The Power of the Sun

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By Robin Rogers

According to the US Energy Information Administration, 76 percent of all power plant-generated electricity is used just to operate buildings and half of US energy production is from coal. EPA estimates that carbon emissions from the US electric power sector are equal to 40 percent of all CO2 emissions in the US.

In comparison to coal, oil, natural gas, and mined uranium combined, the amount of solar energy reaching the surface of the planet in one year is about *twice* as much as will *ever* be obtained from those non-renewable resources. And the sun is highly unlikely to extinguish, at least not for another five billion-plus years (so I've heard) and it provides a cleaner, viable alternative to fossil fuels.

Using solar energy to power our buildings is gaining in popularity. The Solar Energy Industries Association estimates that from 2006 to 2007, new solar installations increased by more than 40 percent. According to *Clean Energy Trends 2009* (http://www.cleanedge.com/reports/pdf/Trends2009.pdf) by Clean Edge, the photovoltaic (PV) industry had 190,000 jobs in 2009.

The Power of Incentives

Municipalities, states and the federal government can encourage solar with direct incentive programs such as tax credits, depreciation allowances and liability shields just as they do for fossil fuels. An increasingly favored option is to set up Renewable Portfolio Standards (RPS) such as those adopted in Colorado, whereby utilities must purchase a certain percentage of solar or renewable energy. Also known as Feed-in Tariffs, or FITs, they are basically payments per kilowatt-hour for electricity generated by a renewable resource. The World Future Council reports that it has been empirically proven that FiTs are the world's most successful policy mechanism for stimulating the rapid development of renewable energy.

Gainesville, Florida, became the first US city to adopt FiTs last spring, where residents with photovoltaic panels on their roofs will receive 32 cents a kilowatt-hour versus paying about 12 cents a kilowatt hour for their electricity, according to Department of Energy statistics. In Canada, an innovative FiT scheme awards higher incentives for small rooftop solar installations than for off-shore wind.

San Francisco's solar program prompted a 450 percent increase in applications for residential solar installations during the first year. It is also deploying large-scale commercial solar incentives that phase out over time as costs go down for solar. Berkeley's municipal tax assessment rebate program (http://www.berkeleyfirst.renewfund.com/) is soon to be adopted at the federal level, promoted by Vice President Joe Biden.

At the state level, California features a monetary incentive based on actual performance over the first five years for large-scale systems, and a one-time, up-front payment based on estimated performance for systems <50kW.

Much of the increase in US solar installations has been on individual buildings generating power that is then fed into the existing power grid. Called net metering, it is now offered in 42 states, some of which offer incentives for installing such power systems. To see what's available in your state, see the up-to-date DESIRE Solar (http://www.dsireusa.org/solar/) database that also tracks all rebates, tax credits and incentives across the US.

To further grow the U.S. solar industry, Mark Z. Jacobson of Stanford University and Mark A. Delucchi of MIT have proposed combining FiTs with a declining clock or reverse auction, such as was proposed in California last August. In this type of scheme, the right to sell power to the grid goes to the lowest bidder. For example, a solar developer would bid on providing power to one of California's utilities; if it had the lowest bid, the utility would award a power-purchase agreement, effectively eliminating risk for the developer by guaranteeing a market and simultaneously allowing the market to set electricity rates for PV projects in California up to 20 megawatts. The authors write that these reverse auctions could provide an ongoing incentive for renewable-energy developers to lower costs, eventually phasing out FiTs.

Storing Solar Energy

What happens to the grid when there's a cloudy day (overburdened almost instantaneously?) and, for large-scale solar power, how is the energy stored for use when the sun is *not* shining, and how can it be transmitted over long distances?

The Department of Energy handed out almost $12 million last summer to five projects (http://www.energy.gov/news2009/7720.htm) looking at solar energy grid integration and big-capacity storage. Solutions might include compressed air storage or pumped hydro where water is pumped up to a reservoir and then released later, down through turbines to generate electricity, often during peak demand. SolarReserve of California is applying to build a 150-megawatt solar farm that will store seven hours' worth of the sun's energy in molten salt; heat from the salt can be released when it's cloudy or at night to create steam that drives an electricity-generating turbine.

Implementing Solar

So many photons, so little time. Where to begin?

For new construction, first, design to capture passive opportunities that require no mechanical or electrical components, thereby reducing or eliminating the need for mechanical cooling and heating and daytime electric lighting. Three primary areas – climate, heat transfer of building materials and human thermal comfort – are addressed using site and location, building orientation, prevailing climate, glazing and shading, and thermal massing for all passive design decisions.

The general goal is to make the building as energy efficient as possible *before* incorporating electricity, and strategies will vary depending on the location. This will usually help maximize most other elements and can reduce size requirements of necessary systems such as photovoltaics or heating/cooling. Perform energy modeling with a program such as DOE-2 that allows custom weighting to get an accurate snapshot of direct-gain and natural ventilation using passive strategies. Also make sure your building design allows active solar with roof, walls or site area situated to accept photovoltaics, whether as building-integrated systems or attached arrays.

The recently completed Omega Center for Sustainable Living (http://www.eomega.org/omega/about/ocsl/) provides an example where the design team used eQUEST to model estimated energy use. Located in New York State, the building supplies all of its own energy needs, with carbon neutral operation. The self-sustaining structure is heated and cooled using geothermal systems, and utilizes photovoltaic power.

Retrofit of existing buildings is also feasible by incorporating improved insulation, high-performance triple glazed windows, reducing of thermal bridges, sealing air leaks, a ventilation system with highly efficient heat recovery, solar hot water, and highly efficient condensing gas boilers, as well as *integrati*on of solar thermal with existing, conventional heating systems.

If you're not already following your building's energy use with Energy Star's Portfolio Manager (http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager), you may want to check it out to help you track and assess energy and water usage in your buildings. Last August, the program was updated so that on-site power from solar or wind can be included in the fuel mix.

Author*: Robin Rogers is the founder of SOLARIPEDIA.com (http://www.solaripedia.com), an online resource for using solar and wind energy.*

Tools:

Portfolio Manager:
(http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager)

DSIRE (Database of State Incentives for Renewable Energy):
(http://www.dsireusa.org/)

Colorado's Renewable Energy Standard:
(http://www.dora.state.co.us/PUC/rulemaking/RenewableEnergyStandard.htm)

Oregon's Business Energy Tax Credits:
(http://egov.oregon.gov/ENERGY/CONS/BUS/BETC.shtml)

State Solar Incentives:
(http://www.statesolarincentives.net/state-solar-incentives-colorado-solar-incentives.php)

Wind Works Feed-inTarrifs Legislation Resources Page:
(http://www.wind-works.org/FeedLaws/USA/Model/ModelAdvancedRenewableTariffLegislation.html)

World Future Council Feed-in Tariffs Project:
(http://www.worldfuturecouncil.org/arguing_fits.html)

Solar Advisor Model from NREL:
(https://www.nrel.gov/analysis/sam/)

Information:

Energy Star's *Energy Strategy for the Future:*
(http://www.energystar.gov/index.cfm?c=business.bus_energy_strategy)

Architecture 2030:
(http://www.architecture2030.org/home.html)

Passive House Retrofit Kit:
(http://www.energieinstitut.at/Retrofit/)

The Clash Over Clean Power Article in Business Week:
(http://www.businessweek.com/magazine/content/09_41/b4150055757494.htm)

Clean Energy Trends Report 2009:
(http://www.cleanedge.com/reports/pdf/Trends2009.pdf)

Omega Center for Sustainable Living Energy-Independent Building:
(http://omega-inst.org/pdfs/OCSL_Project_Overview.pdf)

Solar Integration Article from Renewable Energy World:
(http://www.solaripedia.com/files/367.pdf)

Recovery Through Retrofit report from the White House:
(http://www.whitehouse.gov/assets/documents/Recovery_Through_Retrofit_Final_Report.pdf).

Article from Scientific American "*A Path to Sustainable Energy*" by Mark Z. Jacobson and Mark A. Delucchi:
(http://www.stanford.edu/group/efmh/jacobson/sad1109Jaco5p.indd.pdf)

Evaluating the Feasibility of a Large-Scale Wind, Water, and Sun Energy Infrastructure. Jacobson and Delucchi INCOMPLETE DRAFT FOR REVIEW – DO NOT CITE, QUOTE, COPY, OR DISTRIBUTE
(http://www.stanford.edu/group/efmh/jacobson/WindWaterSun1009.pdf)

Innovation:

Energy Innovations high-efficiency solar module with built-in performance monitoring:
(http://www.energyinnovations.com/sunflower/index.html)

Georgia Institute of Technology three-dimensional photovoltaic system:
(http://gtresearchnews.gatech.edu/newsrelease/3d-pv.htm)