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Considering Renewable Energy: Solar and Wind

by

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Now is an especially interesting time to think about investing in renewable energy on campus. While we do not know yet what a truly "green economy" will look like, many in the government and private sector are envisioning and promoting it. New financial incentives from local, state, and federal governments, as well as utilities, are available even to tax exempt institutions in many cases as the push to "green" America grows. According to a June 2011 report from the U.S. Department of Energy, renewable energy sources supplied 14.3% of electricity to Americans in the first half of 2011.[1]

What are the primary reasons for choosing to invest in renewable energy?

1- To significantly replace your school's conventional, carbon-based energy with clean energy and decrease the school's environmental impact. This is a laudable goal for any school considering investing in renewable energy. Even a small installation will have some effect on reducing conventional energy[2] and carbon emissions. In addition, it will support a growing renewable energy economy.

2- To provide a "pilot" project to the school community for its educational value. For some schools this will be the primary reason to invest in renewable energy. It is an opportunity both to study (perform ongoing monitoring and research) and to model environmentally responsible behavior. Such projects are usually quite visible on campus and tend to raise awareness school-wide.

3- To save money. This depends on several factors that will be addressed below. Though money-saving opportunities are available in some instances, investing in renewable energy is not always done to save money and may entail higher costs.

4- To enhance your school's image and help differentiate it from other schools. Supporting

[1] Conventional hydroelectric sources provided 8.9 percent of the total, while other renewables (biomass, geothermal, solar, and wind) and other miscellaneous energy sources generated the remaining 5.4 percent of electric power. See Electric Power Monthly September 2011. U.S. Energy Information Administration, Office of Electricity, Renewables & Uranium Statistics U.S. Department of Energy Washington. This report is available on the Web at: http://205.254.135.24/electricity/monthly/current_year/september2011.pdf.

[2] Conventional energy is derived from the mix of sources used by utilities in a school's area and often includes large percentages of carbon-based fuels such as coal, oil and natural gas.

green power may increase the school's competitiveness by enhancing its marketability and credibility among stakeholders.

Costs and benefits of renewable energy installations using solar photovoltaic (PV) power as an example[3]

The figures below are rough estimates to give readers a sense of orders of magnitude and will vary greatly depending on geography, site and system characteristics, and other factors.

For a 2 kW_{DC} "pilot" installation, which would be done principally for education and promotion of sustainability (as opposed to meaningful economic or climate effects), the cost could be about $10,000 to $14,000 and the output would be about 2,700 kWh in year 1, declining over time. Based on the three school sizes described in footnote 3, n year 1, this would supply 1% of the small school's annual electricity consumption in year 1, .15% of the mid-sized school's consumption, and .04% of the large school's consumption. Note: The electricity output figures here would be representative of a roof-mounted system in an average U.S. area. Northern and cloudy areas would likely see lower output, and southern sunny areas would see higher output.

For a 50 kW installation, the cost could be about $225,000 to $275,000, and the output would be about 67,500 kWh/yr. In year 1, this would account 27% of the small school's consumption, 4% of the mid-sized school, and 1% of the large school's annual electricity consumption.

For a 150 kW installation, the cost could be about $600,000 to $800,000, and the output would be about 202,500 kWh/yr. (This would not be feasible for the small school.) In year 1, this would supply 11% of the mid-sized school's consumption, and 3% of the large school's consumption.

If a school is planning to build a green building, then it would be feasible to include a solar or other renewable energy installation as part of the project. A LEED certified building, for example, will garner extra points for doing so. Such an installation could generate significant energy to help run the building and would certainly provide ample educational opportunities.

While wind energy projects are less popular among schools than solar PV projects, they can be an excellent choice. Wind projects can generate more electricity per acre of land than solar and often have lower installation costs. They may also be practical in certain areas without strong sunlight, but with strong and consistent wind speeds. (See the Falmouth Academy example in the Appendix below.)

Seek expert advice

If a school is interested in considering a renewable energy installation, whether large or small, then it should seek expert advice in the following areas:

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[3] The following data are based on three actual independent schools that can be classified as small, mid-sized, and large. Small school example: total square footage of building = 32,000 sq ft; total electricity use per year = 250,000 kWh/yr. Mid-sized school example: square footage = 183,000 sq ft; electricity use = 1,777,418 kWh/yr. Large school example: square footage = 627,000 sq ft; electricity use = 6,379,126 kWh/yr.

1- *Strategic*: What is the school looking to accomplish with a renewable energy investment and what system and approach, if any at this time, fits the school's sustainability goals?

Research the technical specifications of the products you are thinking of buying and make sure they have been independently tested and verified. There are always new products hitting the markets, especially when it comes to wind turbines, and the last thing you want is to install a turbine that is not performing to its advertised performance level. Ask the retailer for clients who have already installed similar equipment and call them to find out if they are happy with the performance of the turbine or PV system.

2- *Technical*: How will systems under consideration work? What are the safety, zoning, design, permitting, utility connection, and siting issues involved?

Siting issues – suitability of physical plant and campus – are among your first critical considerations for going forward with renewable energy. For solar installations big, open (from tree or building shading) roofs with many years left on their warranties work well. Ground-mounted arrays are also popular. There are comparable siting issues for wind, geothermal, and other renewable sources. These factors will drive what renewable sources will best fit (economically and operationally) any given school.

If you are considering a wind turbine, visit a location where one is installed to get an idea of how it will look, how big it is, and how noisy it might be. Unless you live in a rural location, there will be community members who will oppose the installation of large turbines. Make sure you choose a turbine company that will work with you to educate the community about the turbine and take care of all the permitting issues. Have a rendering done showing what your campus will look like with the turbines installed and get that out in the community so you can get their response prior to committing to the project

3- *Legal*: Operation & maintenance obligations, warranties, in-depth review of any power purchase agreements, how a change in ownership of the renewable provider is handled, etc.

4- *Economic*: Modeling the investment vs. conventional power; lease vs. buy decision; comparing competing offers through an RFP or otherwise; impact on school balance sheet and operating costs; financial standing of solar provider.

Financing Capability – Broadly speaking, schools will either lease or buy renewable installations. For small, pilot installations, they will typically purchase them (with or without some loan) or have them donated. For larger installations that would make a dent in school-wide energy usage, as described above, the capital costs can be quite large (sometimes $1 million or more). The school will either need to obtain the capital on its own or enter into a long-term lease (15-year to 25-year) with a firm that would own the installation. These leases are often structured as "power purchase agreements" (PPAs) and specify the price and other conditions for operation of the installation. In either case, the school's financial strength will affect the availability and pricing of its renewable options. (See item D in the Appendix for an example of a school district's PPA with a solar power company.)

Understanding State-, Local-, and Utility-Specific Renewable Economics – The key here is determining how a given renewable energy investment will compare, in an estimated fashion over its life, to the cost of conventional energy. Conventional energy costs vary widely from state to state, and even vary from utility to utility within a state. They can vary from about 5 cents per kilowatt hour to 25 cents or more, and some utility rates have especially large charges for high, peak summer demands.

Likewise, state and local incentive programs for renewables vary widely. Some areas have programs that, when combined with the uniform and fairly generous federal programs, can drive down the cost of renewable power close to or even lower than existing conventional sources. In other regions, renewable power can be two to four times as expensive as conventional power. Also, some utility's rules make renewable installations connected in any way to utility power sources prohibitive or very difficult to operate, or place restrictions on the price credit received when an electricity meter spins backwards due to the presence of on-site renewable generation. (For information on incentive programs in your state, see the "Database of State Incentives for Renewables and Efficiency" in the Resources section below.)

All things being equal, a school in a state with high conventional power costs and generous state, local, and/or utility incentives for renewables (e.g., Maryland, New Jersey, Massachusetts, or California) will see much better relative economics for renewables than a school in a low-cost power state with limited renewable incentive programs.

Complicating the effort to determine the relative economics of renewable energy further is the fact that both conventional energy costs and incentive programs may change dramatically over the 20- or 25-year life of renewable installations (or even within the next year).

So, from an economics perspective, it is critical that a school know its conventional power costs today and where they have been in the recent past, and understand available incentive programs that drive down renewable costs. From there, forecasting future utility prices will inevitably play a larger role than decision-makers at schools would probably like. Make sure that any assumptions about future electricity rates and school energy usage from renewable providers or advisers are clearly explained.

Maintenance Costs – Finally, do not forget to consider maintenance costs when factoring in the total cost of the project. Traditionally, PV systems and solar water heating have very low maintenance costs and can last 25 years. Wind turbines have a lower initial capital outlay, but have higher maintenance costs over the life of the unit. If you purchase a wind turbine, you will either have to do the maintenance yourself or pay a third party to do it for you. If you go with a power purchase agreement, the renewable provider usually takes care of the maintenance, and it is in the provider's best interest to make sure it is working 100% of the time as you only pay the provider when the system is operational.

Another Option: Collaborative Purchasing of Renewable Energy

Increasingly towns, cities and institutions are working collectively to purchase renewable energy. Several schools in San Francisco, for example, have joined together to invest in solar power. As a group, the schools offer many potential installation sites and can arrange joint financing of the project. With more competitive bidding and greater scale, the costs are lower per school, whether they are leasing or purchasing directly. The Environmental Protection Agency is currently providing information to schools that wish to pursue collaborative purchasing (see "Clean Energy Collaborative Procurement Initiative" in the Resources section below).

Conclusion – A Prescription for Moving Thoughtfully Towards a Greener Future

Perform an initial, at least informal, assessment of your renewable energy choices as part of a broader review of sustainability goals and practices. Figure out what your basic choices are (types of systems, their costs and financing, comparisons to your normal utility costs, special technical or other challenges you would face). Start to narrow the field, deciding what sorts of options would work under the right conditions and which are off the table. As a rule, bigger schools will have more choices and, all things equal, better unit pricing due to economies of scale. Schools with peak electricity usage during sunny summer afternoons will benefit more from solar power than those with flatter loads. Make any commitments with your eyes wide open and move at a pace that provides comfort.

Appendix – Case Examples

(A) Falmouth Academy (Falmouth, MA) [*solar and wind*]

Solar Installation

In 2010, Falmouth Academy installed a 77kW PV system under a 10-year lease agreement. Their monthly payment is $1,523 ($18,276 a year). Using a 5 year average of $.17/kWh, this is fairly close to what the school would be paying their local utility company for the electricity that the system produces. This system is providing about a third of FA's electricity needs. It produced over 102,000 kWh in the first year of operation. The school also sells the renewable energy credits (RECs), which, as of early 2012, are only worth about $.02/kWh (1,000 kWh = 1 REC). The market looks more promising for the future. (For a detailed description of RECs, see the Dalton example below.)

The initial installation cost was $478,000. After year 10 the school will probably buy the system for $90,000. Under the assumption that electricity rates stay where they are, the school will start seeing significant savings after year 15. The school should save about $19,000 a year. The system has a life expectancy of 25 to 30 years and if rates increase or if REC values increase the financial benefits will be even greater.

After just under 14 months of operation, the system offset over 140,000 lbs. of carbon dioxide, which has stirred up the interest of many students for science projects related to solar energy and has created a number of math class based projects that are using the system's data and projected output for financial and environmental analysis.

Wind Turbine

Falmouth Academy's wind turbine has been an excellent demonstration project. Several math classes have analyzed the data, consistently proving the manufacturer wrong. While the installer's and manufacturer's estimates projected approximately 13,000 kWh/year, the students correctly predicted closer to 4,000 kWh/year.

Contact: Richard Sperduto, director of buildings and grounds, rspud@cape.com.

(B) Hawaii Preparatory Academy (Kamuela, HI) [*solar and hydro*]

(HPA) began investing in renewable energy back in 2006 when the school launched its Go Green initiative sparked by concern from students that HPA was not doing enough to support sustainability. Through the Go Green initiative, the school attracted several donors who enabled the school to move forward in reducing the school's dependency on non-renewable energy sources. In 2007, HPA hired a sustainability consulting firm to hold an "energy charrette" comprised of representatives from senior administration, faculty, maintenance, students and parents. Together, the group came up with a five-year plan to decrease its dependence on conventional energy and become "energy neutral" by 2012. Several projects resulted:

1. Energy Lab – Completed in January 2010, this 3,500 square foot building is devoted to renewable energy, sustainability and energy monitoring of the HPA campus as well as other off-campus projects. It includes design breakout rooms, an open classroom for research on renewable energy projects, and a workshop for project construction. The Center is LEED Certified Platinum as well as the first K-12 school facility to meet the Living Building Challenge accreditation. It is completely water, waste and energy efficient, exporting over half of its energy to help offset the campus electrical needs.

   The building has 26 kW of PV installed in three arrays: 60 Sanyo 210 Watt panels with standard SMA inverters; 48 of the same panels with attached enphase inverters; and 16 Sanyo HIT bifacial panels into a standard SMA inverter. The design team chose different panels and arrays for student research and comparison. The building averages between 90 and 155 kWh per day, which means about 5.5 solar hours per day on a good day. The lab also has temperature sensors under each panel to determine heat impacts on efficiency, and thermal sensors in all inverters to track heat lost there. It has UV and shortwave visible Pyrometers as well, to track incident solar insulation, determining panel efficiency constantly.

2. Pump Storage Hydro – HPA is fortunate to be located on land that could facilitate a pump storage hydro system where water would be pumped up a mountain to a large storage tank when energy is in surplus and released downhill when needed on campus.

3. Sustainable Faculty Cottage – HPA has invested in a faculty cottage that has a 2 kW solar photovoltaic (PV) system on its roof and a solar thermal water heater. The building is energy neutral and used for data gathering and educational outreach purposes.

The school's long-term goal is to produce enough renewable energy every 12 months to compensate for its current expenditure of $45,000/month for electricity (110,000 kWh/month), where the cost for electricity runs between $0.45 and $0.52 per kWh.

Contact: Dr. Bill Wiecking, Director, HPA Energy Lab, bill@hpa.edu.

(C) Dalton School (New York, NY) [*renewable energy certificates (RECs)*]

The Dalton School, located in the heart of Manhattan, purchased more than 2.5 million kilowatt-hours (kWh) of green power in the form of wind-generated renewable energy certificates (RECs) in April 2008. Enough to meet 100 percent of the school's purchased electricity use, Dalton's green power purchase is equivalent to avoiding the emissions of nearly 350 passenger vehicles each year, or the annual emissions from the electricity use of more than 230 average American homes. The school worked with provider Good Energy to make its RECs purchase.

A renewable energy certificate, or REC, represents the property rights to the environmental, social, and other nonpower qualities of renewable electricity generation. As renewable generators produce electricity, they create one REC for every 1,000 kilowatt-hours (or 1 megawatt-hour) of electricity placed on the grid. If the physical electricity and the associated RECs are sold to separate buyers, the electricity is no longer considered "renewable" or "green." The REC product is what conveys the attributes and benefits of the renewable electricity, not the electricity itself.

Dalton School purchased Green-e certified RECs, meaning that they met strict national environmental and consumer protection standards. Green power products certified by an independent third party offer organizations a higher level of certainty that they are getting what they pay for. In meeting specific environmental and customer protection guidelines adopted by the certifying organization, it is assured that the purchase meets nationally accepted standards for resource and product quality.

The school decided to purchase the RECs as part of a series of sustainability actions. Along with its other sustainability actions, purchasing green power allows the Dalton School to promote the importance of sustainability and educate its students on the environmental impact of clean energy choices. Recently, the school installed six solar panels on its roof to further highlight its dedication to green power, and is the only independent school in Manhattan to have done so. The school's system generates 2.4 kilowatts per day (900 kilowatts per year), which provides .047 percent of Dalton's electricity per year. Although the solar panels generate limited electricity, they help increase overall student awareness and could one day be incorporated into the school's science curriculum.

Contact: Ned Pinger, CFO, nedp@dalton.org.

(D) Montgomery County Public Schools (MD) [*solar*]

By allowing a solar power company to install sizable rooftop solar arrays on at least four of its schools and executing a 20-year lease to buy the power from those arrays, the Montgomery County Public Schools district was able to achieve several worthwhile goals:

- lowering its electricity costs,
- stabilizing those costs over the long term,
- providing hands-on education in sustainability, and
- promoting large-scale renewable projects within its state.

Power Purchase Agreement

The school district's contract is called a Power Purchase Agreement (PPA). Under a PPA, the solar company finances, builds, owns, and operates the installations and sells the electricity output to the school district at a fixed per unit rate. The starting rate in 2008-09 was well below the school district's then-current cost for utility power, and the district announced that it should save $100,000 per year. In addition, the solar lease rate is set to increase at a fixed, modest percentage per year, providing price and budget stability to the school district over the 20 years of the lease.

Request for Proposal (RFP) Process

The school district went through a competitive RFP process to obtain the PPA. The economics of the lease were also helped by a Maryland regulation that requires all energy suppliers in the state to obtain a certain percentage of their energy from solar sources. Solar installations tend to occur most frequently in states such as California, Hawaii, Massachusetts, Connecticut, New Jersey, and Maryland where good renewable incentives and/or high utility rates make solar a better financial proposition. No matter the state, there are sizable federal incentives that can apply to certain solar installations if they are owned by a tax-paying entity. For many schools, a lease arrangement like the PPA may be an attractive alternative to the capital outlays required to buy a renewable installation outright.

Resources:

Clean Energy Collaborative Procurement Initiative, EPA. Available at: http://www.epa.gov/greenpower/cecp/index.htm (accessed March 10, 2012). For more information, contact Blaine Collison, Director, US EPA Green Power Partnership, T: 202-343-9139, Email: collison.blaine@epa.gov.

Database of State Incentives for Renewables and Efficiency, NC Solar Center and the Interstate Renewable Energy Council funded by the U.S. Department of Energy. Available at: http://www.dsireusa.org (accessed March 10, 2012).

Green Power Equivalency Calculator - Allows schools to better communicate their green power purchase (or on-site generation) by translating it from kilowatt-hours into more understandable terms, such as an equivalent number of passenger vehicles, homes, or coal plants. Available at: www.epa.gov/greenpower/pubs/calculator.htm (accessed March 10, 2012).

Green Power Locator - Schools can see the green power product options (for RECs and utility-supplied products) that are available in their area and on a national level. Available at: www.epa.gov/greenpower/pubs/gplocator.htm (accessed March 10, 2012).

Guide to Green Power Purchasing (March 2010) - Written for organizations that are considering buying green power, this guide provides an overview of green power markets and the necessary steps to buying green power. See: www.epa.gov/greenpower/documents/purchasing_guide_for_web.pdf (accessed March 10, 2012).

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Top 20 K-12 School – Green Power Partnership. This list represents the largest purchasers among K-12 school partners within the EPA Green Power Partnership. Available at: www.epa.gov/greenpower/toplists/top20k-12schools.htm (assessed March 10, 2012).

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