Energy Conservation Site and Building Design

According to the EPA, buildings in the United States account for 36 percent of total energy use, 65 percent of electricity consumption, and 30 percent of greenhouse gas emissions. The vast majority of energy used to power buildings comes from nonrenewable resources, such as coal, oil, natural gas, and nuclear energy. Fostering a transition to sustainable energy use involves addressing not only the energy’s source but also its efficient use. One of the most cost-effective ways to manage energy use in buildings is to employ principles of conservation design. Together with the growth of alternative sources of energy, the practice of designing new buildings and retrofitting existing buildings to use less energy will prepare communities for the challenges ahead. In this issue of our renewable energy series, we briefly introduce the topic of energy conservation site and building design. We encourage you to explore these topics further and gladly offer our assistance.

Haverford Upper School; LEED Silver Certified applicant and 2009 Montgomery County Land Use Award Winner. Courtesy of The Haverford School.
Site Design
Proper siting of buildings can dramatically reduce energy consumption.

Lot and Building Orientation
When considering building orientation, it is important to assess how the building will receive sunlight. Properly orienting a building will ensure the building will gain heat in the winter and reduce cooling costs in the summer. There are some simple things a site designer can do:

- Situate lots and roads to minimize building exposure to the east and west.
- Orient a building so that the longest building side faces north/south.
- Face the maximum number of windows on the south side of a building with the minimum number facing the north.
- Correctly design roof awnings to maximize sunlight exposure in the winter and shading in the summer.
- Build structures close together to create a wake in the wind (weakening wind velocity) to help save heating costs.
- Design streets and staggered lots to create wind disturbances that will save heating costs.

Landscaping and Other Site Design Considerations
The landscaping installed or the natural features preserved on a site can be a key factor in energy conservation. The following practices can help drastically reduce the energy needs of a building:

- Preserving or installing native shade trees can have a tremendous impact on heating and cooling costs. Properly placed shade trees can reduce cooling costs by up to 25 percent. Deciduous trees work best because they shade buildings in the summer but allow the sun to heat buildings in winter.
- Planting trees or shrubs, usually evergreens, as a windbreak can reduce annual fuel bills by 10–20 percent.
- Considering opportunities for alternative energy production, such as solar and wind, when planning the landscape is important. You want to create windbreaks that will shelter the building but not hamper wind production and plant trees that will not shade solar panels.

Building Dynamics
Once a building is sited correctly, the focus shifts to the proper way of constructing it and how it will function. The following is a simple way of thinking about this process:

Know the Situation. If you are retrofitting or renovating, an energy audit is critical to assess how your building is performing and how it can be improved. Before any construction begins, it is vital to gather ALL the people involved in the process—owner(s), tenants, contractors, and designers—in the early stages so everyone understands the project goals and process. Everyone working toward the same goals will allow the project to proceed efficiently.

Examine the Shell. In new construction and renovations, creating a well-insulated and airtight seal around the building is key. A building can lose much of its heating and cooling energy through leaking windows, doors, and walls. By ensuring quality construction, using proper insulation, and installing correct windows, very little of the energy is wasted. In addition, installing windows that can open allows for better air exchange and reduces the buildup of indoor air pollutants.

Incorporate Technology. It is beneficial to consider technology that will allow you to reduce energy usage and generate your own energy. There are a variety of technologies available to reduce energy consumption. On the next page, we briefly focus on a few of the major technologies, and we recommend you further explore what might work well for your project.
HVAC. HVAC systems use ventilation air ducts throughout a building to supply heat and air-conditioning. There are two key points to consider when purchasing an HVAC system. First, determining the correct size of an HVAC unit is critical. If a unit is too small, it will be inefficient. You can determine the exact size needed by considering building size, climate conditions, and load profile (population and activities). Secondly, make sure the ductwork is sealed and insulated correctly to avoid energy loss while transporting air through the building.

Thermostats. The thermostat system should ideally be adjustable and adaptable. The system should employ maximum temperature adjustment, timing, and zoning. Zoning saves resources by not heating or cooling unoccupied areas. Effective timing functions can save resources each evening when the building is unoccupied. Systems offering specific temperature adjustment allow occupants to keep the temperatures at the lowest comfortable levels.

Changing the Fixtures. It is becoming increasingly popular to use compact fluorescent bulbs (CFLs) in new or existing buildings. CFL bulbs use about 75 percent less energy and can last up to 10 times longer than standard lightbulbs. Savings can be up to $30 per bulb for a standard CFL. They also produce 75 percent less heat so they can be safer to operate and save HVAC costs. Motion sensor switches can also be installed so lights are not being used in unoccupied areas.

Alternative Energy Sources. Incorporate alternative energy sources, such as geothermal or solar, into your project from the beginning design phase when possible. If finances will not allow an alternative energy source to be installed right away, the building can be designed to allow easy incorporation of alternative energy sources in the future. Foresight and planning in the beginning will make implementation easier later on.

Does It All Work? After you have done all the auditing, planning, designing, and construction for a building, it is critical to assess how it is working. This can be determined through the formal commissioning process done for LEED buildings or by monitoring energy usage through utility bills. Reviewing the efficiency and effectiveness of the energy improvements will allow you to make changes to the control mechanisms, focus on occupant behavior, or have the contractors make adjustments.

Changing the Way You Think. It is important that the people occupying the building understand the efforts made to conserve energy. If occupants do not actively participate in energy conservation, optimal performance cannot be achieved. Occupants should be educated to turn off lights and computers, unplug equipment, reduce energy expenditures, and eliminate habits that waste energy, while learning new ways to conserve energy.

What Municipalities Can Do
Building construction in Pennsylvania is governed by the Uniform Construction Code (UCC). Municipal construction regulations must be equal to or more stringent than the UCC and must demonstrate qualifying reasons for a local ordinance to differ from the UCC. It is unclear if requirements for energy conservation would be considered legal exceptions to the applicability of the UCC. Municipalities may be limited in what they can require beyond the UCC and economic building market concerns. Municipalities must be creative in encouraging energy conservation site and building design. It is important that municipalities adopt the latest building codes and have the necessary staff or consultants trained to implement the process.
Regulatory Measures

Though bound by the municipal building code, municipalities have the ability to promote energy conservation through a number of regulatory measures:

Zoning and SALDO. It is important to amend ordinance language that may prevent energy conservation design and create new ordinances that will require or promote energy conservation. If a municipality does not have an ordinance that regulates aspects of energy conservation design, a developer attempting to incorporate these techniques may get summarily denied or forced to go through a costly and time-consuming process.

Permitting. The permitting process should be well-defined, easy to understand, and should allow energy conservation design practices to receive adequate review in a reasonable time frame.

Incentivizing. Since municipalities cannot force standards that are stricter than the building code, they must rely on incentivizing to promote energy conservation design. Incentives for energy conservation design can be offered in many ways and include:

Density Bonus. Municipalities can offer bonuses of square footage, impervious surface, and/or floor-to-area ratio (FAR) for achieving certain standards.

Permitting Fee Reduction. Permitting fees can be reduced for achieving certain standards.

Expedited Permitting. Projects attempting to reach a certain standard are given priority in the review process. (In Pennsylvania there are questions concerning the legality of expedited permitting).

Tax Exemption. Projects that achieve a certain standard receive a tax exemption.

These incentives, and others, are being used throughout the country. The U.S. Green Building Council provides case studies at www.usgbc.org/LEED.

When considering an incentive program, it is important to think about how you will ensure the project meets your energy conservation standards. Many municipalities have created escrow programs or designated a punitive measure to ensure projects meet the necessary standards.

Education

Municipalities should promote energy conservation to the public. This can be done through municipal programs, participation in county, state, or federal educational programs, and collaboration with non-profit organizations. Opportunities should be pursued whenever possible to educate the public and developers about energy conservation in the municipality.