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SOLAR ELECTRIC – PHOTOVOLTAIC (PV)

Description:

Solar electric power is generated from the conversion of sunlight into electricity through a photovoltaic (PV) or solar cell. Compared to the environmental impact of energy produced using fossil fuels (such as oil, gas, or coal), solar electric—or PV—technology makes use of the abundant energy of the sun and has little negative impact on our environment. PV cells can be used in a wide range of products, from small consumer items to large commercial solar electric systems. Commonly known as solar cells, individual PV cells are electricity-producing devices made of semiconductor materials (materials—such as silicon and germanium—that conduct electricity in a limited way). PV cells come in many sizes and shapes—from smaller than a postage stamp to several inches across—and these cells are often connected together to form PV modules. A typical PV module measures three feet wide by five feet long, but they can range from two to four feet wide and four to six feet long. Modules can be combined and connected to form PV arrays (panels) of different sizes and power output, and these connected systems integrate easily with existing energy supplies.

PV panels need to see the sun to make energy; they are often mounted on the roof of a building, facing south at an angle, so the modules receive the maximum amount of sunlight. There are many tools that can calculate the available sun-hours that will be available for a system—the same hours that give a person the fastest tan will also generate the most energy from a PV system. The ideal angle for harvesting sunlight is about 10 degrees less than latitude, but an angle between 20 and 45 degrees will provide a great deal of electricity. Due South is also ideal, but plus or minus 25 degrees will have only a minimal effect on energy production. A site-specific analysis should be completed before any site is ruled out.

A four-kilowatt PV system generates enough electricity to meet about half of the electrical needs of an average home, with additional needed electricity purchased from the local utility from the electric grid. When excess energy is produced by the PV system, the local utility will "buy back" this power—if net-metering is available. Some local utilities are not equipped to handle net-metering. If it is equipped to handle net-metering, the utility will provide a credit for the excess electricity generated by the PV system and apply it to the bill for the grid-electricity that the consumer must purchase. Typically, the consumer's account is reconciled annually, and the utility will buy any excess electricity at their wholesale rate.

A typical feature of a PV system is the inverter, which changes electricity from direct current (DC) to alternating current (AC) so that it can be used by most standard appliances and computers. Batteries may also be added for emergency

backup in the event of power outages or in cases where your PV system is not connected to utility power lines and cannot access electricity from the grid.

While PV systems are often mounted onto a roof, an exterior wall, or another part a building, a Building-Integrated Photovoltaic (BIPV) system can be incorporated into the building, replacing conventional building materials (such as roofing and siding) and blending into the look of the building.

Benefits:

For the community and the environment:

- The electricity generated by a PV system is typically used where it's generated, eliminating load on the local utility's distribution system (electric grid).

- Solar energy promotes a healthier living environment because energy produced through solar power is pollution-free—creating a more livable, attractive community for residents.

- The overall use of fossil fuels is reduced because energy from the sun is a sustainable resource—essentially infinite.

For the consumer— cost-savings and convenience:

- A properly installed PV system requires little maintenance over its lifetime.

- Most solar panels carry a 25-year warranty; inverters can carry a 10-year warranty.

- If batteries are included in the PV system as a backup, the system can provide electricity during a black-out.

- Solar electricity is generated for the consumer during times of peak demand on the electric grid, when purchased power from the utility is most expensive.

- If the cost of connecting to the utility grid is excessive or impossible, solar power can be a very economic alternative.

- Financial incentives and tax credits are often available that subsidize the cost of installing a PV system.

- The cost of PV systems has been decreasing and the cost of purchased electricity has been increasing. Many predict that grid-parody (where the cost of purchased electricity equals the cost of the electricity generated by a PV system) will occur around 2015.

- For installations that are eligible for net-metering, the local utility purchases the excess electricity that is generated by the PV system but unused by the consumer.

Impediments or barriers to development or implementation:

- Currently, the initial cost of a PV system is expensive—costs range from $6/kW to $10/kW. However, costs have been decreasing, and most predict that cost will continue to decrease for the foreseeable future.

- PV systems can only generate electricity when the sun is shining. During the night, or when it is cloudy, or when the panels are shaded, the system will produce very little or no power. The ability of a solar array to produce energy is only as good as the weakest-performing panel; if one panel is completely shaded, all the panels in that array will not generate any energy.

- A PV installation requires a large area for the system to be effective in providing electricity. An area the size of a sheet of plywood (32 square feet) is needed for 500 watts of generating capacity. Thus, 260 square feet of area (8 sheets of plywood) would be necessary for a 4 kW system.

- Panels may need to be cleaned—although, in New York State, if the panels are installed at an angle, rain generally does a pretty good job.

- The location of solar panels can affect long-term performance—trees grow and buildings get built which can obscure the panel's view of the sun.

- Batteries must be included in the system to provide continued generation of electricity during a blackout. Without batteries, when there is an electrical blackout, the PV system will not generate electricity, as the inverter needs the electricity from the grid to synchronize the AC power it is producing.

Resource—examples:

- *PV Awning*, New York State Energy Research and Development Authority (NYSERDA), 17 Columbia Circle, Albany, New York—a two-tiered, photovoltaic awning that helps power NYSERDA's headquarters. The awning system is both active and passive, meaning it will generate electricity while also providing shade to the building's lobby and second floor meeting room, reducing cooling requirements for those areas. The PV Awning is an example of a building-integrated PV system. The awning consists of 45 solar modules, 80 watts each, for a total capacity of 3.6 kilowatts. The system supplies enough AC electricity to meet one-half of NYSERDA's computer-driven power load. The system was also designed to allow testing of new inverters, which are manufactured by New York companies working in NYSERDA's Research & Development program. In addition, the system includes a data-acquisition system that displays real-time weather and system-performance data in the lobby of the NYSERDA building. http://www.powernaturally.org/About/documents/NYSERDAPVAwning.pdf.

- *Town Hall,* Town of Greenburgh, Westchester County, New York— a 5.6 kW PV system, comprising 34 PV modules, installed on a south-facing, sloped, standing-seam roof of the Town Hall, and occupying approximately 479 square feet on the roof. A monitor in the lobby displays real-time data about the

system's performance; and the Town also benefits from the electricity produced by the system, as well as from a reduction in their peak demand. The Town Hall functions as the center of government for the Town of Greenburgh, the largest town in Westchester County. The Town has been an Energy $mart Community since February, 2003, and actively conducts outreach to educate its residents and businesses about energy efficiency and renewable energy. Town officials sought to install a photovoltaic system in the Town Hall primarily as a demonstration system to increase public awareness of the need for and benefits of renewable energy, as the Town Hall's central location, high visibility, and large number of visitors make it an ideal setting for this purpose. For Town Supervisor: http://www.greenburghny.com/Cit-e-Access/webpage.cfm?TID=10&TPID=1750.

- *Happy Haven Farm*, Mooers, Clinton County, New York—a 300-acre dairy farm that is home to 85 dairy cows and 55 young stock. The owners decided to install a PV system to gain control over their energy costs, contribute towards protecting the environment, and make the farm more attractive to future generations of farmers. The system's layout covers approximately 1,000 square feet and is divided into six tracking arrays, which allows the system to receive more direct sunlight throughout the day than would a traditional, fixed array. The system includes 72 photovoltaic panels, each rated at 175 watts, and total AC power generated is estimated at 10.1kW. The total installed system costs are approximately $125,000, but a NYSERDA incentive and a grant from the US Department of Agriculture's Rural Development program reduced that cost by 65 per cent. http://www.powernaturally.org/publications/Happy%20Haven%20Farm.pdf.

Resource-written and web:

- *American Solar Energy Society (ASES)*, a national organization dedicated to advancing the use of solar energy for the benefit of U.S. citizens and the global environment. Their Web site provides information about the use of solar energy as an alternative power source, has links to many programs that promote the use of solar power, and is a good site for general information: http://ases.org/.

- *Florida Solar Energy Center*, which provides general information pertaining to the use of solar energy. Their Web site provides links to different types of applications and uses of solar energy and links to additional sources of information: http://www.fsec.ucf.edu/en/.

- *New York State Solar Energy Industry Association*, a New York trade association for solar energy companies. Their Web site contains information about joining the group, which allows participation in the many programs aimed at enhancing the use of solar energy. For non-members, there are many links that outline the benefits of solar energy, as well as a listing of New York State programs that offer incentives to users of solar energy systems: http://www.nyseia.org.

- *North Carolina Solar Center,* an organization that serves as a clearinghouse for solar and other renewable energy programs, information, research, technical assistance, and training. Their Web site contains links outlining the different uses of renewable energy, from cars to homes to major corporations, as well as links for teachers and students wishing to gain knowledge about renewable energy. The site also contains news that pertains to various renewable energy programs around the world: http://ncsc.ncsu.edu/.

- *Solar Electric Power Association*, a collaboration of utility companies, energy service providers, and the photovoltaic industry that works together to promote the use of renewable energy resources. Thieir Web site contains information on state/local agencies and utilities that offer incentives for the use of renewable energy resources: http://www.solarelectricpower.org.

- *Solar Energy Industry Association (SEIA)*, the national trade association of solar energy manufacturers, dealers, distributors, contractors, installers, architects, consultants, and marketers. Their Web site provides links to various conferences and events focusing on solar energy. Also included on the site are new developments and general news about solar energy policy developments in the national and state governments: http://www.seia.org.

- *Solar Rating and Certification Corporation (SRCC)*, an organization that administers a certification, rating, and labeling program for all solar systems. Their Web site is useful for companies wishing to have a system design certified by the corporation. The site offers a set of standards and ratings that will be used to certify the design as well as companies that are participating in the program: http://www.solar-rating.org.

- *Power ... naturally,* New York State Energy Research and Development Authority—an extensive list of links on Renewable Energy, including General Renewable Energy, Entrepreneurial Networks and Incubators, Buying Green Power, Connecting to the Grid, Staying Off the Grid, Solar Electric (PV), PV Systems for Agriculture, PV Performance Data, Solar Water Heating Systems, Wind Energy, Large Wind Energy Applications, Wind Energy Projects in New York, On-Site Small Wind Applications, Biomass Resources, Oil/Natural Gas/Minerals, and Educational Resources: http://www.powernaturally.org/about/HelpfulLinks.asp.

- *Information on Making Your Own Energy— U.S. Department of Energy,* general information about PV systems, connecting to the utility grid, operating a PV system off-grid, codes and requirements, and more: http://www.energysavers.gov/renewable_energy/.

Resource—technical assistance contact names:

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