Renewable Energy: A Tale Of Four Projects

There's little debate about the need for alternative energy sources. The question is how to choose the right one.

John Vastyan, Common Ground

Earth, wind, and fire. Who'd have guessed the name of the pop/rock band of the '70s and '80s would define today's alternative-energy movement? Decades later, their lively tunes would hardly be a suitable sound track for the mood we're in. The cost of energy and environmental repercussions leave some of us spinning long after the disco floor folded up and left town.

Today, more than three-quarters of the world's energy needs are met by burning fossil fuels in the form of coal, oil, or natural gas. We've learned by recent, tragic example that even the harvesting of crude oil bears enormous risk. Consider the devastating 2010 BP oil disaster in the Gulf of Mexico. Fracking (hydraulic fracturing of shale) for natural gas has stirred controversy, too.

So it's welcome news that the alternative-energy theater now stars wind, solar, geothermal systems (along with geo's cousin, water-sourced heat pumps), and biofuel/biomass. The latter is a broad category that covers everything from raw wood and wood products to corn and methane "biogas" captured from…well, let's just say that dairy farms and beef ranches produce more than milk and steaks.

Yet, just as it is with fossil fuels, alternative-energy sources can cause environmental concerns. Burning wood improperly produces huge amounts of pollution. Done right, however, it's a great addition to our energy mix.

Similarly, conservationists are working with utilities to reduce the environmental impact of wind farms and to protect birds. We know that hydropower is a clean source of energy, but constructing dams to harness it can be disruptive and create other environmental problems.

Step into the brave new world of alternative energy as we look at four projects that illustrate the benefits of harvesting alternative energy. ***Continued on next page***

A 1.2 million-kW wind turbine rises behind the campus of Portsmouth Abbey School. The turbine has become a symbol of the school's commitment to energy independence.

1. Wind Power

Along the shores of Rhode Island's Narragansett Bay is Portsmouth Abbey School, a 500-acre, co-ed boarding school founded by Benedictine monks in 1926. The school has recently gained worldwide attention for its environmental savvy. Anyone traveling within several miles of the school can see its most noteworthy asset, the state's first utility-scale wind turbine.

Installed in 2006 with a price tag of $1.2 million, the spine-shaped tower and three 77-foot blades rise 240 feet above a grassy bluff. According to Benedictine Brother Joseph Byron, the wind turbine, combined with other energy initiatives at the abbey, is part of a deliberate earth-wise endeavor. The V-47 1.2 million-kW wind turbine from Danish manufacturer Vestas immediately became a symbol of the school's commitment to energy independence. It now provides 40% of the school's and monastery's electricity needs.

By displacing electricity purchases, wind-turbine savings pump hundreds of thousands of dollars each year into the school's budget, enabling the purchase of truckloads of insulation, sophisticated energy-management systems, campus-wide window and door upgrades, and the installation of high-efficiency heating systems. "Our savings have allowed us to put money aside for a wide variety of purchases, weighing multiple projects on merit," said Paul Jestings, the school's facility engineer. "We now have new boilers, solar heat, PV equipment, thermal storage tanks, and water heaters."

A call from the Vatican

In its first year of operation, the wind turbine, which generates 1.2 million kWh/year, reduced the school's electrical-energy use by 40%. Displacing retail-rate electricity purchases, valued today at about $0.13/kWh, pumped $220,000 into the school's budget. The energy dividend now grows each year through electricity-cost savings, electricity sold back to the grid, and renewable-energy credits.

At first, school administrators envisioned a five- or six-year payback on the turbine, but they were surprised to see a net gain, with full payback, after only four years. At that point, the savings were steadily pumped into their ongoing efforts to reduce the school's carbon footprint.

Vatican Radio, the official broadcasting station of the Holy See, caught wind of Portsmouth Abbey's operation several years ago. Their interview with Byron examined the success of wind turbines and other on-campus energy-conservation initiatives.

"We're not done yet," added Byron. "Far from it. Solar photovoltaic and geothermal equipment are on the list. So are more solar heat arrays and thermal storage tanks. Some remaining older boilers to replace—all are parts of a greater plan."

2. Water-Sourced Heat Pumps

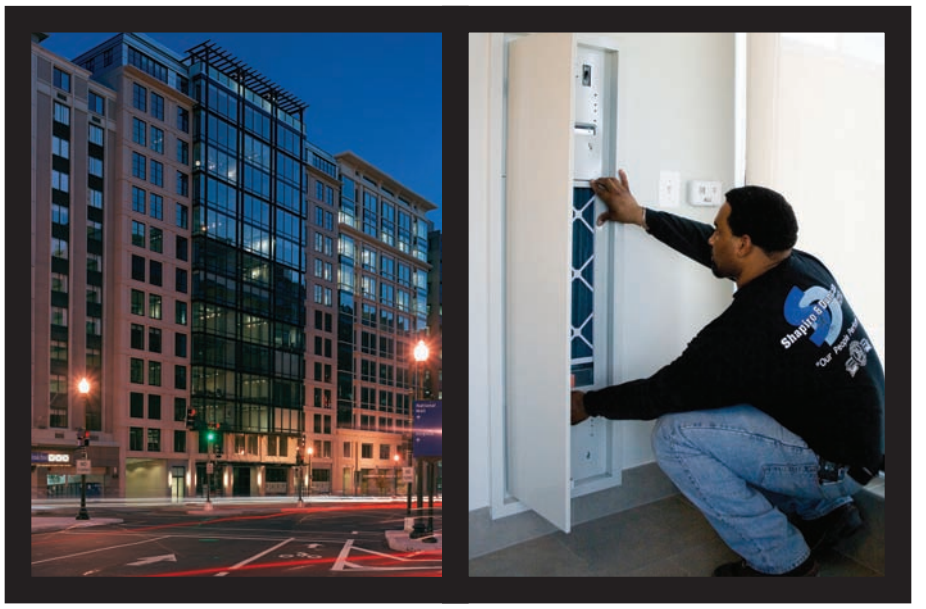
Washington D.C. is famous for many firsts, including the Beatles' first live concert in the U.S. (1964); home of the first Miss America (Mary Gorman, 1921); and the first all-black university (Howard Univ., 1867).

The Alta at Thomas Circle, located just a few blocks from the White House, joined that prestigious list in 2009, when it became the first certified Leadership in Energy and Environmental Design (LEED) condo/mixed-use development in the District of Columbia.

The Alta includes 126 residential units from efficiency to 2-bedroom (with a few larger penthouse offerings), plus two retail spaces on the first floor, all packed into 13 stories, with penthouse roof/deck space at the top and a five-level below-grade parking garage.

What sets the Alta development apart from other high-end condos in downtown Washington are its green characteristics. Everything in its closed-loop heating-and-cooling system—from insulation to paints to the water-source heat pump—was carefully selected for environmental compatibility and sustainability.

The original heating/cooling-specifications included equipment that used R-22 refrigerant. Late in the construction process, however, the managers at developer PN Hoffman Inc., Washington, made a strategic decision to switch to water-source units using HFC-410A, a zero-ozone-depletion refrigerant, which became a key step in achieving the building's LEED certification. Oklahoma City-based ClimateMaster Inc.'s Tranquility systems, built to accommodate HFC-410A refrigerant, got the nod.



The Alta at Thomas Circle is the first LEED-certified condo/mixed-use development in Washington D.C. Vertically stacked heat pumps in each unit were one of the first changes to turn the project green in mid-construction.

The water-sourced heat pump systems don't tap renewable energy necessarily (as their geothermal 'cousin' systems would), but they similarly harvest thermal energy within commercial buildings, moving it inexpensively within the structures to create thermal-energy transfer.

"Water-loop technology has been around for decades, though now—pushed by rising energy costs, the call to arms by the USGBC, and the advantages of LEED certification—interest in the technology is gaining rapidly," said John Bailey, vice president of sales and marketing for ClimateMaster.

Bailey explained that several things add heat to a building: people, machinery, and especially solar gain, which warms entire west- and south-facing sides. In lieu of running the system in cooling mode to reject accumulated heat, as conventional air-source systems do, any additional heat is simply transferred by the heat pumps to other zones that need heat. Thus, solar gain is transferred to various zones in the building or dispelled evaporatively by a cooling tower, as is the case at Alta.

"It's a very simple and efficient system," added Bailey. "Rather than heat one zone and cool another simultaneously, the surplus thermal energy is just moved around the building." The process helps substantially reduce a building's heat load in cold weather.

Today, most of the Alta's residential units have a single water-to-air heat pump. The units are served by a closed condenser water loop, with boiler and cooling tower installed at the roof level. Also, the vertical-stack design of the heat-pump units conserves considerable floor space.

The residential units are relatively tight, offering about 6 sq. ft. to house the heat pump. A cabinet-type unit would have required 15 sq. ft. Many of the smaller systems used in the facility are located adjacent to closet spaces. In some instances they are even built into kitchen islands.

Locating the heat pumps in the middle of each residential unit simplified the closed-loop system because each unit incorporates risers (vertical piping). The units come complete with factory-installed risers and are pre-piped, so they stack vertically from one story to the next. Today, residents at the Alta find that living in a green environment is a net positive in more ways than one.

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3. Geothermal And Wind

The Annett Nature Center near Des Moines (above) uses geothermal heat pumps to keep the center warm even in freezing weather. The equipment room (below) is crowded, but careful planning made room for everything necessary for peak performance.

What would be a more fitting application for geothermal energy than an educational nature center in need of an HVAC retrofit? That's what members of the Warren County Conservation Board thought when the 13-year-old Annett Nature Center (ANC) in Indianola, IA, was due for a makeover. The nature center is a 9,500-sq.-ft., three-story building on 160 acres above a 6-acre lake and an even larger wetland area. Serving as a base camp for activities, ANC also offers displays and exhibits on two levels, offices, kitchen, restrooms, exhibit- and program-preparation areas, and a garage.

In 2009, Warren County received grant funds allocated for an energy-conservation project. The county's board of supervisors saw a geo retrofit at ANC as the best use for the funds; it would achieve energy savings while also providing educational opportunities about renewable energy. The new system went online in May 2011.

According to Jim Priebe, director for the board, ANC installed a 100-foot, 50-kW wind turbine. "It's great to educate visitors and spread awareness of renewable-energy sources with the new systems in place," he said. The board is also looking at installation of a 20-kW wind turbine.

The heat load for ANC was calculated almost entirely around the heating demand. Care was taken not to oversize the cooling element for the project. Five ClimateMaster (Oklahoma City), Tranquility 27 water-to-air geothermal heat pumps in ANC's basement provide a total of 26 tons of year-round comfort control. The units distribute warm or cold air through existing ductwork once connected to old furnaces.

Project goes sideways

Demand for domestic hot water at ANC, typically limited to hand-washing and facility cleaning, is met by a desuperheater, which scrubs heat from the geo systems during the winter months.

To serve the 26-ton geo system, 18 loops of 300 feet each were installed in boreholes, then backfilled with a 40% bentonite grout solution to ensure optimal thermal transfer.

The deep, wet yellow clay of central Iowa allowed horizontal boring not far from the earth's surface. The less-invasive technique is also cheaper than using a vertical well-drilling rig. According to the driller, each ton of geothermal capacity installed using horizontal-bore rigs cost ANC about $1,300. A vertical installation would cost anywhere from $1,800 to $2,000/ton.

"We ran into a few challenges," said an ANC manager. "Space in the mechanical room was limited, but we found a way to squeeze all the gear in there. The other need is for most of us to grow accustomed to the sound of the wind turbine. Here, where we relish the sounds of birds and crickets, teaching children to listen to what nature is telling them, we must now grow accustomed to the sound of spinning blades. We'll get there."

The turbine used at ANC is also ideal for larger farms, schools, and other light-commercial facilities. The turbine will produce 100,000 to 250,000 kWh annually with anticipated winds.

4. Biomass

Two hours north of New York City is Triform, a 365-acre farm community with forests, fields, organic gardens, 10 houses, and a barn with pigs and cows. There's also a dairy, weaving center, bakery, pottery studio, and common areas, all designed to serve young adults with developmental disabilities as residential or day students.

Last year, Triform managers tapped John Abularrage, owner of Stone Ridge, NY-based Advanced Radiant Design, to install a sophisticated wood-burning boiler and thermal-storage system as the heat source for two greenhouses, a wood shop, and a community meeting room. Abularrage devised a plan to install a small district-heating plant that would move BTUs underground to various interior spaces. The system's heart is an advanced, 170 MBH wood-gasification boiler manufactured by Fröling GmbH, Grieskirchen, Austria, coupled with a 1,500-gallon thermal-storage system to convert organic or fossil material into carbon monoxide, hydrogen, and carbon dioxide.

"Fuel costs were chewing through the community's reserves and, at the same

At Triform Farm (left), a wood-gasification boiler uses fuel from the farm's natural supply. The system heats a greenhouse that produces vegetables year round for the facility's residents.

Underground insulated tubing circulates hot water to heat farm buildings.

time, preventing some of the desired facility improvements," said Abularrage. Over the past few years, his crews have installed a dozen or more boiler systems, so he was confident that the wood boiler/thermal storage solution would work for Triform.

European know-how

To provide heat for the community, crews installed the heat plant in an improved area that once housed a wood shop. They dug trenches and buried insulated, 1 1/2-inch R-Flex supply-and-return tubing from Watts Radiant, Springfield, MO, to circulate hot water to the large greenhouses, new woodshop, and the meeting room.

Abularrage explained that, with so many complaints about smoke caused by the outdoor wood boilers that dot the countryside, many towns and states are cracking down on wood burning. New emissions standards are pending at the federal and state levels. European manufacturers such as Fröling have long faced very strict efficiency and emissions standards, far exceeding any current or anticipated North American standards.

"A two-stage combustion process burns standard firewood cleanly and at very high efficiencies," said Abularrage. "The smoke and creosote vapor that would normally go up the chimney and into the atmosphere is burned at 1,800 F to 2,000 F in a second combustion chamber. This cleans up emissions dramatically and gives the boiler near condensing levels of efficiency.

"With firewood harvested from their own land, Triform is also slashing their heating costs," he added.

Keith Bogdanovich, Triform co-director, says that if they were heating the greenhouses with gas or oil, there'd be no economic advantage in growing vegetables for the residents. "But today we harvest our own fuel, saving substantially that way, and now we also save by growing food," said Bogdanovich. "The greenhouses are producing year round. Our only regret is not having done it sooner. Last winter was rather mild, but the winter before was awful. If we had made the switch to wood heat a year earlier, our savings would have been that much greater." BP

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