Green Buildings

"Green Buildings" could better be called 'sustainable buildings'. Green is a color. Sustainable buildings minimize the consumption of resources (energy, water, materials, etc.) and minimize their impact on the environment.

Building impacts of the built environment:

Aspects of Built Environment:	**Consumption:**	**Environmental Effects:**	**Ultimate Effects :**
Siting Design Construction Operation Maintenance Renovation Deconstruction	Energy Water Materials Natural Resources	Waste Air pollution Water pollution Indoor pollution Heat islands Stormwater runoff Noise	Harm to Human Health Environment Degradation Loss of Resources

Green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by:

- Efficiently using energy, water, and other resources
- Protecting occupant health and improving employee productivity
- Reducing waste, pollution and environmental degradation

Note that construction and demolition of a building usually only happen once. Renovation may happen several times. But consumption by buildings happens every year of the life of the building. Therefore, the biggest benefit is gained by optimizing the annual operations of a building than by optimizing the construction, renovation and demolition of a building. Unfortunately, most buildings are optimized for construction (first cost) at the expense of the annual operation of that building.

Best Sustainable Building Practices

Sustainable buildings ALWAYS perform their intended purpose well. If a building doesn't perform its purpose then it will be modified, use changed, vacated or otherwise revised to a purpose it can serve. A 'feature' that reduces a buildings performance of its intended purpose is not sustainable and can never be justified based on sustainability.

The design of a building has the greatest impact over the life of the building. Features like siting, glazing, lighting, equipment efficiency, insulation, etc. impact the building everyday of its life. Most of these will never perform better than they do on the first day of operations. Issues like siting, glazing and insulation are rarely improved throughout the life of the building. Occasionally, equipment efficiency is improved during efficiency upgrades, but these are rare.

Design features that last the life of the building and impact the large resource consumer items will have the greatest impact. For commercial buildings, ventilation air, lighting, and heating/cooling are the three largest energy consumers.

1) The biggest impact will result from minimizing ventilation air volume. In hot and humid climates like central Texas, the humidity in the outdoor air consumes huge amounts of energy to control. Ventilation loads on small commercial buildings are frequently 20% to 50% of the buildings cooling load.
2) The second largest impact will come from optimizing the lighting. High efficiency lighting reduces the electricity consumed by the lighting and reduces the heat load on the air conditioning. Combined they significantly reduce the electricity consumed. Combined lighting and lighting related cooling loads on small commercial buildings are frequently 10% to 40% of the buildings cooling load.
3) Heating and cooling (combined) are the third largest energy consumers. In central Texas, cooling loads dominate the heating loads because the heating season is short and mild compared to the rest of the country. Once the ventilation and lighting are optimized, the cooling loads are the next most important. Typically 30% to 50% of the remaining cooling load is due to glazing. High performance glazing is available and it works well. But high performance glazing is not the lowest first cost option. Shading the glazing works almost as well but typically at a lower cost. The shading needs to be integrated into the design of the building or it impacts the aesthetics of the building.

   Insulation of the roof structure is important, but typically the code required insulation reduces the cooling impact of the roof to not more than a few percent of the total cooling load. Wall insulation is typically about than half of the roof cooling load for single story buildings. Any upgrades to insulation should be made first to the roof where the highest load is found. Adding insulation to the walls is usually has much less impact on the total cooling load.

   Figure 1 below is a heating (left side) and cooling (right side) breakdown for the Strong Electric building. This building thermal enclosure has been fairly well optimized since the walls are 4% of the cooling load and the ceiling (roof) is 22%. This breakdown illustrates how doubling the insulation in the walls would reduce the cooling load by 2% (half of 4%) and doubling the insulation in the roof would reduce the cooling load by 11% (half of 22%). Clearly there is more benefit to increasing the roof insulation than to increase the wall insulation.

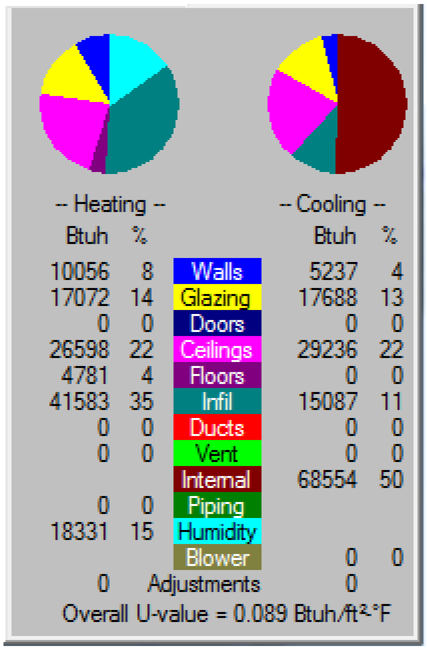

Figure 1 - Strong Electric Building HVAC Load Breakdown

4)Infiltration is one of the least understood issues on commercial buildings. Almost all analysts "assume" infiltration is zero or almost zero. Then when asked how much better the building would perform if it were well air sealed, most answer that air sealing doesn't affect the performance of the building – because their analysis shows there is almost no infiltration. Unfortunately, field testing almost always shows that buildings leak air badly. Most buildings leak outside air so badly that humidity control is poor and there are <u>many</u> reported comfort problems. Air sealing these buildings usually reduces energy consumption while improving indoor comfort. It is far, far easier to air seal a building during construction than it is to air seal it after the building is occupied. Most data on energy savings due to air sealing are poorly quantified. Typical air sealing jobs are combined with other improvements so it is difficult to separately identify the savings due to air sealing versus the other improvements. Historical data indicate that buildings that were air sealed during construction perform significantly better and have far fewer comfort complaints than buildings that were not intentionally air sealed. Just for clarity, I have never seen a building that was 'accidentally' air sealed (as opposed to intentionally air sealed).

The most energy efficient function of energy consuming equipment is turning it OFF. Lighting that is not in use should be turned off. Water heating that is not in use should be turned off. Etc. This would apply to HVAC equipment except that some building finishes and contents are harmed by excessive temperatures and/or humidity. So for HVAC equipment they should be set back whenever possible. All of these require either occupants who manually shut off equipment (not common) or automated controls. Simple automated controls are usually reasonable cost. More sophisticated controls can be very expensive. Sophisticated controls have the capacity to monitor performance and provide an alarm when the performance slips below acceptable levels. Simple controls just don't have the capacity for performance monitoring. It is up the Owner and designer to select the most appropriate controls for each project.

Commissioning – I have to admit I am biased here but I think commissioning is critically important to sustainability. LEED requires commissioning as a prerequisite and I think they were wise. Historical data has shown that most new buildings perform below expectations and degrade from there. If a building is rigorously commissioned, it works much better than average when new and degrades much more slowly over time. To be most effective commissioning needs to start at the very beginning of design to document the Owner's Project Requirements (OPR). The OPR should guide the designers in meeting the Owner's needs throughout the design process. Commissioning that starts near the end of construction frequently identifies issues that meet the contract documents but not the Owner's needs. Even then, there is still a benefit to the Owner in better performance of the new building and better documentation for the operations and maintenance over the life of the building.

In my opinion, commissioning doesn't have to be done by a third party to be effective. It generally works better for the Owner if the Owner provides the commissioning agent (internal or external). Second best is for the General Contractor to provide the commissioning agent (also internal or external). In my experience, the least effective is for the Design Team to provide the commissioning agent. It can work but it frequently doesn't benefit the owner as much as the other options.

"One Time" Sustainability

Some "green" systems seem to put a lot of weight on 'one time' actions. Things like recycling construction waste. Those help sustainability but they don't have the payback of something that happens every year for the life of the building. LEED gives the same credit points for many 'one time' items as it does for annual performance. I don't think that is appropriately sustainable.

Sustainable Items

Light shelves – Can help with lighting loads but needs to be combined with automatic lighting controls to be very effective. The light levels must be automatically reduced or there is rarely any savings. I think they are highly over rated in the actual savings they produce.

Window shading – Typically are very cost effective and pay back every year of the life of the building.

High Performance Glazing – Great way to reduce the cooling loads on buildings with large glazed areas. However, these can be expensive so there has to be a balance between cost and benefit.

Instant water heaters – A good way to minimize standby losses of storage water heaters. However, unless the water heater is high and intermittent there isn't a lot of savings to be gained. Typically there is little cost increase over storage water heaters so there is an efficiency gain at a minimal cost.

Low flow faucets and plumbing fixtures – Typically are good at saving water. Just need to watch the cost impact over 'standard fixtures' to make sure the savings are justified.

Economizer on air conditioners – They look good on paper but are a disaster in the real world. There are only a few controls that make them work properly and those are very delicate and prone to failure. Once an economizer fails it will cause comfort problems in the building. I am working on a code change to fix the code requirement in central Texas. But even if I push this thru on an emergency basis it will be years away.

VRF HVAC systems – Variable Refrigerant Flow (VRF) systems have the potential to be very sustainable. If each room is comfortable to the person working there, the building has optimized its performance. Cost of installation is a concern as is maintenance. (If there are no trained service people it is only a matter of time before the performance degrades or they fail completely.) Long term maintenance data is just starting to be available in the US but these systems have been performing well overseas.

Recycled Content – If there is little cost or performance penalty, this should be sustainable. I wouldn't pay extra or accept reduced performance based on recycled content.

Sustainable Wood – Just like recycled content, if there is little cost or performance penalty, I see no problem. However, my experience is the sustainable wood industry wants to be paid handsomely for protecting their manufacturing process. I don't find that appropriate.

Under Floor Air Distribution – They are only appropriate in computer rooms. This is something the sustainable movement got sold a bill of goods on. Even the federal General Services Agency has all but banned them on federal facilities.

Structural Insulated Panels – Somewhat more sustainable than standard construction. The lower material use and better than normal air sealing are sustainable features. The real benefit is the savings in construction labor if the project is well planned for SIPs.

ICF, AAC, and similar wall systems – Minor improvement in sustainability. Air sealing and thermal bridging are usually improved over standard construction. Marketing would have you believe these are the most sustainable thing you can do for your project. However, wall thermal load is rarely high enough to justify higher than code wall insulation. So these systems don't significantly improve a project but frequently have a major cost impact.

Thermal Bridging – Thermal "short circuits" around or through insulation can significantly reduce the effectiveness of insulation systems. For example, the energy code recognizes R-25 continuous insulation (no thermal bridging) is equivalent to R-38 with thermal bridging of wood structure through the insulation. It is even worse for steel structures.

Batt Insulation - Regardless of the materials that are used to make the batt, most batt insulation systems perform poorly due to installation. Batts can be made to perform well but the cost would be as high or higher than for blown-in or other continuous insulation systems.