PIONEER VALLEY RENEWABLE ENERGY PROJECT

Inventory of Resources, Technology Development, Partners and Activities Related to Renewable Energy in the Region

Pioneer Valley Planning Commission
Funded by The Renewable Energy Trust — Massachusetts Technology Collaborative

I. Overview

Developing energy from renewable resources reduces reliance on coal, oil, and other fossil fuels that contribute to air pollution and global warming. Electricity generated from renewable energy resources is added to the regional electric power grid at the direction and expense of retail or wholesale consumers. Participating consumers, whether individually or collectively, act independently of any particular market structure for electricity supply. Examples of renewable energy sources are wind, biomass, solar photovoltaics, landfill gas, and hydropower.

As technology-driven innovation fuels our economy, PVPC's Renewable Energy Project, funded by a grant from The Massachusetts Technology Collaborative (MTC), aims to identify opportunities for and dissolve barriers to the production and distribution of renewable energy—Spring 2004.

Wind Energy

Wind energy is harvested from moving air that is converted to electric power to create electricity. Due to unequal solar heating of the earth, wind is generated. As air flows past the rotors of a wind turbine, the rotor spins and drives the shaft of an electric generator. Wind turbines with small rotors are often used for battery charging while larger rotors are used to generate large amounts of electricity that is fed into the regional grid.

Biomass

Biomass energy is harvested from organic materials in the environment. Originating as solar energy absorbed by plants, it is converted into chemical energy through photosynthesis. This energy is available in wood, crops, crop residues, industrial and municipal organic waste, food processing waste, and animal wastes. These by-products of various human and natural activities can be burned to create heat and/or steam that are used to generate electricity.

Solar Photovoltaic

Photovoltaic (or solar electric) systems convert energy in sunlight directly into electricity. Photovoltaic (PV) cells are made primarily of silicon, the second most abundant element in the earth's crust, and the same semiconductor material used for computers. When the silicon is combined with one or more other materials, it exhibits unique electrical properties in the presence of sunlight. Electrons are excited by the light and move through the silicon. This is known as the photovoltaic effect and results in direct current (DC) electricity.

Landfill Gas

Landfill gas is created when waste in a landfill decomposes under anaerobic (oxygen-free) conditions. Because landfill gas is about 50 percent methane, it can be used as a source of energy similar to natural gas (which is about 90% methane). Since landfill gas is generated continuously, it provides a reliable fuel for a range of energy applications, including heating and electric power generation.

Hydropower

Hydroelectric (or hydropower) plants capture the kinetic energy of falling water to generate electricity. A turbine and a generator convert the energy from the water to mechanical and then electrical energy. Turbines and generators are installed within or adjacent to dams. Pipelines (penstocks) may also be used. These devices carry the pressured water below the dam or diversion structure to the powerhouse.

Biomass *(0 MW)*

There are two very exciting Biomass projects proposed for the Pioneer Valley.

1) An MTC-funded pilot project in Chesterfield designed to scale up, construct and demonstrate a 10-dry-tons-per-day Renewable Oil International (ROI) Advanced Fast Pyrolysis Biorefinery Plant. The project will use ROI's pyrolysis technology to convert woody biomass into BioOil (a liquid fuel). Pyrolysis is a chemical reaction process where the biomass input is cooked rapidly in a high temperature oxygen free environment. The BioOil produced will be tested in internal combustion engines and a combustion turbine. Based on the successful demonstration tests, the plant will continue to operate at the saw mill site in Chesterfield as a combined heat and power system while further reviews will be completed to determine the feasibility to construct a 125-dry-tons-per-day plant at the site.
2) A Biomass power plant is proposed by private developers at an old paper company site in Russell. A biomass power plant is a power plant that converts biomass into electricity. Biomass, in this case, would be clean wood residue, such as wood chips, ground stumps, or wood from forest thinnings.

III. Organizations Involved in Renewable Energy Development

The Pioneer Valley is rich in organizations promoting renewable energy. A partial list includes:

Academic Institutions:

University of Massachusetts:
The Renewable Energy Research Laboratory (RERL) exists to promote education and research in solar and wind energy conversion technologies. Website includes research notes, "Wind Energy Explained," software simulation tools, links to other renewable energy programs.
Contact: www.ecs.umass.edu/mie/labs/rerl

Mount Holyoke College:
Center for Environmental Literacy
CEL's mission is a curriculum center, providing environmental content throughout the college. CEL also promotes grass roots institutional behavior modifications. Part of the mission is to expand beyond curriculum, and bring environmental literacy into student's everyday life. For example, in 1990 the CEL started a program called the Kill-a-Watt competition. It's a contest between residence halls to reduce their monthly amount of electricity per year. We saw a sharp decrease in the first years, but now it's increasing as more and more people bring computers. Facilities management subsidizes the contest and gives rewards. In 2005 CEL is working with the rest of the college to reduce on-site energy use.
Contact: Tom Millette (413) 538-3091

Municipalities:

Town of Amherst:
Climate Protection Committee
Contact: Steven Roof (413) 559-5667
sroof@hampshire.edu
climateprotection.hampshire.edu

City of Northampton:
Climate Protection Committee
Contact: Martin Urbel (413) 584-2515
rwhite@smith.edu

City of Springfield:
Climate Protection Committee

Non-Profit Organizations:

Center for Ecological Technology:
CET works as a catalyst for changing practices which adversely impact the natural ecology of the Earth. Working with local industry, government and residents, CET demonstrates and promotes practical applications of

IV. Renewable Energy Companies

MassElectric/CET Greener Watts
GreenerWatts is an easy way for households and small business (and non-profit) customers of Mass Electric Company to begin to "GreenUp" the electricity they use.

GreenerWatts matches 100% of a customer's electric usage with 100% Green-E certified renewable resources from New England.

Contact: For more information
or to notify us please
call 800-689-7957
mail your request to
GreenerWatts New England
40 Washington Street
Westborough, MA 01581
or email us at:
info@GreenerWattsNewEngland.com

Co-op Plus Energy Services Inc.
Co-op Plus of Western Massachusetts is a member-owned cooperative organized to create and maintain an economically, environmentally, and socially sustainable energy future, rooted in Western Massachusetts and responsive to the needs of its members and the community.

Contact: Co-op Plus Energy Services
555 South Holyoke Canal Street
Holyoke, MA 01040
(413) 538-8000
info@cooplife.com
www.co-opplus.com

V. Municipal Awareness of Renewable Energy Development and Potential

An informal phone survey of the 7 cities in the Pioneer Valley indicated interest in learning more about resources related to renewable energy. However—no municipal planning staff registered to attend the half-day workshop sponsored by PVPC to educate municipal staff about renewable energy. In addition, no representatives from any Pioneer Valley communities attended the municipal wind power workshops sponsored by MTC in September, 2003.

The biggest energy expenses for municipalities are in the following areas: public schools, waste water treatment plants, water filtration plants, older municipal buildings, and vehicle use, especially the DPW's winter plowing expenses. One community wants to install solar powered streetlights in municipal parking lots. They identified a company that sells the lights, but have not yet been able to find a local contractor to install the lights. A number of the larger municipalities are interested in participating in a renewable energy community day event to educate their residents about renewable energy resources.

VII. Appendix A
Initiatives in the Surrounding Area

Retail:

Home Depot, Greenfield
$10,000 grant from MTC

Home Depot has included green building measures in several retail developments nationwide and plans to improve upon this commitment by incorporating advanced green building measures into its new store in Greenfield. Through its feasibility study, Home Depot will conduct several tasks for the project including a green building charette for stakeholders, a design analysis for LEED Certification, energy modeling, and development of additional energy measures for the project. The focal point of the study is a technical and financial analysis of building-integrated photovoltaics for use in the Greenfield store, which will also inform use of the technology in future Home Depot projects. The completed study will act as a highly visible example for retail chains examining the potential for renewable energy in new developments.

Contact: James Laird, (770) 384-5888

Businesses:

Sun Tech Solar Systems, South Deerfield
Retail sales/Wholesale supplier/Service/ Contractor

Product types: electric vehicle batteries, lead acid batteries, renewable energy system batteries, DC to AC power inverters, solar electric power systems, solar water heating systems .

Contact: STSS
River Road
South Deerfield, MA 01373
(413) 665-4100

Turbosteam, Turners Falls
Manufacturer/Service/Exporter/Engineering Packager of cogeneration systems

Product types: cogeneration systems, packaged power systems, steam turbine electric generators.

Contact: Turbosteam
161 Industrial Blvd.
Turners Falls, MA 01376
(413) 863-3500

Private Firms:

Turtle Island Design, Montague

Construction began in the fall of 2001 for a 2,100 square foot passive solar residence. Features include a master bedroom suite, home office, open living and dining areas, and a tower to access inspiring views of the Connecticut River valley and the town of Northfield. This home will be constructed with lumber from local saw mills and stone from the building site and local quarries. Solar energy will be stored in a concrete floor slab and stone fireplace mass in the south-facing great room. Large overhangs and existing shade trees will help keep out unwanted summer sun. Additional heating energy will be provided by a wood fired furnace, while electricity needs will be provided by photovoltaic solar panels and possibly a fuel cell in the future.

Contact: TID
62 Randall Wood Drive
Montague, MA 01351
(413) 522-1811
turtleislanddesign.com

Educational Farm:

Seed of Solidarity Education Center, Orange

A 30-acre, family-owned farm. Solar electricity powers their home, education center, office, and apprentice housing. Two solar electric systems provide for all of their electricity needs, such as lights, well pump, refrigeration, computers, and stereo equipment. They bring their solar generating, grease powered van to educational and community events.

Contact: SSEC
165 Chestnut Hill Road
Orange, Massachusetts
(978) 544-9023
www.SeedsOfSolidarity.org

Public Tour:

Green Buildings Open House, Greenfield

This event provides the public with a unique opportunity to witness renewable energy and other green building technologies at work. Homeowners and building managers showcase their buildings and green builders, architects, and businesses advertise their work and products. Homeowners and building managers are on site to describe their green building features and answer questions. The public learns basic principles of green building, such as designing for passive solar heating, energy-efficient building techniques (e.g. superinsulation, air sealing), safe indoor air quality, and resource-efficient and healthy building materials. Many of the 275 buildings demonstrate the collection and storage of solar hot water, placement and integration of photovoltaics, and the generation of power using wind. The Green Buildings Open House demystifies green buildings, proving that they are comfortable, affordable, and attractive.

Contact: Northeast Sustainable Energy Association
50 Miles Street
Greenfield, MA 01301
(413) 774-6051
www.nesea.org/buildings/openhouse

Public Park:

Energy Park, Greenfield

A 2kW array is sited in the park and connects to NESEA's Headquarters. Together with 1.25kW panels installed on the roof of NESEA's headquarters, they provide approximately 25% of NESEA's electrical needs. Indoor invertors and batteries educate visitors about the amount of power generated on a continuous basis. Another display is located on our annex at Bank Row, highlighting the use of solar electricity at a remote site. A solar panel sits atop a south-facing pole with a friendly sun logo connecting to an independent light pole with interpretive signage. Western Massachusetts Electric Company and Northeast Utilities provided funding with partnership of the Kiwanis of Greenfield working closely with NESEA. A Solar Clock Train gives visitors a chance to see solar power at work incorporated into a handsome sculpture

Contact: Northeast Sustainable Energy Association
50 Miles Street
Greenfield, MA 01301
(413) 774-6051
www.nesea.org/park/tour.html

Collective:

Pioneer Valley Photovoltaics:
A Worker-owned Cooperative, Greenfield

Contact: 324 Wells Street
Greenfield, MA 01301
(413) 772-8788
www.pvsquared.coop

VIII. Appendix B: Detail on the Technologies

WIND POWER

Wind power is a fast-growing renewable energy technology which is cost-competitive with other fossil-fuel based electric generation technologies. A wide range of types and size of wind projects exists; small single turbines provide the electric needs of an individual house or farm while large-scale, commercial wind farms may contain hundreds of turbines. Municipalities are participating by developing 1 to 3 turbine projects to supply clean power. The distinction between commercial and non-commercial turbines is generally drawn at 100kW. In Massachusetts, state law allows net-metering for systems of 60kW or less. Net-metering is the ability to "spin the meter backwards" when on-site generation exceeds on-site electrical demand. The net excess of generation is purchased at the avoided cost price, which is much less than the retail cost. One 660 kW turbine displaces 1,100 tons of coal, six tons of sulfur dioxide, four tons of nitrogen oxides (based on the average U.S. fuel mix).

Many siting and permitting issues are involved with wind projects. The RERL, with funding from MPC, has developed a series of user friendly handouts on al aspects of wind energy. For a copy www.MassTech.org. The Berkshire Regional Planning Commission (BRPC) has developed a user-friendly 4-page overview on "permitting Wind Facilities". Contact Lauren Gaherty at 413/442-1521 for a copy.

The following wind power projects are either currently operational or have been proposed. In Massachusetts, the best wind resources are offshore and on ridge-tops in the western part of the state.

MASSACHUSETTS:

Hoosac Wind, Florida and Monroe

HW is building a 28.5 MW project in the Berkshire towns of Florida and Monroe. The sites will contain 19 turbines at 1.5 MW each. The towers are 213' high and the tip of the blade will reach 340'. The turbines are spaced 630' to 700' apart and the nearest house is 1,880' to a turbine. 45 to 50 acres will be cleared for the turbines and roads. Generally a commercial sized turbine needs approximately one acre of land, although the footprint of the tower is much smaller. The acre measurement ensures a safe "fall-zone." Special permits have been granted and Florida voted 65 to 25 to negotiate a 35-year lease with EnXco. The non-binding vote was 170 to 47 in favor of wind power. The total cost for the project is $31 million. Ten turbines in Florida will provide $126,000 in property taxes annually plus whatever lease payment is negotiated. A pro-wind community group formed to build support for the project. An anti-wind group, Hoosac Range Scenic Preservation Association, objects to turbines' impact on scenic vistas.

Town of Hull

This town has a long history with wind power. The town installed a 40 kW turbine on an 80 foot tower next to the high school in the early 1980's. The cost at the time was $78,000 and was funded by the MA Dept. of Energy Resources. The turbine reduced the school's electric bills by $21,000 (28%) throughout its existence. In the late 1990s, a citizens group began a drive to replace the turbine with a modern one. The Renewable Energy Laboratory at UMass worked with the citizens group and Hull Light to establish the first commercial scale turbine on the East Coast and the first urban-sited turbine in North America. Most recently, Hull Light contracted with Vestas, a Danish company, for a 660 kW fuels to reduce toxic air emissions and improve performance.

Residues are biomass materials that are byproducts from activities such as wood products manufacturing, construction, agriculture, and forest harvesting or management. These residues can be inexpensive and clean sources of biomass. Using biomass residues as a fuel can bypass fossil-fuel purchases while reducing the costs and environmental impacts of disposal. In the future, fast growing grasses, shrubs, and trees (also referred to as "energy crops") could be grown specifically for use as fuels to meet a growing demand for sustainable electricity and transportation fuels.

Recent studies indicate that Massachusetts has fair biomass resource potential. An estimated 2.1 billion kWh of electricity could be generated using renewable biomass fuels in Massachusetts. This amount of electricity can fully supply the annual needs of 209,000 average homes, or 13 percent of the residential electricity use in Massachusetts. These figures are based on estimates for five general categories of biomass: urban residues, mill residues, forest residues, agricultural residues, and energy crops. However, most forest residues, agricultural residues, and energy crops are not presently economical for energy use. New tax credits or incentives, increased monetary valuation of environmental benefits, or sustained high prices for fossil fuels could make these fuel sources more economical in the future.

Wood is the most commonly used biomass fuel for heat and power. The most economical sources of wood fuels are usually urban residues and mill residues. Urban residues used for power generation consist mainly of chips and grindings of clean, non-hazardous wood from construction activities, woody yard and right-of-way trimmings, and discarded wood products such as waste pallets and crates. Local governments can encourage segregation of clean wood from other forms of municipal waste to help ensure its re-use for mulch, energy, and other markets. Using clean and segregated biomass materials for electricity generation recovers their energy value while avoiding landfill disposal. Mill residues, such as sawdust, bark, and wood scraps from paper, lumber, and furniture manufacturing operations are typically very clean and can be used as fuel by a wide range of biomass energy systems. The estimated supplies of urban and mill residues available for energy uses in Massachusetts are 699,000 and 135,000 dry tons per year, respectively.

Forest residues include underutilized logging residues, imperfect commercial trees, dead wood, and other non-commercial trees thinned from crowded, unhealthy, or fire-prone forests. Because of their sparseness and remote location, these residues are usually more expensive to recover than urban and mill residues. The estimated supply of forest residues for Massachusetts is 366,000 dry tons per year.

Agricultural residues are the biomass materials remaining after harvesting agricultural crops. These residues include wheat straw, corn stover (leaves, stalks, and cobs), orchard trimmings, rice straw and husks, and bagasse (sugar cane residue). Due to the high costs for recovering most agricultural residues, they are not yet widely used for energy purposes. However, the development of supply infrastructures will allow biomass resources to be economically recovered and delivered to energy facilities.

Energy crops are crops developed and grown specifically for fuel. These crops are carefully selected for fast growth, drought and pest resistance, and ready harvesting. Energy crops include fast-growing trees, shrubs, and grasses such as hybrid poplars, hybrid willows, and switchgrass. In addition to environmental benefits, energy crops can provide income benefits for farmers and rural land owners. For Massachusetts, the production potential for energy crops is estimated at 236,000 dry tons per year.

LANDFILL GAS

Landfill gas (LFG) is made up of 50% methane CH_4 and 50% CO_2, along with trace levels of other compounds. Methane is 21 times more effective at trapping heat than CO_2 and waste-produced methane composes 30% of anthropogenic methane emissions. Waste methane is second in importance to methane contributions from the ag sector. The basic process of converting landfill gas to energy consists of first trapping the methane emissions and secondly using the methane as a fuel source to produce electricity. A variety of technologies can be used to covert methane to electricity.

Typically the most cost-effective and most common is the reciprocating engine for operations in the 1 to 5 MW category. These four-stroke lean-burn engines operate similar to a car engine and produce electricity at 4 to 7 cents per kWh. They are also the most polluting of the technologies producing 3.2 to 6.4 lbs/MWh of Nitrogen Oxides, a major component of ozone and smog. The 3.2 lb level is close to the emissions of natural gas turbine technology (1.5 to 2.1 lb/MWh). Natural gas engines are usually used for larger projects: those over 3 MW. In areas with stringent NOx standards, small and medium LFG projects would be discouraged. Despite these emissions, the EPA believes the environmental benefits of capturing and utilizing the methane are much greater than not managing the resource. In addition to reducing methane emissions, LFG operations reduce the need for fossil fuel based electricity and decrease the risk of dangerous concentrations of methane at the site. A 5 MW project is equivalent to planting 80,000 acres of trees per year or removing the annual emissions of 60,000 cars. The EPA runs the Landfill Methane Outreach Program (LMOP) that assists in the assessment and development of LFG projects. Currently there are 340 operational LFG projects in the U.S, producing almost 900 MW of electricity. Best candidates for LFG projects are sites that have 1 million tons of waste-in-place. Landfills of this size support an .8 to 1 MW project. LFG continues to be emitted 20 to 30 years after a dump closes. LFG should be considered as a bridging strategy for renewable energy. Usable gas production typically lasts from 10 to 15 years. Long term, it is likely that waste recycling, reduction, and reuse programs will reduce the amount of waste headed to landfills. With this reduction in waste, the long-range potential for LFG facilities is likely to be limited. Some critical success factors include:

1) a well-engineered and managed landfill;
2) an accurate assessment of the LFG resource; and
3) the correct choice of suitable energy recovery plant.

DTE Biomass Energy is a company that has designed and constructed 25 LFG systems in the U.S. The Riverview plant in Michigan was built in 1987 for $6 million on a 120 acre landfill. The dump has 31,400,000 cubic yards of waste. The two gas turbines produce 6.6 MW of electricity, enough to power 6,800 homes.

The EPA highlights the Pattonville Maryland High School LFG project. The school paid $175,000 to run a pipeline from the landfill to its boilers. The landfill donated its methane to the school. The school will save $40,000 per year and the project payback is five years.