Conservation Campus

featuring working examples of:
geothermal heating & cooling,
wind power, solar power,
adaptive reuse, and green building
and green roof technology.
Donohoe Road, Greensburg, PA

There's a growing "conservation campus" in Greensburg, Westmoreland County, where you can see a variety of practical, alternative energy technologies.

The campus consists of three distinct sustainable energy showcases:

- the Westmoreland Conservation District headquarters – a 125-year-old, 7,600-square-foot barn that has been adapted with a variety of energy-conservation measures for reuse as offices and a conservation-education center,
- the Penn State Cooperative Extension sustainable energy project – a 10-kilowatt wind turbine and a 2-kilowatt solar array, located behind the campus's Donohoe Center building, that serve as a demonstration open to the public, and
- GreenForge – a vacant, 25-year-old, 23,000-square-foot commercial building that is now being rehabbed with conservation materials and technologies and may be the first "green" rehabilitation of a commercial building in the county.

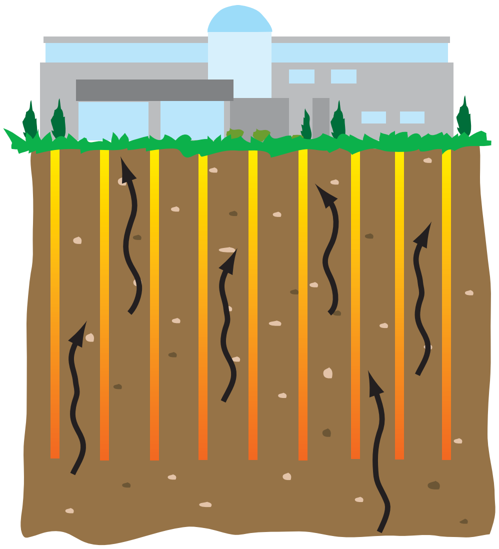
Alternative energy technologies have been incorporated in these buildings not only to reduce the use of non-renewable electric and natural gas energy in the buildings' operation, but also to serve as demonstrations, showing area citizens how these technologies can be employed in their homes or businesses to save energy and money, create a healthier environment, and make their living or work environment a more pleasing place to be.

The following is an overview of the major alternative energy technologies on the campus.

Westmoreland Conservation District's adaptive reuse project

Penn State Cooperative Extension's wind turbine and solar array

GreenForge: The county's first commercial green rehabilitation project



Geothermal Heating & Cooling

Geothermal is a heat-transfer system. Under the surface of the earth, the soil, rocks, and water naturally maintain a relatively constant temperature of about 55 degrees all year long. Geothermal systems use wells to tap into this warmth and draw it up to the surface to heat buildings in winter. In the summer, the system cools the buildings by using the wells as a place to deposit the heat that builds up inside the structure.

Drilling geothermal wells at GreenForge

Unlike typical combustion-based systems, geothermal does not create by-products such as carbon monoxide. It is typically a more comfortable heat because the warmth is delivered continuously; there are no "blasts" of hot air like those that occur with combustion-based systems that use ductwork. Overall maintenance costs are low, and most geothermal systems also provide hot water at low operating costs.

Both the Westmoreland Conservation District headquarters and the GreenForge building use geothermal technology.

The Westmoreland Conservation District headquarters uses 19 wells, each 150 feet deep, to draw on the earth's natural thermal qualities. The GreenForge building, which is a little more than three times larger than the District's barn, employs 30 wells, each 200 feet deep.

As is typical, these geothermal systems were more expensive to install than a traditional HVAC system, but have the advantage of steadily paying for themselves through lower heating and cooling bills.

Combined costs to run the geothermal system and all the electric in the Westmoreland Conservation District's headquarters average $360 a month. If the building had used natural gas instead of geothermal, the District estimates that those costs would be closer to $800 a month. When it is operational, GreenForge's heating and cooling costs will be monitored for effectiveness. Anticipated energy savings of the geothermal system in this building, versus the present natural gas system, should be in the neighborhood of 618,000 cubic feet of gas, representing a cost savings of some $6,180 a year.

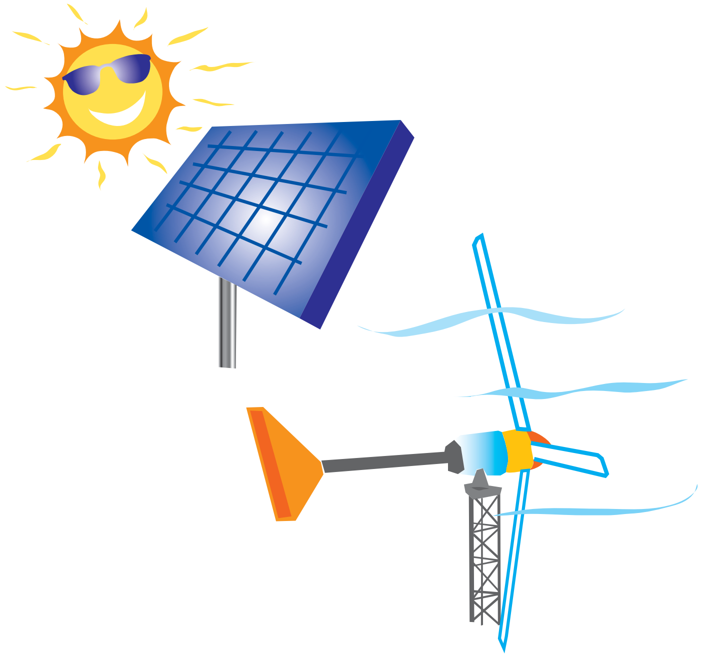
Concrete for flooring is poured over tubes that carry warm water from the geothermal system in the winter.

Radiant floor heat – In winter, warm water from the geothermal system flows through flexible tubing under the concrete floor in the Westmoreland Conservation District headquarters, warming the floor gradually to a maximum of 85 degrees and then acting as a huge radiator to keep the air warm just above the floor's surface, instead of letting the warm air rise to the ceiling (which in this case, is two stories up!).

This zoned, radiant floor heat is efficient because it avoids heating unused space; yet it also is extremely comfortable because it works on the principle that people are most comfortable when their feet are warmer than their head.

Water heating – A 'Heat Scavenger' device, located in line with the geothermal wells, removes excess heat from the system and transfers it to the hot water heater, saving electricity.

Geothermal wells at GreenForge with tubing in place and ready to be connected.



Solar and Wind Power

Solar – Photovoltaic cells convert sunlight directly into electricity. These cells commonly are used to power small calculators and wristwatches. More complex systems provide electricity to pump water, power communications equipment, light buildings, and run appliances.

How much of an energy contribution solar makes depends greatly on the local conditions. In Arizona, with its 300 days a year of cloudless sky, solar can contribute much more to the energy mix than it can here in the Northeastern U.S., where typically only about 50% of our days have cloudless skies. Nonetheless, solar systems can be important in Pennsylvania; they help reduce combustion by-products, and they produce some energy even under cloudy skies.

Wind – A wind energy system transforms the kinetic energy of the wind into mechanical or electrical energy that can be harnessed for practical use. The typical "farm windmill" seen in rural areas is often used to pump water, grind grain, or do sawing. Wind electric turbines generate electricity.

Wind power is gaining ground in Pennsylvania. You may be aware that a large-scale windmill farm already exists just off the Pennsylvania Turnpike in Somerset. And in June this year, Governor Rendell affirmed that "Pennsylvania is blazing a new trail by making strategic investments in small wind energy systems to help us meet the clean energy needs of our residents and our economy."

On this conservation campus, there are several examples of solar power and one example of wind power.

- A solar panel located on the south side of the District's headquarters powers a pump that moves water from a 3,000-gallon cistern about 250 feet uphill to the demonstration, flower, herb, and vegetable gardens maintained by Penn State Cooperative Extension beside Donohoe Center.
- A 3.5-kilowatt solar array is planned for GreenForge. Preliminary discussions with a potential supplier of the solar electric system have suggested a system that:
  - includes 19 individual 185-watt panels
  - produces about 4,052 kWh annually
  - results in an annual cost savings of some $240 (at 6 cents/kWh)
  - results in an annual mitigation of some 8,493 pounds of carbon dioxide
  - costs approximately $8.25 per watt, or $28,875.

  If excess electricity is generated by the system, it can be easily sold because the campus already has access to the local power grid (see last bullet point in this section).
- In addition to the solar arrays, the campus features examples of passive solar heating, cooling, and daylighting.

  In adapting it for its current use, the District's headquarters was designed with low-E glass windows that can be swung wide open allow nature to do the space conditioning on temperate days. Careful orientation of the building and elongating the east-west axis allows the structure to draw significant natural warmth from the southern sun in winter and to make maximum advantage of the prevailing breezes in summer – reducing dependence on mechanical systems for these necessities. During

A solar panel located on the south side of the Westmoreland Conservation District headquarters powers a pump that moves water from a 3,000-gallon cistern uphill to help water flower, herb, and vegetable gardens maintained by Penn State Cooperative Extension.

summer, south-facing windows are shaded by a canopy to reduce heat gain. Concrete floors provide thermal mass and help in passive solar performance.

- A hybrid solar/wind demonstration behind Donohoe Center uses a 2,100-watt solar array and a 10-kilowatt wind turbine atop a 120-foot tower to provide additional power generation for that building. The system is tied directly into the local power grid, and thus reduces the overall electricity required from the electric utility company. Production of the wind turbine averages 20 kilowatt-hours each day, and annually prevents emissions of 16,156 pounds of carbon dioxide, 47 pounds of nitrous oxide, and 28 pounds of sulfur dioxide.

  Production of the solar array averages 6.5 kilowatt-hours each day, and annually prevents emissions of 5,283 pounds of carbon dioxide, 15 pounds of nitrous oxide, and 9 pounds of sulfur dioxide. Through net metering*, 100% of the value of the electricity generated is captured as savings to the electric bill.

** Net metering is an arrangement with the local electric utility that allows us to use the electricity we generate first. This reduces how much electricity we buy from the utility. For those applications that can generate more electricity than they could use, net metering allows the excess to go through the electric meter and into the grid.*

Adaptive Reuse

Buildings sometimes outlive their original purpose. Adaptive reuse is an approach that adapts existing buildings for new uses while retaining their historic features, such as when an old factory is transformed into an apartment building.

Here on this conservation campus, the Westmoreland Conservation District headquarters is a prime example of adaptive reuse.

This structure was originally built in the 1880s as a working barn on a farm in Penn Township. It housed grain, animals, and farm equipment. By the late 1990s, the farm had ceased production and the land was marked to become a housing development. In the process, the 7,600-square-foot barn was slated to be demolished.

Instead, the Westmoreland Conservation District enlisted Amish craftsmen to dismantle the barn, marking each of the more than 300 hand-hewn beams and timbers with a code so they could be rejoined in exactly the same way when the structure was reconstructed at its current location a few miles away.

More than 80% of the barn's original timbers of poplar, white oak, red oak, and chestnut were reused, and actually are in such fine shape that they should be able to stand and serve in their new purpose for at least another 100 years.

Raising the 125-year-old barn timbers at their new location.

In adapting the barn for its new use as an education center, the District – whose mission is to help citizens use natural resources wisely – incorporated recycled/recyclable materials, energy-efficient fixtures, and a variety of low-maintenance, sustainable technologies, so that the structure itself would be a teaching tool; a working model of conservation in action (see Green Building section).

The District is in the process of applying for certification of the building from the LEED (Leadership in Energy and Environmental Design) Green Building Rating System®, a national standard for high-performance, sustainable buildings.

Green Building

Green (or sustainable) building is a practice that seeks to create structures that use resources more efficiently in their construction and operation…that minimize the overall impact on the environment…and that are healthier for people to live and work in.

Both the Westmoreland Conservation District headquarters and the GreenForge building incorporate a variety of green building practices.

The water garden beside the Westmoreland Conservation District headquarters uses recirculated rainwater from the roof of the building.

Some of the green building features of the District headquarters include the following.

- The building is a "bank barn," a design created to nestle the structure into the natural slope of the land, and take advantage of the earth's thermal properties to help moderate the inside temperature.
- The building was designed to create no burden on the storm sewers. A cistern catches half the rainwater from the roof, and the other half is used to create a beautiful, recirculating water garden. Gravel parking areas allow snow and rain to slowly infiltrate into the ground.
- Water-saving toilets reduce the amount of potable water drawn from the municipal system and save twice: once in the cost of water and once in the cost of sewage.
- The exterior deck floor is covered with a protective coating made entirely of recycled automobile tires.

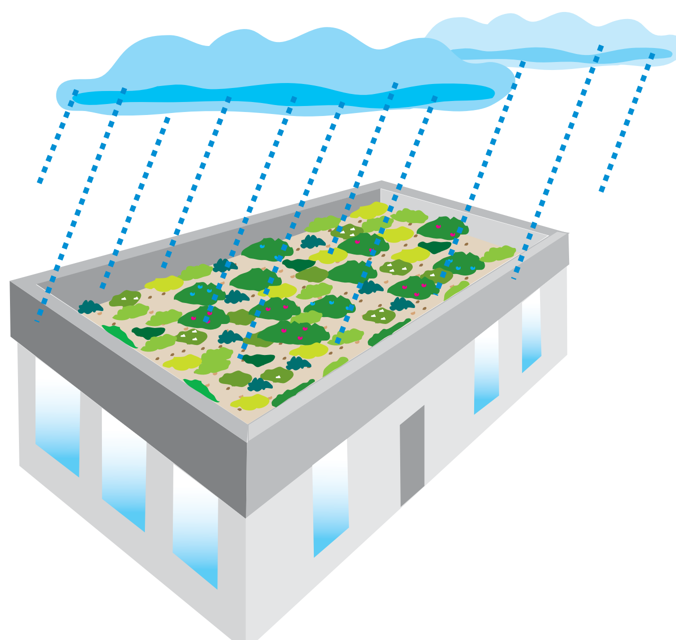
Some of the green building features of GreenForge include the following.

- The current asphalt parking lots will be retrofitted with bioretention cells – which essentially are catch basins under the surface with landscaped islands above – to capture and manage stormwater. Employing bioretention cells will most likely give GreenForge the distinction of being the first building project in the county to increase the number of associated parking spaces while decreasing the amount of impervious (paved) surfaces.

Both buildings are in the process of being presented for certification from the LEED (Leadership in Energy and Environmental Design) Green Building Rating System®, the national standard for high-performance, sustainable buildings. Energy Star ratings also are an important consideration in all aspects of both buildings' adaptation.

Green Roof

This nontraditional roofing approach uses living, green plants as a natural way to moderate building temperature (and so reduce the amount of energy needed to heat and cool the building), reduce stormwater runoff (and so alleviate pressure on the local sewer system), enhance air quality by absorbing and converting carbon dioxide and producing oxygen, insulate sound, and improve aesthetics and habitat.



GreenForge has Westmoreland County's first-ever green roof.

In late September 2006, two of the building's flat roofs – representing a total of some 9,000 square feet – were planted with nine types of sedums, one species of delosperma and one species of talinum. The 6,000 total individual plants were grown specifically for the GreenForge building by a greenhouse in Maryland.

GreenForge's green roof began to take shape in the spring of 2006, when a brand new traditional roof system was installed. This structural reinforcing was necessary because, in general, green roofs must support more load per square foot than conventional flat roofs. GreenForge's green roof weighs approximately 20 pounds per square foot. This reinforcing work also included the addition of a 4-ply membrane, more than

Installing the green roof layers at GreenForge.

Cranes were used to lift the sacks of special planting media and distribute it over the surface of the GreenForge roof.

600 mills thick, to help to ensure the life of the conventional roof beneath the green materials. In general, green roofs are likely to last much longer than conventional roofs, since the roofing material itself is shielded from ultraviolet light and thermal stresses. Green Roof Service, the company that installed GreenForge's green roof, says these may extend roof life by two to three times.

Next, a 1/4"-thick, 100% recycled filter fabric was laid down on the roof, and topped with waffle-shaped, 50%-recycled plastic sheets called drainage plates. Instead of just rolling off the roof, rainwater is retained within the pockets of these drainage plates and used by the plants. If there is any excess water, it spills over the edges of the plates and is carried off the roof through the drains. In Westmoreland County, rainfall averages about 4 inches a month and is evenly spread throughout the year. A single rain event usually yields about 1/2".

The waffle-shaped plates were topped with another, thinner layer of recycled filter fabric and about three inches of planting media – a blend of inorganic and organic soil components. The filter fabrics, drainage plates, and planning media all were manufactured according to strict German FLL standards, which are equivalent to the US ASTM standards. Green roofs have been extensively used in Germany for more than 25 years.

Initial maintenance of the roof will involve watering to establish the plants and periodic weeding until the desired plants cover the entire surface (usually about 2-3 growing seasons). After that, little maintenance is necessary.

The roof will be monitored to measure, among other things, how much water it is retaining. The GreenForge roof was designed to retain 50% of all rainwater. In actual applications, however, such as in the green roof recently installed at Carnegie-Mellon University, designers are finding a significantly higher retention rate.

The total cost of the GreenForge green roof was approximately $21 per square foot – about $9 or $10 per square foot more than more conventional commercial roofs.

Volunteers begin planting the first green roof in Westmoreland County.

For more information

Solar Power
Wind Power

Gary Sheppard, county extension director, Penn State Cooperative Extension Westmoreland County, (724) 837-1402.

Adaptive Reuse
Geothermal Heating & Cooling
Green Building
Green Roof
Solar Power

Gregory Phillips, District manager/CEO, Westmoreland Conservation District, (724) 837-5271.