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# What It Means To Be Green

## Energy Efficient Practices in Building Design, Construction and Operation

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The topic of energy efficiency has been studied, discussed and written about in newspapers and magazines for decades and much of the technology that exists today was developed years ago as well. But, aside from the energy crisis of the 1970's, we have never really been pressed to consider energy efficiency as necessary criteria for improving our physical and financial well being as much as we are today.

The relationships between energy efficiency (through the reduction of a reliance on fossil fuels), climate change, global warming, pollution control, water management, resource management, global economies, and human health have never been clearer. Energy production in this country releases sulfur dioxide, nitrogen oxide and carbon dioxide and is a significant contributor to air pollution. These pollutants are primary contributors to smog, acid rain and global warming. The U.S. Department of Energy estimates that 37% of the energy and 68% of the electricity produced in the United States is used by buildings. The existing U.S building stock comprises roughly 300 billion square feet. While these may be rather discouraging statistics, the up side is that each year we will demolish about 1.75 billion square feet; we will renovate about 5 billion square feet; and we will build new about 5 billion square feet. According to this schedule of construction, by the year 2035, about 75% of the built environment will be newly constructed or renovated. An unprecedented opportunity lies ahead for us to dramatically reduce our energy needs (and our carbon footprint) by better and more efficient building designs and construction practices that will enable and encourage the healthy and efficient operation of those buildings for many years to come.

For almost every construction project, the first issue to address is the location and orientation of the building on the site. Unless the site is particularly difficult to access or traverse, there is usually no additional cost at all to place the building in such a way that it will benefit from passive solar gain through a broad southern facing façade. Naturally convective cooling can be accomplished through proper shading options, either through building design elements or through naturally occurring, or planted vegetation, coupled with thoughtful placement of operable windows. These strategies, if properly executed, can allow for a much smaller mechanical system to adequately heat and cool the building resulting in dramatic energy savings over the life of the building, not to mention the lower initial cost of the smaller equipment. Another point worth making about selecting a building site is that when you consider the energy required to harvest, manufacture, and transport building materials to a job site, the option to renovate or rehabilitate an existing building where much infrastructure is already in place is often a much more energy efficient process, when viewed in its entirety, than constructing new.

Once a site and building location are determined, and the actual building design process is about to begin, two of the most important design considerations that should be addressed are the size of the building (area and volume), and the design of the building envelope (walls, roofs, windows and doors). The actual required size of a building and its individual spaces is not

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often adequately investigated. Without the knowledge of what each space is to be used for and the sizes of equipment and furnishings, it is not much more than guesswork. This can lead to rooms and whole buildings either being undersized or oversized. Undersized buildings create problems of utility when they are not able to function adequately or provide the occupants with sufficient spaces to be productive or comfortable. Solutions can be costly and inefficient and may involve the construction of additional space, or spaces, to meet requirements that were not thoroughly discussed and evaluated from the start and that may not integrate as well with the existing building because they were an afterthought. On the other hand, over sizing buildings because spatial requirements have not been addressed or because the mentality that "bigger is better" prevailed in the early design stages results in more expensive construction projects and buildings that require substantially more energy to heat, cool, operate and maintain. Inefficiencies in such buildings can be enormous. The best approach is to plan thoroughly and size buildings correctly.

The building envelope represents a transition space where the interaction between outdoor forces and indoor conditions can be controlled. Most building related problems and inefficiencies can be tied to poor design, inappropriate material selection, or improper construction of the building envelope. Efficient and comfortable buildings have greater control of the movement and management of heat energy, light, air and moisture through the building envelope. Unfortunately, most of our design and building practices have not changed much, especially with regard to residential construction, over the past several decades. The simplest and least expensive improvement that can be made is to increase the insulation in walls and ceilings. Merely meeting the building code requirement is not enough. The codes specify the minimum levels allowable. In other words, the worst possible building that can legally be constructed is one that meets the building code. This is not a benchmark that designers and builders should be satisfied with. It should certainly not be satisfactory to building owners. Minimizing heat loss through added insulation is by far the greatest value per dollar spent on increasing energy efficiency.

Another way to improve a building's energy efficiency is to design a tighter building envelope. The average house, for instance, has the equivalent of a four foot diameter hole in it through which air, heat and moisture move freely. This hole is an aggregate of all the tiny spaces around doors, windows, attic scuttles, appliance vents, and other poorly constructed and poorly sealed areas where there is no separation between the indoors and the outdoors. Without proper and adequate separation between these conditioned (indoor) and unconditioned (outdoor) spaces, more energy than necessary is being used by buildings to heat and cool these spaces. A tighter envelope is a key factor in improving building operating efficiencies, not to mention occupant comfort and indoor environmental quality. A fairly inexpensive means of determining how tight the building envelope is and locating sources of air leakage for a new or existing building is to conduct what is called a "blower door test" in which a building is pressurized using a

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calibrated fan and pressure differentials are measured to determine air tightness. However, there is more to creating a good building envelope than just making it tight. Air barriers, vapor barriers, insulation products, rain screens, and cladding all have distinct material properties and functions and their correct placement in the wall or ceiling assembly is critical in achieving the desired results. The correct materials installed in an incorrect manner or sequence can yield disastrous results such as trapped moisture inside a cavity where it cannot escape resulting in mold damage, insulation failure and wood rot which can then lead to problems of energy inefficiencies, poor indoor air quality and health risks for building occupants. “Sick Building Syndrome” is a term often used to describe such situations which may affect buildings of any scale from skyscrapers to single family dwellings. Good building envelope design must address the issue of water management as a necessary means of preserving the integrity of the building and helping to maintain an efficient system of climate control within the occupied spaces.

The mechanical and electrical systems can be evaluated and also designed efficiently. To begin with, the heating, cooling and electrical loads should be accurately determined based on reduced energy needs achieved by proper siting and building orientation and improved building envelope design. These systems can often be substantially smaller than what would be required in conventionally built buildings. Again, the practice of sizing it right will yield higher efficiencies and cost savings. Rule of thumb estimates to size equipment are no longer applicable. Energy modeling is a much more accurate and powerful tool that is becoming a valuable part of energy efficient building design. Once the proper equipment sizes are determined, high efficiency units can be selected such as gas boilers that operate at 93% AFUE (Annual Fuel Utilization Efficiency) and furnaces that are rated at 96% efficient. As a point of comparison, the Department of Energy requires a minimum AFUE rating on any new furnace to be at least 78%. This means that 78% of the fuel used will create heat and the other 22% will be lost through the chimney. This is another example of why minimum allowable standards are not where we should set our sights if we are trying to achieve higher energy efficiencies than what we currently have. Instantaneous hot water heaters are another means of providing heat and hot water without the need to store large quantities in tanks which may need to be reheated if not used within a certain timeframe. The requirements and choices of equipment are extensive and every project has different requirements so a more detailed investigation is best done on a project by project basis. In general, looking for things like “Energy Star” labels on appliances, high AFUE ratings on fuel burning appliances, and “WaterSense” labels on plumbing fixtures, will help guide the selection of more efficient products.

Once a building’s energy needs have been reduced through an integrated, energy efficient design, then the availability of alternative sources should be explored. Renewable energy sources such as sun, wind, and geothermal options may exist that building owners can tap into directly or that they may purchase in the form of Green-e certified power. Alternative energy sources are an integral part of any sustainable design but they should be implemented only after other building inefficiencies have been addressed.

Existing buildings in which no major work is planned can still be operated in a way that reduces energy demand by identifying many of the phantom electrical loads. These phantom loads are loads that we are not actively aware of and consist mainly of the electrical power drawn by appliances and equipment even when they are not in use but remain plugged into an active power source. The list can be long, but some examples are microwaves, televisions, invisible pet fences, computers and water heaters. Estimates report that the average US home continuously leaks at least 50 Watts of electricity as a result of these phantom loads. This is roughly 450 kilowatt hours per year of invisible that can be substantially reduced by unplugging some of these appliances or having them controlled by a wall switch when they are not in use.

The technologies, resources and materials are all readily available for us to be able to design, construct and afford much more efficient buildings than we have grown accustomed to. While some countries have mandated such efficiencies and sustainable practices into their building codes, we still have a choice. Let's choose wisely.

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