Microturbines

Microturbines are a relatively new technology with significant applications in green building design. By using natural gas as a fuel (also diesel or propane), microturbines generate electricity and hot water, rather than just one or the other. In this way, about 80% of the energy value in the fuel is converted to useful work. Microturbines can range from 25 kilowatt (kW) output to 500 kW, have low emissions of nitrogen oxide, are about 20% to 30% efficient in producing electric power and can produce hot water at 120°F to 175°F, a range quite suitable for a number of uses, including swimming pools and service water.

Microturbines offer a number of potential advantages over other technologies for small-scale power generation. These include a small number of moving parts, compact size, light weight, greater efficiency, lower emissions, lower electricity costs and ability to use waste fuels such

Capstone Turbine Corporation

Microturbines at 60 kW power output are about the size of a large refrigerator. They are typically installed in group of five or more, to match demand for hot water and electricity in a building.

as biodiesel. They can be located on sites with limited space for power production, and waste-heat recovery can be used to achieve total system efficiencies of more than 80%.[102]

Microturbines typically come in 60 kW modules, about the size of a large refrigerator. By coming in small modules, it is easy to assemble a group of microturbines into an onsite power system and to match the electrical and thermal output to the building's demands. For example, the turbine's heat output can be used for water heating in a hospital or hotel, a facility type that requires lots of hot water on a 24/7 basis. If there is a swimming pool that gets a lot of use, any excess hot water can be used to heat the pool (which loses heat mainly through evaporation).

Other facilities that can benefit from microturbines include data centers, schools and colleges, food-processing or manufacturing plants, supermarkets and even sewage treatment plants.

The benefits of microturbines today are the same as those of cogeneration systems; they are cost-effective whenever there is a connected thermal load that uses heat most of the time. The electricity generated by the microturbines displaces the purchase of energy from a utility, at full retail rates; and the heat displaces natural gas that would have to be purchased otherwise just for a single purpose. In many cases, there is less air pollution and lower carbon dioxide emissions than from conventional generation.

Measurement and Verification Systems

How does a green building maintain its energy savings over the long haul? This is one of the critical questions in green building design, since there is plenty of evidence that building energy performance degrades over time. Systems wear out, and new building maintenance and operations people may fail to make necessary repairs, carry out preventive maintenance and generally fail to manage the building's energy-using systems as originally designed.

Green buildings are encouraged by LEED to take two simple measures to counteract this tendency toward energy-efficiency degradation. First, projects can gain a LEED point by developing a monitoring and verification plan, following established international protocols and then installing sensors that measure the actual performance of key energy-using systems such as chillers and boilers. The sensors are connected to the building

automation system and provide information that allows engineers and building operators to pinpoint problem areas and fix them. Creating the plan and installing extra sensors are not that costly, typically $30,000 to $50,000, which is barely more than pocket change for a large office or residential building.

Additionally, building owners are encouraged to document systems training so that future operators can learn proper use and maintenance of the systems. The LEED for Existing Buildings standard encourages buildings to be re-commissioned every five years, so that energy performance can be maintained over the building's lifetime. For most institutional building owners, this is a smart thing to do since they're paying the bills.

The leading force in the US behind measurement and verification is the Federal Energy Management Program, which developed the International Performance Measurement and Verification Protocol, to identify and codify best practices techniques for verifying the energy performance of new buildings.

Think for a moment of the simple task of comparing this year's utility bill to last year's to determine if you're using more or less energy. What could affect the outcome? Weather is certainly a major variable: was this year colder or hotter than last year? Did the use of the building change, so that there were more or fewer occupants? Did the hours/days the building was occupied change significantly (for example, did someone put on a second shift)? Did someone put in a data center that uses a lot of power for servers, generating also a lot more waste heat that increased cooling demand? What about changes in lighting levels, occupancy sensors, ventilation levels and set-point temperatures for heating and cooling? Was preventive and remedial maintenance carried out? Were portions of the building vacant for any substantial period? How would *you* determine all this without a good plan and enough measuring and monitoring points to get accurate information? You can see the wisdom of planning ahead by following the LEED protocol for creating a plan, installing enough sensors and then collecting the data.

Native American and Native Canadian Ways of Living

If there is an underlying theme in green buildings that has a long history, it's that our contemporary civilization needs to learn the art of "living in place" for an extended period of time. For most North Americans, the Native American and Canadian way of life, with respect for the land, viewing the Earth as a Mother who gives all life, offers a way to live today to benefit seven generations into the far future. Most Americans would also agree that the attraction of this way of life is nostalgic at best, given our present urban society. Nevertheless, Aboriginal traditions exert a powerful pull on our psyche and have found expression in a number of elements of green buildings and green development. The idea of preserving open space and natural habitat is one way of honoring nature, while preserving natural elements in buildings is undoubtedly good for the psyche.

Another way Native American and Native Canadian approaches are being incorporated into buildings lies in climate-responsive design. Many architects are inspired by the Mesa Verde cliff dwellings in southwestern Colorado, where the overhanging cliffs protect against the harsh summer sun, high in the sky, while still allowing the lower-angle, warming winter sun to enter the homes. The adobe and stone buildings also stay cool in summer and warm in winter through their "thermal inertia," the ability to

Taos Pueblo, New Mexico, providing "homeland security" since 1492.

soak up heat during the day, for example, and release it slowly during the evening. Other Southwestern developments have been influential in local architectural styles. In 2006 I visited the Taos Pueblo in northern New Mexico that has several stories of apartments constructed of adobe bricks in two structures on both sides of a small river. There's a large plaza and a recorded population of nearly 4,500 people, but otherwise nothing remarkable to suggest that this site has been continuously occupied for almost 600 years. However, the adobe building style is endemic to New Mexico and has influenced building styles throughout the arid Southwest.

In the maritime Pacific Northwest, the Native American building style is the longhouse, a wooden structure large enough for an extended family, with plenty of access to nearby woods, rivers and the ocean — sources of abundant food, shelter and clothing. Preservation of rivers, riverbanks, public access to the beaches, marshland habitats, native plants and old-growth forests is very much part of the Northwest psyche, as are increasingly strong efforts to protect the varieties of wild salmon, the totem animal of that region.

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Nature, Design with

Originally popularized by landscape architect Ian McHarg in the 1960s and still promoted by many landscape architects, "design with nature" starts with the land, geology, native plants and animal species, climate and water patterns, and then uses these dynamics to inform site planning. McHarg's premise was that ecology, the science of interrelationships between animals and plants, should be the basis for land planning and site design, at a regional scale as well as for individual sites. This approach helps to avoid stupid mistakes, such as building in areas prone to mudslides, earthquakes and floods.

"Nature always bats last" is an apt slogan for land development. We can look at the aftermath of Hurricane Katrina as a great example of how powerful natural forces can be, and while we sympathize with those displaced, killed or injured and economically hurt by Katrina, we can also see the futility of trying to rebuild a large city located in a place that will eventually become part of the Gulf of Mexico.

The green building movement addresses design with nature in a number of ways. First, we don't want development on sensitive ecological sites

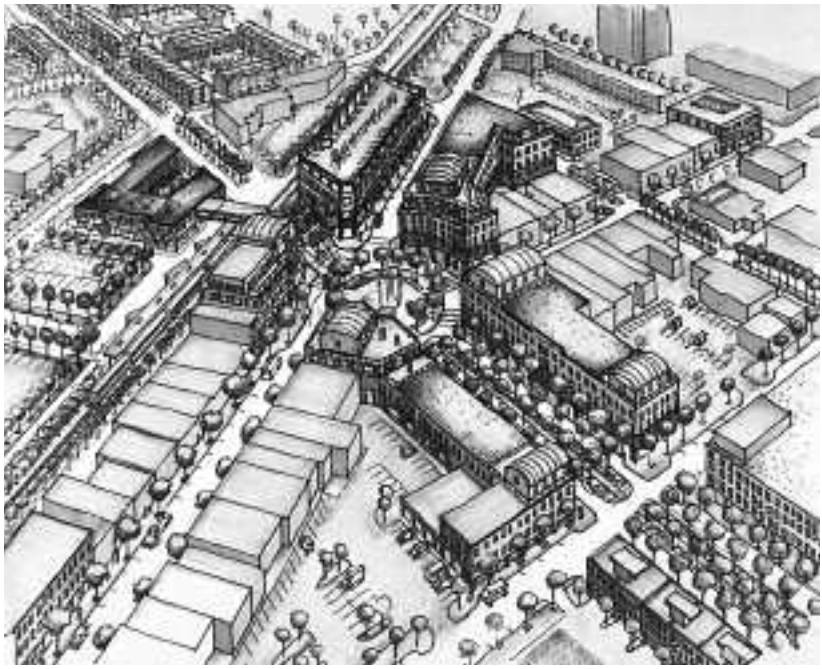
within 100 feet (or greater distance) of wetlands or river, on prime farmland or on land that is habitat for rare or endangered species. Second, we want land development to be more compact than the traditional, post-World War II suburban sprawl model. This means leaving more land in open space, even in greenfields developments. Ironically, developers are discovering that leaving open land in and around a development makes the remaining building sites even more valuable because future residents will have access to natural areas, trails and wetlands right outside their back doors, something that most people treasure. In Florida, where large tracts of swampland are unbuildable, developers have taken to touting the natural areas as "conservation easements" to attract homeowners and tenants interested in environmental preservation and willing to tolerate the occasional alligator encounter while jogging or walking.

When I sought a home in Tucson in 2006, I found a relatively new housing development where the natural desert had been left intact around the building lots, so that the local fauna (coyotes, bobcats, jackrabbits, chipmunks, the occasional javelina or peccary, quail, snakes, roadrunners and multitudes of birds) could coexist with the homes in perpetuity. For me, this is a very attractive way to live, even if I have to take extra precautions to protect my small dog.

Another quite different example of design with nature is the way landscape architects are introducing more natural water features into building projects. A leading exponent of finding out how water wants to flow in a park is a German designer, Herbert Dreiseitl, who speaks about how closely urban design and settlement patterns have been linked with water and its use, both functionally and artistically. As we are water creatures, one expression of biophilia in design is allowing water to be expressed in many ways, from flowing channels to water walls, to fountains and plazas, ponds and water-based microclimate cooling systems, stormwater collection and treatment with constructed wetlands.[103]

New Urbanism

New Urbanism is a movement launched in the early 1980s by planners and architects such as Andrés Duany and Elizabeth Plater-Zyberk in Miami. One of the earliest projects to demonstrate the principles of the New Urbanism was the village of Seaside in the Florida panhandle, near Ft. Walton



Conceptual design of a New Urbanist town center for Normal, IL, from Farr Associates, Chicago.

Beach. These developments are compact neighborhoods, often with densities of eight to ten units per acre, with front porches so neighbors can actually see and talk to each other. They are also very walkable, with key amenities such as a grocery store and a transit or bus stop within a few hundred yards. A typical New Urbanist plan, in this case for Normal, Illinois, shows how to design these elements.

The New Urbanism is often linked to a related movement toward Transit-Oriented Development: building homes, offices and commercial development at or near light-rail stations or other major transportation hubs, to make it easier for people to avoid using the single-occupant vehicle to get to/from work, home, recreation, etc. A growing body of research indicates that people are healthier in places where they can walk or bike to basic services instead of using a car for every errand. Think of your own experiences, living, working or visiting great cities like New York, San Francisco, Boston or Chicago where you can (and do) walk or take transit to most places.

In new communities, New Urbanism today is particularly expressed in several key concepts:

- Connecting communities by locating shops and basic everyday needs within walking distance.
- Neighborhood location, so that people can walk to transit and also walk separately from roadways.
- Traffic calming — using various methods to slow down cars — to make streets safer and street life more viable.
- Land-use patterns that respect natural drainage contours, wildlife corridors, etc. by increasing density in built-up areas to allow for more open space in a development.