps and fans can be significant users of electric power. In a conventional application, the pumps and fans operate at a fixed rate based on maximum design conditions regardless of actual loads. Adding variability to the pumping and fans to allow modulation of flows based upon actual systems needs, as opposed to design conditions, can provide significant electrical savings.

Pros and cons:

Pros include energy savings resulting from variable flow and speed control, variable speed drives, VSD, and a soft start for equipment. Used with two-way valves, the systems are self-balancing, and are quieter than conventional systems.

Cons include higher first cost, proper regulation, a direct digital control (DDC), BAS is required, and variable flow on condenser water flows needs to be maintained sufficient to maintain flow over the cooling tower fill.

4) ENERGY CONSERVATION SYSTEMS

This section focuses on the equipment that generates electricity, steam, hot water, and chilled water. These include distributed electrical generation, boilers, furnaces, electrically driven water chillers, and thermally driven absorption chillers.

Green Tip #10 Low-NO_X Burners

These are natural gas burners that improve energy efficiency and lower emissions of oxides of nitrogen, NO_X. They can be purchased as an option for new equipment or retrofitted to existing equipment.

Pros and cons:

Pros are improved energy efficiency, reduced energy costs, and reduced emissions, which may be required by code.

Cons are higher first cost and a higher maintenance cost.

Green Tip #11 Combustion Air Preheating

Preheating combustion air by using waste heat from the exhaust stack increases the energy efficiency of equipment such as boilers and furnaces. The principle is to introduce preheated hot air into the combustor instead of cold air, thereby reducing energy consumption.

Pros and cons:

Pros include the reduction of energy costs, an increase in the overall thermal efficiency of the unit, and reduction of CO_2 emissions.

Cons include additional costs for heat recovery apparatus with controls, potential corrosion, and increases in combustion temperature that may increase NO_X emissions.

Green Tip #12 Combustion Space/Water Heaters

These consist of a storage water heater, a heat delivery system such as fan coils or baseboards, and associated pumps and controls. The single unit does dual duty, as a water heater for a domestic hot water heater and as a source of hot water for the hydronic heating system.

Pros and cons:

Pros include a reduction in floor space, lower capital cost, and improved energy efficiency.

Cons include limitations in available sizes, as all space heating systems piping has to be designed for potable water. No ferrous metals or lead-based solder can be used, and all components must be able to withstand prevailing city water pressures.

Green Tip #13 Ground Source Heat Pumps, GSP

These systems extract heat stored in the ground when in the heating mode. In the cooling season, they reject heat from the building into the ground. They consist of a loop of piping or a well in the ground, and indoor units consist of evaporators and condensers connected into the ground water loop. GSPs can reduce the energy required for space heating, cooling, and service water in commercial/institutional buildings by as much as 50 percent.

Pros and cons:

Pros include less mechanical room space, less outdoor equipment exposed to the elements, energy efficiency, reduced operations and maintenance costs, simple unitary controls, and installation costs can be lower than many conventional central system costs.

Cons include a large surface area for the ground source heat exchange, a higher first cost, and additional site coordination and supervision.

Green Tip #14 Water Loop Heat Pump Systems

Consists of multiple water source heat pumps within a building all tied into a neutral temperature loop that serves as a heat source and a heat sink. The loop temperature in turn is maintained at this neutral point by supplementing with heat from a boiler or cooling from a cooling tower.

Pros and cons:

Pros include that it recycles waste heat that is discharged to the loop, loop piping does not have to be insulated, properly sized and installed it saves energy, it is quiet, and provides zoning control. It is ideal for facilities with multiple operating schedules for various spaces.

Cons are that the decentralization of equipment into each individual zone makes maintenance more costly and difficult. The system is dependent upon very good loop water chemistry and filtration, it can be noisier than central station units and is an all-electric system, not depending upon potentially lower cost fuels during the heating season.

Green Tip #15 Thermal Energy Storage for Cooling

This is an active storage system that uses the building's cooling equipment to remove heat, usually during the night and off-peak periods to take advantage of lower-cost electricity during those periods and make ice slurry or chilled water. This enables a number of control and operational strategies. For example, smaller chillers can be purchased and the building peak loads are satisfied with ice made during the off-peak periods.

Pros and cons:

Pros may include a lower first cost for chiller equipment, as the chiller plant mechanical equipment can be smaller, although some of this cost reduction is offset by the cost of storage tanks. Operating efficiencies are realized in that the smaller equipment operates at a greater proportion of the time at or near peak load, which is more efficient than part-load efficiency.

Cons may include higher first cost and decreasing energy efficiency as the temperatures are lower than with a conventional chiller plant. It also requires more design engineering input, space for the storage tanks, and more complex responsibilities for the operations personnel.

Green Tip #16 Double Effect Absorption Chillers

Chilled water for facility cooling can be driven by electricity or thermal energy, such as steam. In absorption chillers, thermal energy such as steam is used to drive a process using water and a salt solution, such as lithium bromide, in a vacuum-sealed shell to produce chilled water. There are no ozone-depleting refrigerants used in this process. Absorbers come in single and double effect types, the double effect having a COP of about 1.2 versus the single effect COP of about .8.

Pros and cons

Pros include reduced electrical consumption, fuel flexibility for cooling, environmentally friendly water as a refrigerant, system expansion even if the electric supply system is capacity limited, and versatile use of various energy sources.

Cons include a higher cost of absorption chiller equipment, absorber physical size is greater than electric chiller, larger cooling towers and condenser water pumps and piping, and fewer plant operators are familiar with absorption technology.

Green Tip #17 Gas Engine Driven Chillers

Chilled water systems that use energy sources besides electricity can help offset high electricity costs. Generally, these are engines run on natural gas and coupled to a chiller compressor section. Essentially, it is an engine replacing the electric motor of an electrically driven chiller. Gasoline and diesel fuel can also be used, depending upon engine types selected.

Pros and cons:

Pros include reduced electrical consumption, fuel flexibility, and system expansion even if the electric supply system is limited in capacity expansion.

Cons include higher first costs, additional space for the engine, larger cooling towers needed, site emissions increased, noise attenuation is an issue, and significant engine maintenance costs need to be planned for.

Green Tip #18 Gas-fired Chiller/Heater

Gas-fired chillers are a special type of absorption chiller wherein the thermal energy source is a direct burner typically firing natural gas, although other fuels could be used. This as opposed to the conventional absorber operated with steam. The chiller/heater can do double duty, both to make chilled water and hot water simultaneously.

Pros and cons

Pros include a reduction in electric consumption, allows fuel flexibility, a boiler may be eliminated, and system expansion at sites with electric capacity issues.

Cons include higher first costs, a size of equipment much greater than electric chiller equipment, larger cooling towers and condenser piping and pumps, and fewer operators familiar with operations of this equipment.

Green Tip #19 Desiccant Cooling and Dehumidification

Rotary desiccant dehumidifiers use solid desiccants, such as silica gel, to attract water from the air. Humid air is dehumidified in one part of the desiccant bed while a different part of the bed is dried for reuse by a second air stream.

Pros and cons

Pros include the fact that desiccant equipment is very durable, often the most economical way to dehumidify below 40 degrees F, and eliminates condensate in the air stream that limits the opportunity for mold growth.

Cons are that desiccant materials must be replaced every 5 to 10 years and, in comfort applications, simultaneous heating and cooling may be required. Controls are also relatively complex and expensive.

Green Tip #20 Indirect Evaporative Cooling

This technique can be used to reduce the amount of energy consumed by mechanical cooling equipment. There are two types of indirect evaporative coolers, direct and indirect. Direct introduces water directly into the air stream and the water evaporates and reduces the dry bulb temperature of the air. Indirect sprays water onto a coil, and through evaporation from the fins of the coils reduces the dry bulb temperature also. However, no water is added to the air stream with this method.

Pros and cons:

Pros include a reduction in the size of mechanical cooling equipment, lower cooling costs during periods of low wet bulb temperatures, and it can be designed into equipment such as self-contained units.

Cons include an airside pressure drop, cooling tower fans may operate more hours, and condenser pumping and piping must be provided for in the design.

5) Energy and Water Sources

The designer may not have much option in the selections of energy sources for the building being designed. Typically energy is provided by the area utilities in the forms of gas and electric. However, the designer can consider options to supplement the conventional energy sources with renewables such as wind, solar photovoltaics, PV, and hydro as the site permits. PV is generally the most applicable renewable energy source for buildings. The others are too site specific.

Green Tip #21 Solar Energy System - Photovoltaics

Sunlight shines on solid state crystals of silicon and generates low voltage direct current electricity. Applications simply require full access to the sun and sufficient space, typically on the roof, to generate useful amounts of electricity. The low voltage DC can be inverted, and voltage boosted to be supplied directly into the building's electrical distribution system. Thus there is no need to locate a specific low voltage DC load for the power produced.

Pros and cons

Pros include a reduction in greenhouse gases, reduction in nonrenewable energy demand, enhanced green image marketing, lowered electric costs, and reduced infrastructure costs.

Cons include higher capital costs, may require energy storage in batteries, and may encounter regulatory barriers.

6) Lighting Systems

The GreenGuide section here is designed to familiarize the HVAC&R engineer with lighting systems and their potential impact on the equipment sizes and designs. However, it states that it is best to engage a lighting designer who will design according to the Illuminating Engineering Society—North America, IESNA, standards. However, the guide does make one suggestion for lighting.

Green Tip #22 Light Conveyor

A light conveyor is a large pipe or duct with reflective sides that transmits artificial or natural light along its length. There are occasions wherein designers have used light tracking to enhance the performance of light conveyors.

Pros and cons:

Pros are that the conveyor provides a simple method for bringing natural light down into the core of a building. It also isolates the light source from the illuminated area, can reduce glare by providing very dispersed light, and lowers lighting maintenance costs.

Cons can consist of higher first costs, the tube type may increase roof losses, and the effectiveness may not be worth the additional costs.

7) Plumbing and Fire Protection Systems

Although not usually within the purview of the HVAC&R designer's expertise, both must be able to work together in developing a fully integrated design. There are several tips that include aspects of both skill sets.

Green Tip #23 Water Conserving Plumbing Fixtures

Water conserving strategies can save owners both consumption and demand charges. Options to be considered for water conservation are:

- Infrared faucet sensors;
- Delayed action shut off valves;
- Low flow toilets;
- Faucets with flow restrictors;
- Metering faucets;
- Water efficient dishwashers;
- Waterless urinals;
- Closed cooling towers to eliminate drift and filters for cleaning tower water.

Pros and cons:

Pros include water conservation that reduces potable water demand, which in turn reduces the load on municipal water supply and wastewater systems, thereby lowering costs and energy for all. It may save on first costs, as waterless urinals are simpler and less costly to install.

Cons include the fact that some states' codes may not allow the use of the latest in water reduction technologies and the maintenance of the newer fixtures needs different skills for cleaning.

Green Tip #24 Graywater Systems

Graywater is defined as wastewater coming from operations such as showers, bathtubs, washing machines, and sinks. This is separate from blackwater, which is wastewater from toilets and sinks that contains organic or toxic materials. Where allowed by code, graywater can be filtered, treated, stored, and used later for nonpotable uses such as irrigation of landscaping and flushing of toilets. Distribution would be through a piping system clearly separated from all others.

Pros and cons:

Pros include reduction in potable water use, thereby reducing demand on the entire municipal water supply and waste stream infrastructure.

Cons include an added first cost for the separate piping systems, negative public perception about the use of graywater, incremental maintenance costs for the additional equipment, and the local health code authority may make this option unfeasible.

Green Tip #25 Point-of-Use Domestic Hot Water Heaters

These provide small quantities of hot water at the point of use without a tie into a central hot water source. Generally electrically heated, savings are obtained through the avoidance of large amounts of hot water storage.

Pros and cons:

Pros include a simple and direct way to provide a small amount of water per use. Also saves on long insulated piping runs, has a lower first cost, is convenient, saves floor space in the central plant, and provides redundancy in that any single failure is localized.

Cons are that it uses expensive electricity for energy, water impurities can cause scaling, it cannot handle large capacity loads, and some local codes may require temperature and pressure relief valves.

Green Tip #26 Direct Contact Water Heaters

This consists of a heat exchanger in which flue gases are in direct contact with the water to be heated. Cold water enters the top of the heat exchanger, natural gas is burned and flows up through the heat exchanger wherein the water is cascading down, acquiring the heat of the burned gas. Although there is direct contact between exhaust gases and the water, there is very little contamination of the water. These are suitable for dairy and food processing uses, as well as many other processes.

Pros and cons:

Pros include increased part load and instantaneous efficiency; reduced NO_X and CO emissions as the water absorbs these, increased safety, and increased system response time.

Cons include higher first cost, less effective higher-pressure applications, and additional water consumption, as significant amounts of water are evaporated up the stack.

Green Tip #27 Rainwater Harvesting

Although not a new concept, it has been around for thousands of years, and is a simple and effective technology to apply. Rainwater is channeled into cisterns for nonpotable uses such as needed irrigation, toilet flushing etc.

Pros and cons:

Pros include a reduction in potable water use, thereby reducing demand on the entire municipal water supply and treatment systems. Rainwater is soft and does not scale up equipment, so it can be used as cooling tower makeup. And it can reduce the need for stormwater containment and treatment.

Cons include first cost associated with the collection system; space requirements for the water storage, and the local health code official may require special backflow preventers and other precautions in the system.

8) CONTROLS

These can be thought of as the "nervous systems" of the building's mechanical and electrical infrastructure. Controls can be used for temperature and humidity control, ventilation control, energy management and analysis, etc.

Green Tip #28 Mixed Air Temperature Reset

This refers to the mix of outside and return air that exists on an operating system supply air handling unit prior to any "new" energy being applied to it. The concept is to reset the mixed air temperature, MAT, to a temperature that just satisfies the lowest cold air demand. Reset controls involve raising the setpoint of the MAT controls based upon input that indicates the demand of the zone needing the coldest air, limited by the minimum amount of outside air for IAQ purposes.

Pros and Cons:

The pros include savings on heating and cooling energy, a short payback period, and relatively low cost to implement, as it is mostly a controls strategy.

Cons include greater attention to controls calibration, the need for a good deal of zone temperature sensing, a sampling of zones may be difficult to do effectively, and it is relatively easy to do as a retrofit.

Green Tip #29 Cold Deck Temperature Reset,
CDT, with Humidity Override

CDT is similar to MAT, but it applies to air leaving a cooling coil. The concept here is to allow the discharge temperature from the cooling coil to go to higher temperatures when demand for cooling is low. However, this strategy can create high humidity indoor conditions on occasion. Thus humidity sensors are located in the spaces to override the rising cold deck temperatures and drive temperatures back down to extract more moisture based upon demands for temperature and humidity control.

Pros and cons:

The pros consist of energy savings, a good payback period generally, and capital cost is relatively low when considering the savings potentials.

Cons include the need for good controls system calibration, and the possibility of high humidity conditions if system is not carefully maintained.

Other Elements of Green, Good Design Covered but no Specific Green Tips Suggested by the GreenGuide are:

- Expressing and testing concepts.
- Completing design and documentation for construction.
- Post design—construction to demolition.
- Builder/contractor selection.
- Construction.
- Commissioning.
- Operation/maintenance/performance evaluation.

SUMMARY

The ASHRAE GreenGuide is the first effort by ASHRAE to aid the HVAC&R designers of green buildings. This represents the first step in what is intended to be a comprehensive effort to improve the way we conceptualize, plan, design, construct, operate and maintain our built environment. The intent of this article was to give the reader an overview of ASHRAE's efforts towards green design. Possibly after reading this article, the readers will feel a need to acquire their own copy of the GreenGuide.

References

ASHRAE GreenGuide, 2003—Editor David L. Grumman

ABOUT THE AUTHOR

Mr. Nick Stecky is in the process of starting up an energy and green building consulting firm. He has a Bachelor of Science in engineering and a Master's Degree in systems science. He holds certifications as a Certified Energy Manager, CEM, Leadership in Energy and Environmental Design, LEED, and a Six Sigma Green Belt. He has over thirty years of experience in the construction, operation, and management of various facilities including industrial, process, corporate headquarters, and R & D facilities.

In addition to his business experiences, Nick has been a very active leader in organizations such as the US Green Building Council, AEE, BOMA, IFMA, and ASHRAE. He has served on numerous chapter committees and was the New Jersey ASHRAE chapter president in 1993. He is the president of the NJ Chapter of the Association of Energy Engineers and on the board of directors of the New Jersey chapter of the US Green Building Council.