Renewable Energy Project

Tanoma AMD Wetlands Treatment System
Environmental Education Center
Evergreen Conservancy

The main purpose of the Tanoma AMD wetlands system is to remove the iron from the abandoned mine discharge that would otherwise enter the local watershed. The site was immediately recognized as a great tool for education on pollution, the watershed, the use of natural systems for water restoration, alternative energy, stream ecology, water testing, birding, plant, and tree identification, and other environmental education issues. Evergreen Conservancy has spent several years developing the area into an outdoor environmental education center, with a pavilion, parking lot, ADA compliant pathways, and signage. The public can visit the site and take advantage of the self-guided wetlands trail. In an effort to expand the educational aspect of the site, we have installed an off-grid renewable energy system that includes the alternative energy sources of water, wind and sun. On site you can see a micro-hydroelectric generator, a wind turbine, and a solar panel installation in operation.

Having this "green" renewable energy project available at this site will also add to the educational aspects of our outdoor classroom: standard 120 AC electrical power is available for educational and public events and meetings, running laptops, projectors, displays, and other presentation devices. In addition, the electricity is used for site maintenance for recharging electric lawn mowers, string trimmers, and power tools for other projects. Recently, Evergreen Conservancy has started to exhibit light-up displays for night-time viewing, showing fun or relevant themes. Opportunities to see these innovative technologies in action will help visitors understand how we as a community and as individuals can help to conserve our resources. The electricity generated by the system will also be used to run aerating "bubblers" in the cells of the treatment system. This will help the other existing iron-removal systems to precipitate more iron from the water, because dissolved oxygen (DO) combines with the iron to form the solid substance iron oxide. After the iron oxide is precipitated out, it can be harvested and used commercially. Evergreen Conservancy collects enough iron oxide to give to local artists for use in their artworks and makes chalk, ink, and tie-dye T-shirts. The hydroelectric generator is run by the actual discharge from the AMD water flow; in fact, putting the AMD water flow to work in generating electricity to help get the iron out is an uncommon approach with a certain "irony" about it – the polluted water is made to work to clean itself up.

The Renewable Energy Project was developed with the support of the following:

- Indiana County Endowment/The Pittsburgh Foundation
- Sprout Fund/ Community Connections
- Dominion Foundation
- Penelec Sustainable Energy Fund of the Community Foundation for the Alleghenies
- Foundation for Pennsylvania Watersheds
- The Sprout Fund/Spring Program
- EPCAMR/ Western Pennsylvania Coalition for Abandoned Mine Reclamation (WPCAMR), ARRIPA
- Indiana Parks and Recreation
- The many individual and groups of volunteers and members of Evergreen Conservancy!

This shed houses the heart of the renewable energy system, with batteries to collect the generated electricity and a power inverter to change the DC current from the batteries into AC current in the electric lines. This is what is called an "off-grid" system with no power lines from the electric company coming into the site. All the electricity we use is generated completely on-site.

The Need for Change

Because of global warming, it is very important for environmental education to demonstrate the uses of renewable energy. The scientific evidence is overwhelming that global warming exists and is caused by the human burning of fossil fuels, like coal, oil and natural gas. During the last century, because of fossil fuel use, the global temperature has gone up roughly 10 times faster than at any time in Earth's history in the last 2 million years. Satellite and surface instrument data is abundant and tells scientists that natural causes of climate change, such as variations in sunlight striking the Earth, forest fires, volcanic eruptions, and tiny wobbles in Earth's rotation, are simply too minor to account for the abrupt and rapid temperature rise we've seen in the last century. Also, if increased sun activity was responsible, we would have seen a temperature rise in all parts of the atmosphere, including the upper stratosphere. However, since 1950, the stratosphere has become cooler. This is consistent with higher rates of burning fossil fuels and creating greenhouse gases like carbon dioxide and methane that trap the sun's heat at lower altitudes and prevent the stratosphere from being heated. The global warming is definitely not a natural process and is not a result of any of these natural cycles or causes. There are a number of "climate skeptics" who want to deny that global warming is real or that human activity is causing it, but they have no scientific evidence to back up their claim.

If global warming continues unchecked, we will see more severe heat waves and droughts in some areas, and much higher rainfall and floods in other areas, such as we've seen in recent years. Hurricanes, tornadoes and other storms will increase in intensity and frequency. Sea levels will continue to rise as the polar ice caps and glacier fields melt. Data shows that sea levels have risen significantly since 1870, and since 1993, the rate of sea level rise is accelerating. Many island nations will disappear, and up to 10% of the world's population who live in coastal areas will be displaced by higher sea levels.

At some point humanity will need to do something about the global warming it is causing, and one major alternative will be to shift our energy economy to the use of renewable energy sources, such as wind, solar and water power. Renewable energy does not emit greenhouse gases and will not contribute to further global warming. That is why it is important to have examples of renewable energy generation at environmental education sites such as Tanoma.

And you don't need to wait to make use of renewable energy. There are lots of websites where you can shop for solar panels, wind turbines and other needed accessories. Many of them provide free tech support to help you install a home system, large or small. Don't think you need to live in Arizona to make use of solar; solar panels work just fine, even in cloudy Indiana County. They need to be mounted at an angle in winter anyway, and as a result will shed snow fairly well. Local projects include one garage system with just two solar panels supplying enough power for running an electric lawn mower, all other electric lawn equipment (string trimmer, hedge clipper, edger, etc.) as well as all power tools for many projects. Look at your electric needs and think about how you might cut your electric bill with even a small independent renewable energy system. Every kilowatt counts – and they are getting much more expensive every year.

Costs of going solar in your home are dropping every year and can greatly reduce your electric bill. Numerous installers are available in the Pittsburgh area and could provide you with an estimate. The initial expense may be pricey, but the number of years before the reduced electric costs pay off your investment may surprise you. Solar shingles have dropped in price and replace ordinary roof shingles. Add in any government tax incentives or rebates, and the cost of a new roof may pay for itself in the long run, as well as helping the environment.

Another simple way you can help the environment is to do what Tanoma has done – purchase an electric lawn mower. Two things to think about with respect to using gasoline-powered lawn mowers:

First, which do you think causes more atmospheric pollution, your gas-powered mower or your car? Surprisingly, it turns out that lawn mowers, since they are not equipped with pollution-control devices, are far more polluting than automobiles. In fact, estimates vary, but studies have shown that gas-powered lawn mowers create from 11 times to 40 times more pollution than cars. Some legislation has been passed to make newer lawn mowers somewhat less polluting, but that will only make them a little better. They will still be major polluters of our air.

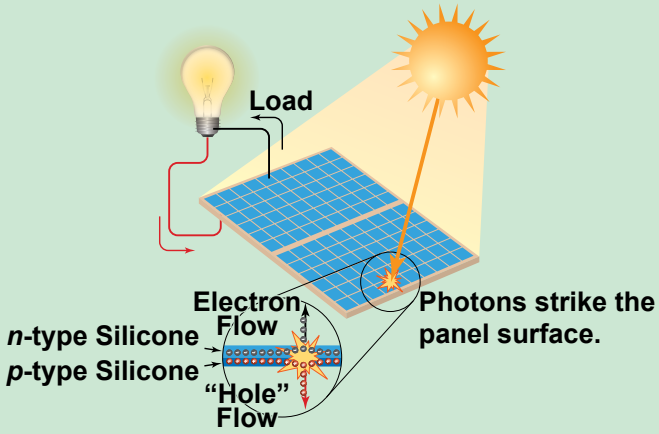
Second, it is typical when you are lifting a heavy gas can to refill the gas tank on a lawn mower that you may spill or splash a little gasoline on the outside of the tank. It may not seem like that's such a big deal, but how much gasoline do you think gets spilled that way in the US during a year? Another surprise: more gasoline gets spilled in one year refilling lawn mowers than was lost in the Exxon Valdez disaster! Those little spills really add up.

Besides being less polluting, electric mowers run quieter and need almost no maintenance. We recommend that you consider getting a self-propelled lawn mower, especially if you are mowing rough or hilly lawn areas, because the batteries add a little extra weight. Of course, on small, flat lawns you may be happy with a regular cordless electric mower or even a corded model. Any time you are out at Tanoma and would like to try out our lawn mower, feel free.

Solar Power

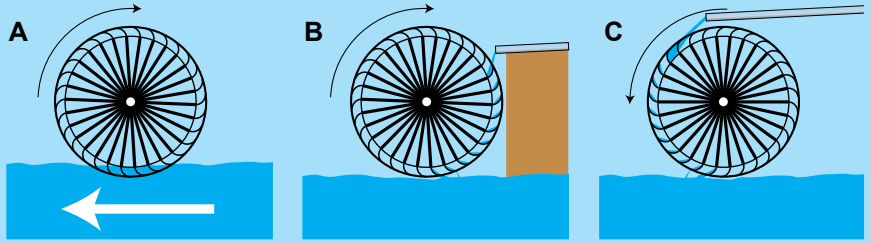
Part of the renewable energy system at Tanoma is a solar array of 4 solar panels, each delivering 225 watts of peak power, for a total of 900 watts. On average, these solar panels are providing 100 kilowatt hours of power per month, enough electricity to run approximately one-seventh of an ordinary household's electric needs. Evergreen Conservancy hopes to add even more solar panels in the near future to increase its electrical production.

Solar panels are often called "photovoltaic" or "PV" panels because they use the "photovoltaic effect" to generate electricity. Look at the diagram below to see how they work. Sunlight, which is a stream of photons, strikes specially treated, thin silicon sheets. The photons knock electrons from the silicon atoms, and the electrons are collected in one part of the panel to create an electric current.

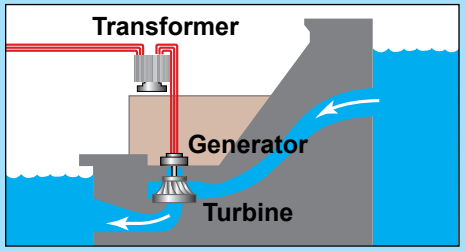


Hydro Power

Water has been used for thousands of years as a power source. You might have heard it called a watermill, water turbine, or water wheel. The basic concept is that a wheel placed in flowing water is connected to a network of gears to be used for a specific purpose. The gears turn creating mechanical energy from the kinetic power of the water passing by the water wheel. There are three types of designs for wheel placement in a flowing water body: Undershot – water flows under wheel (A), Breastshot – water flows towards middle of the wheel against the bank (B), Overshot – water flows over the top of wheel (C).

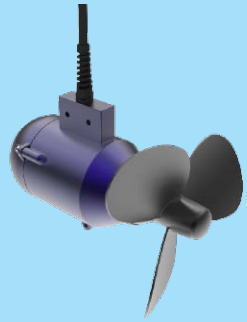


These mills were used to manipulate raw materials into products like agricultural products, textile, lumber, and metal. A famous example is a flour mill. Grains like oats, wheat, rye and barley were collected by farmers and brought to the mill. At this mill, the grain was ground on stone that rotated from the circular motion of the water wheel and gears.



More contemporary water turbines utilize different designs other than these classical water wheels. Turbines may use a variety of enclosed blades or cups, or exposed vanes or paddles with powerful streams of water directed against them to produce the mechanical power. This power can then be used to turn generators to make electricity. This method of harnessing energy is called hydro-electricity. Dams are the most commonly known hydro facilities used. Dams create a reservoir (man-made lake) that can control the outflow of water through a water turbine generating electricity. Pennsylvania has several power plant dams that create hydro electricity. These include:

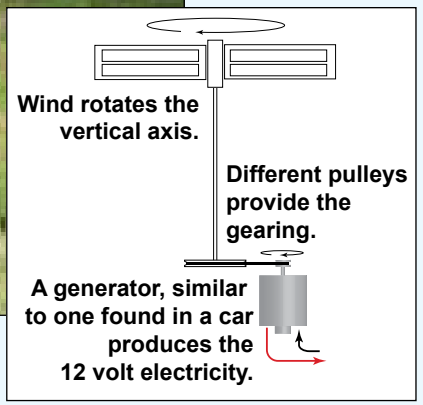
1) Holtwood Dam – crosses lower Susquehanna River, generates over 100 Megawatts, opened in 1910 and created Lake Aldred.
2) Kinzua Dam – crosses Allegheny River, generates 400 Megawatts, opened in 1965 and created Allegheny Reservoir or Kinzua Lake in Allegheny National Forest.
3) York Haven Dam – crosses Susquehanna River by Conewago Falls, generates 19-20 Megawatts, opened in 1904 and created Fredric Lake.
4) Safe Harbor Dam – crosses lower Susquehanna River, generates over 400 Megawatts, opened in 1931 and created Lake Clarke.



Tanoma has a water turbine too. It is called an Ampair 100 and is a type of turbine that works well in a flowing stream where there is very little drop in elevation of the flowing water. The turbine is expected to produce an estimated 100 watts of constant 24/7 electrical generation.

Wind Power

Sailboats, wind mills, kites, and weather vanes are examples of everyday items that move, or fly because of the kinetic energy of wind. Wind has been a source of power used by people for years dating back to the early ages of civilization. We actively feel, use and depend on wind, but do you understand where and how wind works? Here is a simple explanation of this common earthly feature:



Air floating over land is warmed by the solar heat during the day. This warming effect causes the air to rise because it is less dense. As it rises, cold air over water flows in to fill the void. At night it is the opposite effect. The sun goes down, the land cools down. The air sinks over land and rises over water. This daily pattern is a continuous movement of air masses that cross the globe. This motion is what we call wind. Land features such as mountains, hills, valleys and prairies increase or decrease the velocity of the wind, creating a variety of speeds depending on location. Also, the west-east rotation of the earth contributes to the motion of wind. Known as the Coriolis Effect, in the Northern Hemisphere the wind follows the rotation of the earth. In the Southern Hemisphere, the wind follows the counter rotation flowing east-west. In summary: the heat provided from our sun and the rotation of the earth provide the wind we rely on.

Over the years, people have found a way to capture the energy of wind to produce electricity. These structures are called wind turbines. Modern wind turbines come in a variety of sizes, shapes and styles. Typically, turbines consist of blades or some form of a rotating head and a drive shaft connected to a generator. The rotating head creates drag against the wind turning the drive shaft which produces electricity through the generator. With enough turbines on several acres of land, the area is called a wind farm. Pennsylvania has a few wind farms such as:

1) Armenia Mountain (Bradford and Tioga County): 67 Turbines
2) Locust Ridge II (Columbia and Schuylkill Counties): 51 Turbines
3) Waymart (Wayne County): 43 Turbines
4) Allegheny Ridge (Blair and Cambria Counties): 40 Turbines

All of the wind turbines you see at these sites are “horizontal-axis wind turbines” or “HAWT’s” because the axis of their rotation is parallel to the ground. Find out about other Wind Farms in Pennsylvania at www.pennfuture.org or www.pawindenergynow.org.

The wind turbine installed at the Tanoma Wetland AMD site is a prototype vertical-axis wind turbine (or a VAWT). This prototype is approximately 15 ft. tall and 14 ft. across. It rotates in a horizontal plane around the vertical axis, hence its name. Because it doesn’t have sharp, fast-moving blades like the typical horizontal-axis wind turbines now in use everywhere, it poses no threat to birds or other wildlife, and that’s an important consideration in a conservancy location which provides a habitat for a number of birds. Flaps in the back of each vane rise and fall as they change their orientation to the wind. This feature allows wind blowing on the backs of the vanes and resisting the turbine’s rotation to simply flow through. That greatly increases the efficiency of the turbine, making it comparable in efficiency to the horizontal-axis turbines. We estimate that this turbine will on average provide around 40 kilowatt hours per month to the system.

Besides its safety features, the design of this wind turbine allows for a flat, compact installation on building rooftops, making it compatible with locating an array of solar panels above. That is an important aspect of this design, since it is best to combine solar and wind for future residential and commercial applications.