Renewable Energy:
A Primer for Massachusetts Campuses

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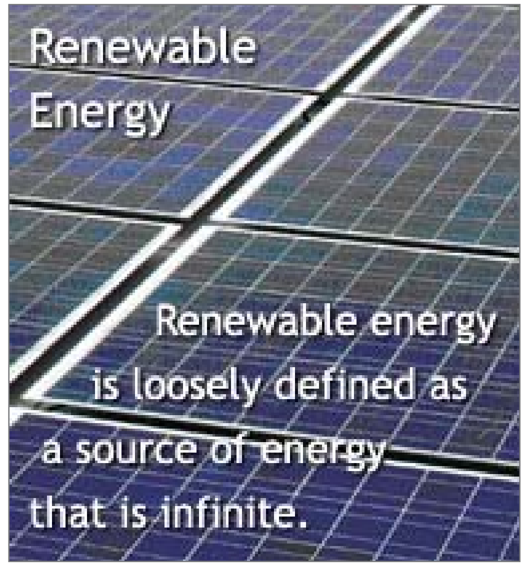
INTRODUCTION

This guide will assist Massachusetts campus facility managers, faculty members, fiscal officers, students, sustainability coordinators, and others to lead their schools forward in on-site renewable energy production and energy independence.

Why Renewable Energy?



A growing body of scientific evidence demonstrates that our reliance on fossil fuels is destabilizing the climate. Greenhouse gas emissions must be reduced in order to avert the worst impacts of global warming. In Massachusetts, global warming will inextricably change the way college campuses are managed; the challenges campus administrators will face are as varied and unpredictable as extreme weather, the spread of insect-borne viruses, sea-level rise, and higher utility bills.

On-site renewable energy installations **provide multiple benefits** at global and local levels:

Energy produced by renewables results in greatly reduced greenhouse gas emissions relative to energy produced from burning fossil fuels.

On-site generation enables campuses to rely less on fossil-fuels, and minimizes the financial and environmental costs of transporting foreign and domestic energy supplies.

On-site renewable energy production is a meaningful way for colleges to help mitigate climate change. Common forms of renewable energy technologies presently in use in Massachusetts state colleges are biomass, solar photovoltaics (PV), solar thermal, and wind turbines. Renewable energy technologies can be used to heat and cool environments, heat water, and generate electricity.

Leading By Example

Innovation is a part of every college and university's mission, making campuses natural incubators for clean-power technologies. Campuses in Massachusetts have always served as leaders and examples for their community neighbors, alumni family and sister institutions elsewhere around the country. In the realm of renewable energy, campuses have the potential to be at the center of regional renewable energy production.

In 2007, in part because so many Massachusetts campuses were already leading the way in renewable energy experimentation and installation, Governor Deval Patrick signed Executive Order No. 484. This established mandatory energy consumption and greenhouse gas **emission reduction goals for all state-owned buildings**.

In order to achieve these goals, **state agencies are required to take a number of steps, including using clean renewable sources for electricity and heating.**

EXECUTIVE ORDER No. 484 requires that state agencies:

- Reduce their overall energy consumption 20 percent by 2012, from 2002 levels, 35 percent by 2020.
- Reduce greenhouse gas emissions 25 percent over the next five years, 40 percent by 2020, and 80 percent by 2050.
- Obtain 15 percent of their electricity from clean renewable sources by 2012, 30 percent by 2020
- Use biofuels for 3 percent of heating oil in winter 2007-08, 5 percent in 2008-09
- Meet Massachusetts's LEED-Plus green building standards for all new construction and major renovations, and consider energy performance in leasing decisions
- Reduce potable water use 10 percent over the next five years, 15 percent by 2020.

In addition to the 29 Massachusetts state college compuses, 16 private colleges and universities in Massachusetts are also ACUPCC signatories. This strong commitment demonstrates Massachusetts's leadership role in mitigating climate change. Find out more about the ACUPCC at http://www.presidentsclimatecommitment.org.

Not only are Massachusetts state colleges and universities leading by example within their communities and their state, **all 29 state campus presidents and chancellors have signed** the American College and University Presidents Climate Commitment (ACUPCC). This voluntary commitment requires that each signatory school reduce its greenhouse gas emissions and ultimately achieve climate neutrality.

Renewable energy installations will be a crucial factor in meeting the greenhouse gas emission requirements of the ACUPCC.

RENEWABLES and the BOTTOM LINE:

Over the life of a renewable installation, on-site renewable energy is less expensive than that produced by fossil fuels. Utility and fuel costs have risen dramatically in recent years and costs will continue to rise. Many financial officers see renewable energy installations as a hedge against increasingly volatile market rates.

But market prices aren't the only thing that will be unstable. Diversified energy systems that supply clean energy can help schools survive prolonged power outages.

Opportunity

Research for the future: The 2007 "America Competes Act" established an Advanced Research Projects Agency-Energy, or ARPA-E, charged with leading U.S. research and development efforts to develop transformative climate and energy technologies capable of meeting future climate and energy challenges. When ARPA-E is funded, colleges and universities will have the opportunity for increased funding in renewable energy research.

Even without national programs like ARPA-E, many Massachusetts colleges have created large renewable energy research, development, and curriculum programs. From designing wind turbines to installing them, Massachusetts state college students are at the forefront of a growing clean energy economy.

Developing a Green Workforce: Students are excited about green careers and seek schools with renewable energy curriculum offerings. Massachusetts' clean energy industry supports 14,400 jobs, and the sector is expected to grow by 20 percent in 2008.*

**Massachusetts Technology Collaborative, "Mass.Clean Energy Industry Census" (Westborough, MA: MTC, 2007): 1.*

PR and Community Relationships

Congressman John W. Olver and Massachusetts State Senator Stephen M. Brewer at MWCC's biomass plant. (Courtesy MWCC)

The threats posed by global climate change and the need to adjust our energy supply to one that is clean and renewable are growing topics of concern and consideration in communities across the country. Installing renewable energy systems provides schools an opportunity to focus the community's attention on the positive steps being taken on campus to address environmental and energy concerns.

Renewable energy projects are attracting the attention of local and state leaders. For example, Congressman John W. Olver and Massachusetts State Senator Stephen M. Brewer toured Mount Wachusett Community College's biomass plant soon after it was opened. Renewable energy installations can foster positive relationships between a school and the surrounding community, building capacity for funding and support for future projects.

Beyond the ribbon cuttings, the outreach and educational possibilities are endless. For example, energy and environmental fairs; groundbreaking and "turn-on" celebrations; media coverage; use in recruiting; fundraising; and parent- and alumni-affairs communications. Mount Wachusett Community College received the Climate Champion Award for campus action from CA-CP in part as a result of their commitment to renewable energy. On-site renewable installations are used in a number of credit and non-credit courses at Massachusetts colleges, talking points used to great advantage in campus outreach efforts and student recruitment.

Look for other outreach ideas in Clean Air – Cool Planet's Renewable Energy Outreach web guide, planned for launch July 2008 (see www.cleanair-coolplanet.org for updates).

Case Study: Cape Cod Community College

Dignitaries at a recent ribbon-cutting ceremony at CCCC cut an orange power cord rather than a ribbon. (Courtesy CCCC)

Cape Cod Community College's renewable energy program has garnered international attention and won multiple awards. CCCC turned the necessity of reducing energy costs, and meeting ACUPCC benchmarks, into an opportunity to attract students, faculty, and funding. CCCC is recognized as a leader in renewable energy education, and many of CCCC's Environmental Technology program graduates go on to work in Massachusetts's expanding renewable energy field.

RENEWABLE ENERGY 101: EVALUATING TECHNOLOGIES

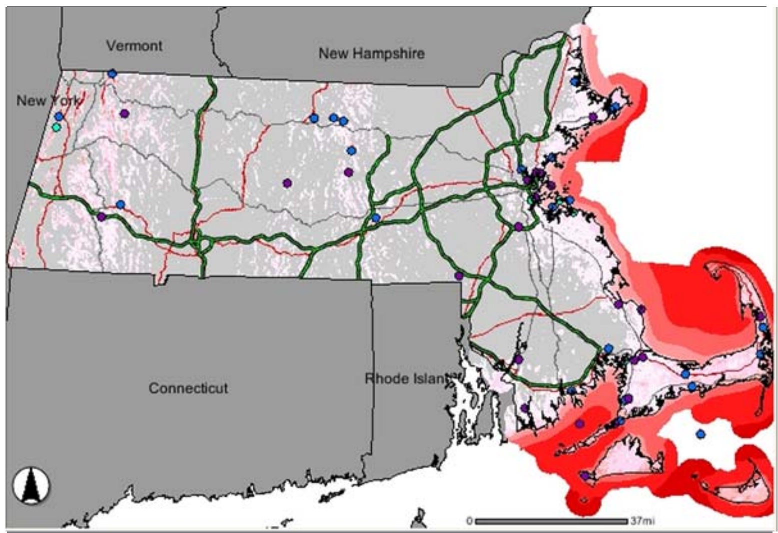
Which renewable energy technology is right for you? The question is a complicated one and a complete answer requires an in-depth feasibility study. We strongly urge you to consider all renewable energy technologies before settling on one for a specific project. That said, there are some general considerations that might help to narrow your selection process.

For example, in considering the installation of a wind turbine, you would first want to ask yourself a few questions:

1. Check out the Massachusetts Wind Map: Are you in an area that has wind speeds of 6 meters per second or greater at a height of 70 meters? (http://maps.massgis.state.ma.us/wind/)

2. Do you have adequate space for a wind turbine (i.e. 1.5x the height of the tower, and 3x the height to neighbors)?

3. Do you have large on-site electrical load capacity?



If you answered no to any of these questions, a large-scale wind turbine might not be right for you.

Keep reading for more questions and rules of thumb and look for an interactive web-based decision making tool from Clean Air–Cool Planet in July 2008.

Feasibility Studies:

1. **Technological Feasibility**: Including site evaluation, location, site ownership, potential negative environmental impacts
2. **Economic Feasibility**: Development costs, construction costs, projected revenues, ROI

The Massachusetts Technology Collaborative (MTC), a quasi-public agency, is the partial funding source for many of the renewable energy projects you'll read about below. MTC provides **financing for feasibility studies** for large-scale electricity-generating renewable energy projects (greater than 10kW). However, MTC aid is only available for campuses that do not receive their electricity from municipal electric departments. If you're not sure if you have a municipal electric provider, find your community on the Massachusetts Electric Utility Map. (http://www.masstech.org/renewableenergy/green_buildings/ElectricUtilityMap.pdf)
MTC feasibility grants are capped at $40,000, with an applicant cost share of 15 percent. Examples of successful feasibility grant applications may be found at: www.masstech.org.

Because of the growing interest in renewable energy among state executive branch agencies, the Massachusetts Technology Collaborative has reached an agreement with a state inter-agency team (including representatives from the Executive Office of Energy and Environmental Affairs (EOEEA), Division of Capital Asset Management (DCAM) and Division of Energy Resources (DOER)), to authorize this team to coordinate all state agency applications for on-site renewable energy grant funds, including feasibility studies, from MTC. (Go to http://www.mass.gov/envir/Sustainable for more information).

Renewable Energy Costs

While renewable energy, heat, and cooling often costs less than that derived from fossil fuels – it still costs money. Although the cost lies primarily with initial expenses such as feasibility studies, design, construction, and special equipment, there are also operations and maintenance (O & M) costs with renewable energy systems. These O & M costs are frequently less than what they might be for a conventional system, but maintenance, insurance, and warranty costs must still be considered.

Of course, not all renewable energy technologies are created equal, nor do they cost the same. In their book *The Business Case for Renewable Energy: A Guide for Colleges and Universities*, Andrea Putnam and Michael Philips compare average first costs for renewable energy systems and average electricity production. According to Putnam and Philips, a solar PV installation in a cloudy environment could cost as much as 64 cents a kilowatt-hour, whereas hydropower could cost as little as 3.2 cents a kWh.1 Solar (PV) panels have a higher cost per kWh, but **PV is the most frequently employed renewable energy technology**. Why is that?

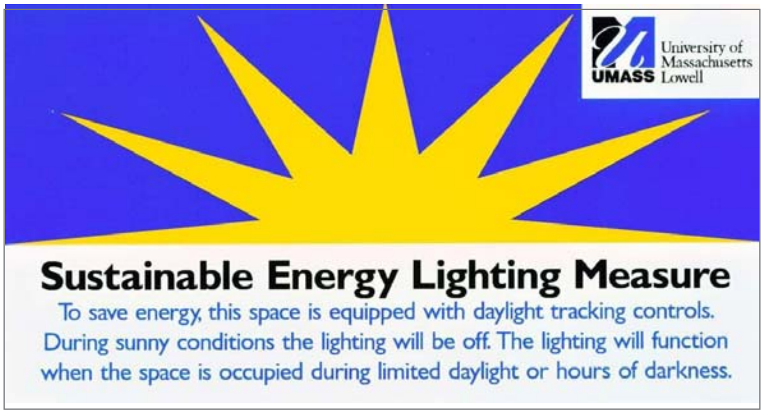
PV panels are easy to install and are the most flexible in their application. PV installations can vary in size and can be accommodated on most campuses. PV panels also have very little negative environmental impact. Although hydropower might generate more electricity than a comparable PV installation, fewer schools have the opportunity to take advantage of hydropower and even fewer would receive the necessary federal approvals. There are many more siting and environmental concerns with hydropower than solar.

Most importantly for the bottom-line, there are many **grants and incentives** for PV installations. Many Massachusetts schools have successfully installed renewable energy technologies using multiple sources of funding ranging from grants to bonds to capital campaigns. Read more about the range of renewable energy funding opportunities below, and remember to compare renewable energy first costs before and after calculating funds from incentives and grants.

Dave Kiser, Director of Physical Plant, UMASS Lowell:
"Renewable energy will be most attractive when coupled with effective energy management and conservation programs so that renewables make their maximum contribution to our total energy needs while minimizing their required infrastructure."

Energy Efficiency: The First Renewable

Campus buildings consume vast amounts of energy, a situation that is unlikely to change in the near future. Many schools have created successful energy conservation programs which ask students and staff to turn off computers and lights. Some colleges now require students to reduce plug-loads in dormitories, leading many students to remove refrigerators and televisions. Conservation measures alone save the **University of Buffalo** $2 million a year. Despite conservation measures, campus culture requires that libraries be open late at night, shower water be warm on demand, and classrooms be equipped with multi-media presentation equipment. These high-energy requirements mean that even campuses with robust renewable energy generation programs will not be able to meet energy demand with onsite generation without significant energy efficiency renovations.



Energy Efficiency: "Not Sexy"

Many schools have paired renewable energy installations with energy efficient renovations. This coupling provides a visual symbol and assists in increasing community buy-in for energy efficient measures which are most frequently invisible. Photographs of PV panels lend themselves to brochures and websites much more readily than photographs of heat exchangers--but both are vital!

Springfield Technical Community College has coupled a PV installation with energy efficiency measures ranging from lighting sensors, variable frequency drives in motors and pumps, a computerized energy management system, electric meters on each building, and white roofs on all academic buildings.

UMASS Lowell's physical plant team has found ways to call attention to their energy efficient measures. For example, the team created signage to accompany automatic daylighting sensors. Now students, staff, and faculty using those spaces are reminded of the campus's ongoing energy efficiency projects. In this way, UMASS Lowell has generated interest and institutional support for their very significant financial savings.

BIOMASS

Biomass is a general term that refers to a range of fuel types as well as a range of conversion and power generation facilities. Biomass fuel could be anything from lumber mill scrap to agricultural waste to landfill gas. Successful biomass power generation projects require a steady supply of a local or on-campus biomass.

THE ABCs OF BIOMASS

***BIOGAS**:* Methane is produced when organic materials decompose in oxygen-poor environments. In landfills, methane is typically released into the atmosphere. But when captured and burned, biogas can be a potent fuel. Landfill methane now provides more than 80 percent of the University of New Hampshire's electricity at the Durham campus.

***BIOMASS GASIFICATION**:* Biomass is converted into a synthetic gas that is subsequently burned to generate energy.

COGENERATION: For schools that generate on-site heating and cooling in centralized plants, equipment can be installed that generates both electricity and heat. This process is called cogeneration or CHP (combined heat and power).

Smith College in Northampton, MA replaced its 60-year-old steam plant with a 3.5 MW single-boiler CHP system in summer 2007. The $11.5 million system will provide 70 percent of campus's electrical needs, save an estimated $1.8 million a year in costs, and cut greenhouse gas emissions in half. The project's payback period is seven years.

Mt. Wachusett Community College (MWCC) replaced its electric heat plant with a biomass heating plant that uses woodchips, switch grass, and other organic matter for fuel. The facility provides 85 percent of the campus's heating needs and reduced on-campus electrical consumption by 46 percent. Of the initial $4.3 million first costs, the campus borrowed only $1.87 million. The rest of the first costs were paid for by the U.S. Department of Energy, Massachusetts Renewable Energy Trust Fund, and utility rebates. MWCC projects an **annual cost savings** of $396,800, a l**ower operating budget** than that of its conventional plant, and a **five year simple payback** on the loan. Biomass, like other renewable energy technologies, has applications at various scales. Even if a large scale biomass plant is not feasible on your campus, consider a small scale application. A wood pellet furnace, for example, might be a good alternative for a building that is not part of a central heating system.

The conversion to biomass has cut the college's carbon footprint by 22.5 percent, slashed electricity usage by 38 percent, and water usage by 52 percent. The facility has saved the college $2.4 million since its installa-tion in 2003. (Photo courtesy Mount Wachusett Community College)

Financing Biomass Projects
(See Financing Options on page 16)

- Federal
- MTC
- Renewable Energy Certificates (RECs)

FUEL CELLS

Fuel cells create electricity through an electrochemical process in which hydrogen and oxidant (air) combine in a catalytic reaction. The hydrogen can be supplied as a pure gas or reformed from hydrocarbons such as natural gas. If the hydrogen is created from fuel that is carbon neutral, then the energy made by the fuel cell is considered carbon neutral. The University of Massachusetts at Lowell's Center for Electric Car and Energy Conversion has a number of on-going fuel cell production experiments.

Fuel cell energy production is measured at UMASS Lowell's Center for Electric Car and Energy Conversion ***(Courtesy UML)***

Learning Renewables at UMASS Lowell

UMASS Lowell's Center for Electric Car and Energy Conversion (EC&EC) has an MS and PhD program enabling students to study the creation and storing of renewable energy.

UMASS Lowell's Center for Sustainable Energy takes students on service learning trips where they install solar panels for vaccine refrigeration in remote parts of Peru.

GEOTHERMAL

Some argue that geothermal heat pumps do not qualify as renewable energy technologies because electricity is required to run the pump. Although this is true, **geothermal energy is a viable greenhouse gas reducing strategy** for many campuses.

Geothermal systems, or ground source heat pumps (GSHPs), use the constant temperature of the earth as an HVAC system. While Massachusetts experiences seasonal temperature extremes, the ground several feet below the surface remains at a relatively constant temperature. This ground temperature is warmer than the air above it during the winter and cooler in the summer. A GSHP takes advantage of that variant by exchanging heat with the earth through a ground heat exchanger. The GSHP system delivers heated or cooled air through a building in the same manner asa typical HVAC system.

According to the U.S. EPA, geothermal systems can reduce heating energy consumption (and greenhouse gas emissions) up to 44 percent. And geothermal systems use 72 percent less energy than comparable cooling systems.

SITING: The specific geological, hydrological, and spatial characteristics of your land will help determine if geothermal is right for your site, and which kind of system would work best. Composition of soil, presence of surface water, and availability of land all determine geothermal cost effectiveness.

Financing Geothermal Projects (See Financing Options on page 16)

- There are currently no financial incentives available for the installation of geothermal systems, but geothermal systems can be an economical choice.
- Systems can be costly but first costs are generally paid back within 5 to 10 years. System life of the underground components is typically 50 years or more, much longer than a comparable HVAC system.
- Geothermal systems require less ongoing maintenance than conventional systems, making long-term savings from geothermal installations much more significant.

Case Study: The Noble and Greenough School

The Noble and Greenough School in Dedham installed a geothermal system in 2007. Projected savings for the middle school are $17,000 a year. Although the system cost $723,000 (about $100,000 more than a conventional HVAC system) the additional first costs will be recouped in six years.

GHP heating efficiency is measured by its coefficient of performance (COP). The COP is the ratio of heat provided in Btu per Btu of energy input. Cooling efficiency is indicated by the Energy Efficiency Ratio (EER), the ratio of the heat removed (in Btu per hour) to the electricity required (in watts) to run the unit. Look for a GHP with a COP of 2.8 or greater and an EER of 13 or greater.

HYDROPOWER

Hydropower uses the power of fresh water flows to produce electricity. Most Massachusetts industries were built on hydropower in the 19th century; mill complexes centered around rivers and water wheels are iconic Massachusetts images. Hydropower technologies have been updated since that time and many new and renovated hydropower sites are supplying electricity. These updates were crucial because, in addition to necessary modernization, conventional hydropower facilities destroyed natural habitats and inhibited the movement and migration of wildlife.

Hydropower is different from other renewable energy technologies in that it is fueled by, and can produce, a relatively constant stream of power. Other renewable energy technologies, such as wind turbines, only produce power intermittently. Of course, drought conditions can make hydropower just as variable as wind or solar power.

The Other Hydropower: Wave and Tidal Energy

Tidal and wave technologies convert the kinetic energy of moving water into electricity. Ocean thermal systems tap the solar heat absorbed by marine waters to generate clean energy. Wave energy captures the kinetic energy produced by the up-and-down movement of waves.

There are a number of ongoing projects in New England to explore the wave and tidal energy production. Although there are few tidal or wave systems producing energy in the United States, these technologies are growing rapidly.

Financing Hydropower Projects (See Financing Options on page 16)

- First costs are generally high but hydropower facilities have long life cycles and O & M costs are typically low.
- MTC / DCAM
- RECs
- Federal

SOLAR

Solar energy can be harnessed in many ways, including solar power concentrator systems, passive solar heating and daylighting, photovoltaic systems, and solar hot water systems.

Solar energy can mean small-scale or large-scale applications. Because solar technologies are constantly evolving, this report will only discuss those employed most frequently at Massachusetts state colleges — photovoltaics and solar hot water. That said, we urge you to explore other emerging technologies. It's hard to

Solar powered trash compactor at MMA. (Courtesy

stay abreast of the multiple technologies and finance opportunities, but students can help keep you up to date. Don't forget to tap their research expertise when exploring on-site renewable options!

Photovoltaics

Photovoltaics (PV) enable the direct conversion of sunlight into electricity. Some PV modules are integrated into the building components, such as roofing and wall glazings (these are often referred to as building-integrated photovoltaics).

The **performance of a solar cell** is measured in terms of its efficiency at turning sunlight into electricity. A typical commercial solar cell has an efficiency of 15 percent—about one-sixth of the sunlight that hits the panel is turned into electricity.

PV modules are made out of materials similar to those used in computer chips. When sunlight is absorbed by the PV component, electrons flow through this chip-like material to produce electricity.

The process of converting light (photons) to electricity (voltage) is called the photovoltaic (PV) effect.

SITING: Panels can be either ground mounted or installed on roof-tops. Rooftop installation minimizes the potential for vandalism. But rooftop installations require that a roof not only get enough sunlight, but also withstand the weight of an installation.

Many schools choose roof-top PV panel systems because they tend to be less expensive to install. Because of their modular construction, initial PV systems can be modest in size and are easily expanded over time. However, small installations have been employed in surprising places! The **Massachusetts Maritime Academy** powers trash compactors with small PV panels.

The Massachusetts Executive Office of Energy and Environmental Affairs has created a **Solar Site Assessment guide.** This great resource will help you determine if a solar installation is right for your campus. The guide is available on-line at http://www.mass.gov/envir/Sustainable/documents/pv_site_selection_survey.doc.

Case Study: Massachusetts College of Liberal Arts

MCLA's Venable Hall was an ideal site for a solar installation because of its sunny location and visibility to the campus community. Venable Hall's 9-kilowatt PV system was manufactured by RWE, a Massachusetts solar technology manufacturer.

MCLA uses the electricity produced by the PV system in its campus buildings, and perhaps more importantly, as an onsite pedagogical resource for students studying renewable energy.

The Center for Ecological Technology (CET) coordinated the installation using funds from the MTC Renewable Energy Trust and the U.S. Department of Energy.

SOLAR-THERMAL

Solar-thermal devices directly absorb the sun's radiation in order to heat air or water for use in a building. Open loop solar systems heat water as it is piped through a rooftop collector; these systems must be drained in the winter. Closed loop systems circulate antifreeze through the solar collector; the heat is then exchanged in a conventional water heater. Closed loop systems operate year round.

UMASS Lowell is currently in preliminary stages of evaluating a solar-thermal system to heat water in its pool complex.

While there are no direct financial incentives available for solar thermal systems, many schools have still found them **cost-effective alternatives** to natural gas or oil-heated water systems. And with the constant increase in natural gas and heating oil prices, solar thermal systems will be more widely incorporated into campus design. Solar thermal systems are especially cost effective for buildings with year-round hot water demand.

Environmental Studies students at MCLA studying the onsite installation (Courtesy MCLA)

Financing PV Projects (see Financing Options on page 16)

- Commonwealth Solar
- RECs
- CREBS

WIND

A wind energy system transforms the wind's kinetic energy into mechanical or electrical energy. Wind energy may be captured by both small and large-scale turbines.

Small Wind

UMASS Lowell currently has three small-scale turbines installed and is evaluating the energy production of the different models. Small turbines are typically installed on the rooftops of buildings. Because many first costs are standard despite the size of the installation, schools often opt for larger installations to get a greater return on their investment. Rooftop installations can provide a surprising amount of energy, however, and as new small-scale technologies are tested, there will be more viable small turbine options. Small wind-systems can be good complements to other renewable installations such as PV or geothermal.

Big Wind on Your Campus

Wind installations demand specific reqiuirements. Large turbines require an adequate amount of space and wind. But they also have other less obvious requirements. Feasibility assessments must address local utility distribution, permitting variances, soil quality, environmental impact, noise, and regional bird and bat flight migration patterns.

Financing Small Wind Projects (see Financing Options on page 16)

- MTC Small SRI program
- RECs

Utility-grade Turbines

Because wind is an intermittent source of power, the actual power production is between 15-30 percent of the rated capacity (i.e. a 1 MW turbine would have an average output of 0.15 to 0.3 MW).The rated capacity of large commercial turbines generate between 500kW and 4.5 MW of electricity. Rated capacity measures the amount of electricity that would be generated under ideal conditions. The rated capacity of large commercial turbines is between 500kW and 4.5MW of electricity.

Case Study: The Massachusetts Maritime Academy

Facing staggering operating costs due to its high electricity demands, **Massachusetts Maritime Academy** turned to on-site electricity production in order to reduce costs. Wind energy was deemed a good choice for the campus's coastal location. After a feasibility study and environmental impact assessment, the large utility-grade turbine was installed in 2006. Since its installation, the 660 kW turbine has produced over 1 million kWh a year, and has **saved the school $160,000** annually. The school reports that in the turbine's first 15 months of operation, 690 tons of CO_2 were avoided. An online monitor shows daily, monthly, and yearly totals of power produced. (www.maritime.edu/12.cfm?page=160)

The school expects an **additional revenue** of $86,000 from **energy sales to the grid** and the sale of **renewable energy credits** into the Massachusetts REC market. MMA was awarded a $500,000 construction grant from the Massachusetts Technology Collaborative. With the sale of RECs, the payback period on the school's remaining first costs was reduced to a mere 5 years.

MMA Environmental Engineering students with the newly installed turbine **(Courtesy MMA)**

"This turbine is an example of how the environment, economics and education come together. Our cadets will have the benefit of learning about this innovative technology, our campus will save money, and we do our part for the planet. A win for us all."

MMA President Richard Gurnon
(reprinted in State Sustainability 4, 2006)

Financing Large Wind Projects

- First costs are generally high but hydropower facilities have long life cycles and O and M costs are typically low.
- MTC / DCAM
- RECs
- Federal

RENEWABLES "ON THE GO"

Changing fuels in campus fleets, or switching the entire fleet to renewable vehicles, will also go far in reducing campus costs and greenhouse gas emissions. Although some conversions are costly, the steady increase in fossil fuel prices means that these first costs are recovered more quickly. To cite just one example, **Cape Cod Community College**'s facilities department uses electric-powered golf-cart trucks. The electricity used by the fleet is generated onsite by PV panels. Thus the only ongoing costs for the facilities fleet are occasional vehicle and PV panel repairs!

CCC's facilities team travels around campus in solar-powered golf carts. (Courtesy CCC)

Higher-powered trucks or cars might be necessary for some campus facilities and police work, but many purchasing managers have found that switching conventional vehicles to biodiesel is a cost-saving compromise. Biodiesel comes in many grades – from B5 (5% biodiesel, 95% diesel) on up. Many campuses have found that the most efficient way to fuel the fleet is to convert used vegetable oil from campus cafeterias into biodiesel, though care to ensure quality is essential.

ON-SITE: TAKING THE NEXT STEP

There are a number of resources available to state campuses considering renewable energy installations. Now that you have a sense of your options, and which technologies might work on your site, contact the Executive Office of Energy and Environmental Affairs (EOEEA). EOEEA can provide guidance on site evaluations, choosing a consultant, and working with a contractor. See EOEEA's website for more information: http://www.mass.gov/envir/Sustainable/pdf/07_renewable_funding_guide.pdf.

FINANCING OPTIONS

FEDERAL

1. CREBs (Clean Renewable Energy Bonds)**:** The Energy Tax Incentives Act of 2005 helped governmental agencies and electric cooperatives finance clean renewable energy projects. CREBsare issued with a 0 percent interest rate; the borrower pays back only the principal of the bond, and the bondholder receives federal tax credits in lieu of the traditional bond interest. Although many renewable projects were eligible for CREB financing, funding is first awarded to the smallest qualified projects (consequently solar energy projects are most likely to be funded because they require the least capital investment).

CREB financing in Massachusetts was organized by Mass Development. **The CREB program is currently unfunded but most anticipate the program will be renewed soon, or that other incentives will become available in their place**. See www.massdevelopment.com for updates.

2. The Department of Energy is a major provider of funding for basic and applied research for converting biomass resources to biofuels. Many financial assistance opportunities are available for small to large-scale research activities. The DOE's e-center site (http://e-center.doe.gov) contains information on renewable energy funding opportunities.

STATE

1. Renewable Energy Trust Fund: As part of its November, 1997, electric utility restructuring legislation, Massachusetts created public benefit funds for renewable energy programs. The Massachusetts Technology Collaborative (MTC) is administering this Renewable Energy Trust. MTC's current programs include grants for large-scale renewable electricity producing technologies. As part of the Large Onsite Renewable Initiative (LORI), colleges may apply for aid to complete feasibility studies, design, and construction of renewable installations.

For projects greater than 10 kW, applications are processed by a Massachusetts Intergagency team. Go to http://www.mass.gov/envir/Sustainable/pdf/07_renewable_funding_guide.pdf for more information.

2. MTC's Small Renewables Initiative (SRI): SRI provides rebates for the installation of wind systems up to 10 kW. The applicant must be a customer of a Massachusetts investor-owned electric distribution utility. Go to http://www.masstech.org/renewableenergy/small_renewables.htm for more information.

Other Options

1. Renewable Energy Certificates (RECs): RECs are certificates issued by clean power producers (in this case, your campus) that make the *environmental benefits* of clean power a saleable commodity. The sale of RECs can be used to finance on-site energy production and offset first costs; for example, the sale of RECs helped finance Massachusetts Maritime Academy's wind turbine. However, selling the rights to the pollution avoided means that you will be unable to count those GHG reductions in your campus's own climate neutrality calculations.

2. Utility Rebates: Most utilities offer energy efficiency and renewable energy incentives to homeowners and businesses within their region. Check with your service provider to see if your campus is eligible for aid.

3. 3rd Party Financing: The third-party service model allows a college or university to use electricity generated on campus with no upfront costs. A third-party company owns and operates the system, and assumes all risk. Your school will have to pay for the electricity produced on site – but at a long-term fixed price (typically lower than conventional electricity costs).

IT'S BUILT. Now What?

Many Massachusetts schools are using renewable energy installations in student **recruitment, fundraising initiatives**, and **curriculum development**. The common denominator is student interest: students want to attend schools that are playing a role in the battle against global warming and many students want to major in fields that explore renewable energy technologies.

FACULTY and FACILITIES teams

Student-faculty research projects can explore the potential of various renewable energy technologies on campus. Faculty can be great allies for facilities managers hoping to finance renewable energy projects since many labs and courses could use onsite installations as learning tools.

Cape Cod Community College faculty and students install a small turbine.

RESOURCES

AASHE: The Association for the Advancement of Sustainability in Higher Education, is a member organization of colleges and universities in the U.S. and Canada working to create a sustainable future. (www.aashe.org)

ACUPCC: The American College & University Presidents Climate Commitment is a high-visibility effort to address global warming by garnering institutional commitments to neutralize greenhouse gas emissions, and to accelerate the research and educational efforts of higher education to equip society to re-stabilize the earth's climate. (Www. http://www.presidentsclimatecommitment.org)

The Center for Energy Efficiency and Renewable Energy (CEERE) at UMASS Amherst provides technological and economic solutions to environmental problems resulting from energy production, industrial, manufacturing and commercial activities, and land use practices. (http://www.ceere.org/rerl/)

Clean Air-Cool Planet: Clean Air-Cool Planet is the leading science-based, non-partisan, non-profit organization dedicated solely to finding and promoting solutions to global warming.

Conservation Services Group, Inc. (CSG), based in Westborough, is a nonprofit corporation that specializes in the design, development and delivery of energy efficiency and renewable energy programs for utility companies, public housing authorities, public agencies, and private clients. (http://www.csgrp.com/)

The Database of State Incentives for Renewable Energy (DSIRE) is a comprehensive source of information on state, local, utility, and selected federal incentives that promote renewable energy. (http://www.dsireusa.org/index.cfm?EE=1&RE=1)

Egan, David J., Julian Keniry, and Justin Schott, "Higher Education in a Warming World." (Reston, VA: National Wildlife Federation, 2008) Available at http://www.nwf.org/campusEcology/BusinessCase/index.cfm

Leading by Example: The Leading by Example Program was created by Executive Order No. 484, issued by Governor Deval Patrick on April 18, 2007 to help state agencies minimize the environmental impacts of their operations and activities and to promote innovative solutions to critical environmental problems. (http://www.mass.gov/envir/Sustainable/default.htm)

Massachusetts Technology Collaborative (MTC) The Massachusetts Technology Collaborative is the state's development agency for renewable energy and the innovation economy, which is responsible for one-quarter of all jobs in the state. MTC administers the John Adams Innovation Institute and the Renewable Energy Trust. (Www.mtpc.org)

Northeast Sustainable Energy Association (NESEA) is the Northeast's leading organization of professionals working in sustainable energy, whole-systems thinking and green technologies. NESEA advances the adoption and practical application of sustainable, low carbon energy practices. NESEA accomplishes this through a number of ongoing programs and annual events. (www.nesea.org)

Putnam, Andrea and Michael Phillips. The Business Case for Renewable Energy: A Guide for Colleges and Universities (Alexandria, VA: APPA, NACUBO, SCUP, 2006).