Promoting Solar Power on Brownfields in Brockton, Massachusetts

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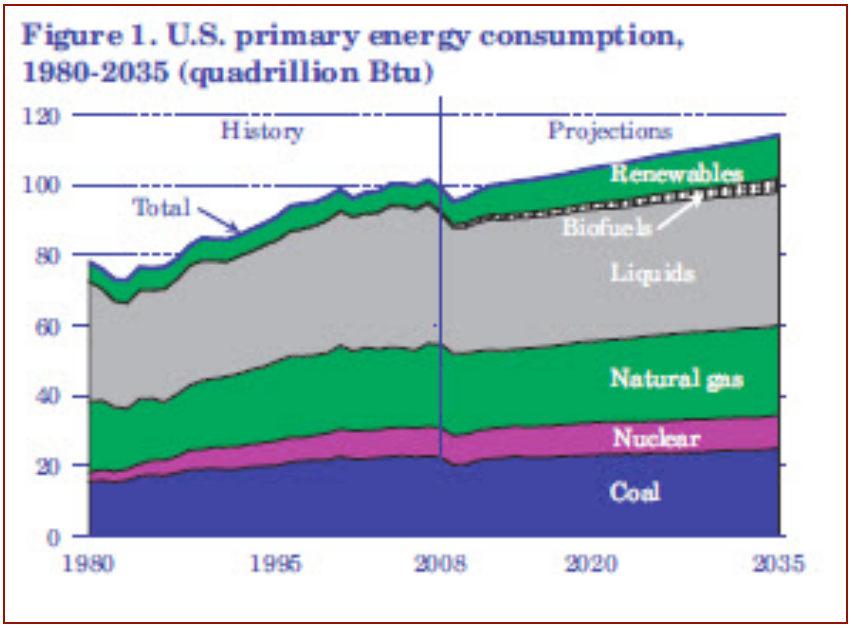
Clean energy development is a critical component of the Obama administration's economic recovery plan. It rests on the belief that rebuilding the country's energy infrastructure can help generate investment and economic growth and reduce greenhouse gas emissions as we make greater use of alternative energy technologies—wind, solar, biomass, geothermal—in place of fossil fuels. The transition to a cleaner economy, like any change of an entrenched and powerful socio-technical system, is likely to be complex and uneven. In its business-as-usual scenario the Energy Information Administration (EIA) projects total energy consumption will increase in the US by 14% between 2008 and 2035, with renewables increasing from 9% of electricity generation in 2008 to 17% in 2035.[2]



Source: Energy Information Administration, 2010

While this projected increase in renewable energy's market share is impressive, it is quite modest in comparison to the transition necessary to prevent runaway climate change. With this limited transition away from fossil-fuel based electricity production, the EIA forecasts that annual energy-related carbon dioxide emissions will rise from 5,814 metric tons in 2008 to 6,320 million metric tons in 2035, an increase of nearly 9%.[3] Some experts have argued that we can achieve a zero-CO_2 economy within decades at a reasonable cost and in a manner that

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[2]The "business as usual," or "Reference" scenario assumes current laws and policies. *Annual Energy Outlook 2010: With Projections to 2035*, DOE/EIA-0484 (2010), Energy Information Administration, U.S. Department of Energy: Washington, DC,2010
[3]*Ibid*.

contributes to economic development in those regions that produce fossil fuels.[4] Others have called for a next-generation utility model which relies on smaller, decentralized, self-contained energy sources, such as solar-panel arrays, that are located near the final point of energy consumption and in many cases, on brownfields. Instead of centralized electricity systems with enormous power plants generating electricity from coal, a distributed power system could be less expensive, quicker to deploy, and above all cleaner. Furthermore, by definition, power systems built on brownfields do not disturb unspoiled natural resources.

In many ways, these ideas of distributed energy systems and greater reliance on renewable energy were prefigured in the "brightfields" concept put forward by the Clinton administration in the late 1990s. The term brightfields was defined as "the conversion of contaminated sites into usable land by bringing pollution-free solar energy and high-tech solar manufacturing jobs to these sites, including the placement of photovoltaic (PV) arrays that can reduce cleanup costs, building integrated solar energy systems as part of redevelopment, and solar manufacturing plants on brownfields."[5] A brightfield could be a ground-mounted solar array, a solar manufacturing plant, or a solar array mounted on the roof of a building developed on a brownfield. Solar power is particularly well suited to transform brownfields in dense, urban areas.

Compared to wind turbines, for example, solar arrays—quiet, unobtrusive in the landscape—can be installed on a brownfield site with little public opposition; moreover, unlike wind turbines, the technology can be placed on the surface of a brownfield without penetrating a cap or some other subsurface engineering control. And while the environmental benefits of brightfields are attractive to many communities, perhaps even more so are the potential jobs from solar panel manufacturing and a wider set of community benefits. Solar systems can provide a new stream of tax revenues, act as a hedge against unpredictable energy costs, and spur area-wide redevelopment.

There is no shortage of candidate brightfields. The U.S. Environmental Protection Agency (EPA) estimates that there are roughly 500,000 sites and almost 15 million acres of potentially contaminated properties across the United States, including Superfund, Resource Conservation and Recovery Act (RCRA) corrective action sites, brownfields, and abandoned mine lands. Of these sites, the EPA and the National Renewable Energy Laboratory (NREL) have identified some 470 sites that have excellent solar resources and acreage to generate power at the megawatt or multi-megawatt scale as well as 145 utility-grade sites suitable for the use of concentrating solar power[6] (see below). An additional 1,355 sites in areas of moderate solar resource have been identified as "policy-driven" brightfields, which means the development potential of the site for solar power generation is contingent on state incentives such as renewable portfolio standards or solar carve-outs that requires a certain percentage of a state's electricity be generated from solar. And 11,384 sites have been identified as having the potential to generate power for the energy needs of a single property. EPA is currently working with states and other stakeholders to identify additional sites for PV development.

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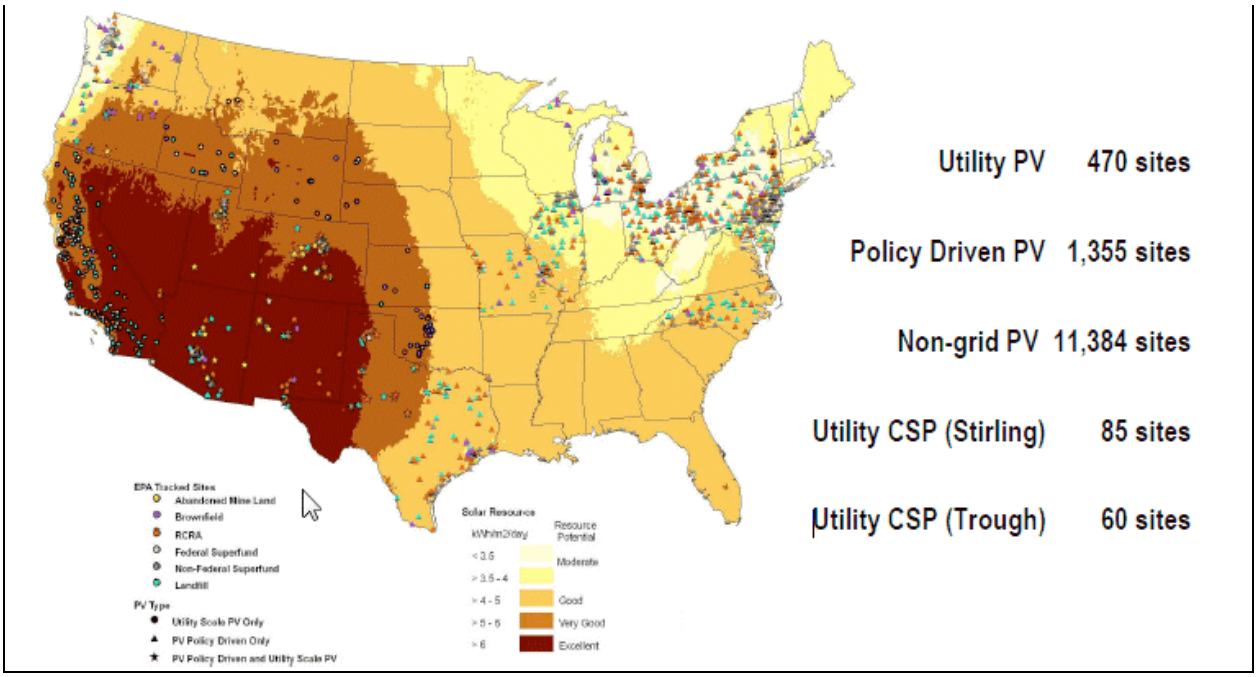
[4]Arjun Makhijani, *Carbon-Free and Nuclear Free: A Roadmap for U.S. Energy Policy,* RDR Books, IEER Press, Takoma Park, MD, 2007

[5]U.S. Environmental Protection Agency, http://epa.gov/brownfields/partners/brightfd.htm

[6]Concentrating Solar Power (CSP) technology uses the sun's thermal energy to heat a liquid that drives a generator to produce electricity.



Courtesy of U.S. EPA

Contaminated Sites with Solar Potential

In broader terms, the brightfields concept is part of a paradigm shift in how we think about the future of the U.S electric power supply. Generating renewable energy on potentially thousands of brownfields sites suggests a sustainability path that is not predicated on large public investments in technologies embedded in a limited number of highly capitalized, massive nuclear and coal power plants. Instead it encourages numerous competitors in the high-tech sectors to explore a wide range of fundamentally safe, more varied alternative technologies (*e.g.,* thin film photovoltaic cells), the most promising of which can advance relatively quickly through product design and commercialization. This paradigm shift has made federal agencies and state government catalysts for clean energy entrepreneurship.

Brockton Gas Works Site, Brockton, Massachusetts

The implementation of the brightfields concept in Brockton, Massachusetts, illustrates however, that the availability of suitable land and local willingness to go solar are not enough. To build solar arrays on contaminated lands, the finances have to work. The Brockton case shows how difficult this was, but the passage of new state legislation should make similar projects in Massachusetts easier to consummate.

In 2000 the city of Brockton, about 20 miles south of Boston, received one of the first US Department of Energy brightfields grants. Six years later, after many twists and turns, the city managed to construct a utility-scale solar array across three acres on the former Brockton Gas Works site, a 19th century manufactured gas plant (MGP). When completed, it was the largest brightfield in the country, containing nearly 1,400 solar modules with a generating capacity of 465 kilowatts (kW), enough energy to power 77 homes. [Since the installation went on line in September 2006 it has generated nearly 2,300 megawatt-hours (MWh) of electricity, or roughly

575 MWh/year. If a typical home consumes .750 MWh/year that's about 77 homes worth of electricity.]

The Brockton Gas Works site had been sitting idle when the city identified it as a potential brightfield. In 1989 following some investigative work by the Massachusetts Department of Environmental Quality Engineering, U.S. EPA began sampling and found soil contamination. The EPA issued two orders, under its removal authority, requiring the site owners, the Bay State Gas Company, to eliminate potential exposure pathways to soils containing MGP residuals (*e.g.,* volatile organics, such as benzene, toluene, and xylene, as well as semi-volatile organic compounds known as polycyclic aromatic hydrocarbons or PAHs), remove contaminated soil from surrounding residential properties, and install a cap. The company installed monitoring wells to measure soil vapor infiltration in MGP-impacted groundwater. In 2004 remedial activities were completed and the site was capped. Bay State Gas retained ownership of the land but leased it to the city for 30 years.

The Former Brockton Gas Works Site

Community Attitudes

In 2000, the neighborhood in which the brightfield is located was designated a state Environmental Justice area, with a median annual household income below 65% of the statewide median and with 25% or more of the residents minority and/or foreign born. In addition to the 27-acre Brockton Gas Works site, neighborhood residents were burdened by a construction and demolition debris transfer station, a wastewater treatment plant, a foundry, and a home-heating-oil company. Apart from a proposal to put a cold storage facility on the site, there was little interest in the site on the part of the private sector.

The city was hesitant to seek an end use on the site that local residents would find objectionable. An initiative to locate a tire-recycling plant on a large brownfield site in a

different part of the city had provoked intense and sustained resident opposition. There were concerns about noise, health effects, and increased traffic congestion, and in the end the proposal was defeated. Would the residents find a brightfield equally objectionable?

The Brockton Brightfield

The city presented its site plan for the brightfield to some fifty community residents. Anticipating the interests of the community, the plan illustrated various sight lines and showed that the solar modules would be unobtrusive. The facility, it was emphasized, would be quiet and non-polluting. Some local residents initially were concerned that the facility would raise their electricity bills, or that the panels themselves would glare. By addressing local misperceptions, the city persuaded the residents to accept the concept of a solar facility in their neighborhood, even though the project would be directly connected to the grid and thus not help local residents subsidize their electricity costs. In addition to the electricity cost issues, many residents were concerned about fencing and landscaping. As the local paper reported, "Neighbors of the Grove Street property where thousands of solar panels may be located say they support the project. They just do not want to see it."[7] With local residents supporting the project, the next hurdle would be financing.

Financing

To gain support from the City Council and others, the project was designed to be revenue-neutral. This meant that project revenues would need to cover the debt service on city bonds issued to finance the project as well as any operations and maintenance costs. The cost of the project was estimated to be $3.6 million. The project received City Council approval to issues a municipal bond for $1.6 million and sought the remainder in grants from state and federal agencies. The city was able to secure a $1 million grant from the Massachusetts Renewable Energy Trust but it had fallen short of its fundraising goals by $500,000. As the project coordinator noted:

[7] "Brockton Residents Want Solar Panels Hidden," *Enterprise,* September 19, 2002

> The lack of available funding programs proved a hurdle the city could not overcome to reach its capital development goal. [U.S. Department of Energy] solar funds could not cover hardware and installation; economic development funds whose primary metric is job creation had other priorities; private foundations interested in renewable energy support education, outreach advocacy and policy rather than local implementation projects. [8]

The Brockton Brightfield

After considerable effort and transactions costs, the city was able to raise the remaining monies through the sale back of one of the lots comprising the property to the Bay State Gas Company, which had donated the site to the city in 1972. The company, a responsible party at the site, was required to maintain the integrity of the cap in perpetuity and decided it wanted to have site control to diminish it ongoing liability. With the proceeds of the sale the city reached its capital development goal, but it encountered two unexpected barriers.

First, it learned that Brockton, or any city or town in the Commonwealth, could not obtain a 20-year bond because under the relevant sections of the state's enabling legislation addressing renewable energy projects, a city was limited to a issuing a 10-year bond. This meant that the city, under its financial model, would not be able to generate adequate revenues to pay for debt service over ten years.

Moreover, the city's legal counsel decided that the city lacked the legal authority to finance, develop, or own a solar-power-generating facility under state legislation. To have any chance to implement the project, the city needed to draft special state legislation to provide it with the necessary authority to pursue the project, then have it approved by the Brockton City Council and later by the state legislature. After considerable wrangling and lobbying, the bill was approved by the state house and senate and signed into law by then Governor Mitt Romney in

[8]Lori A. Ribeiro. *Does It Have be So Complicated? Municipal Renewable Energy Projects in Massachusetts*, MIT, 2006, p. 50.

February of 2005. The new law gave the city of Brockton the authority to issue a 20-year municipal bond to finance the project.

The project team estimated that they city would need annual revenues of some $135,000 to pay for the city's debt service as well as operation and maintenance costs. In Massachusetts, the project team benefited from the state's Renewal Portfolio Standard (RPS). In April 2002, the Massachusetts Department of Energy Resources (DOER) adopted RPS regulations that required all retail electricity providers in the state to utilize new renewable-energy sources for at least 1% of their power supply in 2003, increasing to 5% by 2010. An electric power provider can achieve this by either producing a certain amount of its electricity from renewable energy resources or through the purchase of renewable energy certificates/credits (RECs) that correspond to a unit (*e.g.,* MWh) of renewable electricity. The electric power provider can purchase these certificates at the same time that it purchases the renewable power or it can purchase the RECs independently. The sale of these tradable RECs creates a revenue stream that can be used by the cities such as Brockton to service its debt and cover the operation and maintenance costs of the brightfield.

When the project team was looking at various finance models, RECs were often procured under short-term contracts or on spot markets. In most instances, REC contracts were for 1 to 5 years. The uncertainty of REC prices over the life of the project could have been a significant barrier for the project proponents. Brockton's REC marketing approach in this regard was quite bold. The city sought a 20-year contract that would last the term of its debt service. To minimize revenue risk in the event Constellation New Energy defaulted on its payment, the city negotiated an agreement with the Massachusetts Green Power Partnership (MGPP) for a "put option" for the project's Renewable Energy Certificates in years 9 through 18 of project operation. Under a "put option" Brockton could sell RECs to the MGPP over the contract period at a set price. The city entered into a 20-year agreement with Constellation New Energy to sell RECs at a variable rates of $180 per MWh for year 1-5, $180 per MWh for years 6-15 with the city assigning the MGPP put option agreement to Constellation New Energy, and market value for the remainder of the contract.[9]

Constellation New Energy also agreed to buy electricity generated by the facility at a rate of 7cents per kWh for 10 years and at market value for each of the final ten years of the contract. By selling the electricity generated at the site and Renewable Energy Credits generated at the site to Constellation New Energy the city of Brockton has been able to generate nearly $145,000 in annual revenue from the project. [10]

The Brockton Brightfields project was not intended to generate a cash stream for the city, but rather to be revenue neutral. While the solar modules are warranteed for twenty years, the system is expected to run from 30 to 50 years. When the bond is paid off in 2026, the city will benefit from a revenue stream from both the sale of RECs as well as the energy generated by the

[9]When the city was devising its REC marketing strategy is was also negotiating a new energy supply contract with Constellation New Energy and thus had some leverage to induce Constellation New Energy to sign a long term contract to buy RECs.

[10]Personal communication, Lori Ribeiro, September 24, 2010. Since the facility came on line in September 2006 it has generated some 2,300 megawatts of electricity. At $180 per REC (1 REC = 1MWh), this amounts to roughly $104,000 per year in revenue. As noted above the city also sells electricity at 7 cents per kWh to Consolidated New Energy. This provides a revenue stream of some $40,000 per year.

facility. There are, of course, other benefits from the brightfields project to the city and the surrounding community. Since the brightfield went on line in September 2006, it has generated nearly 2,300 MWh of renewable energy, avoided 3.8 million pounds of carbon emissions. Furthermore, the city has created a public amenity in the place of a neighborhood eyesore.[11]

The Next Wave

The city of Brockton is a pioneer in brightfield development in Massachusetts, and its experiences have informed changes in state policies to encourage brightfield development. The Brockton examples clearly shows that without appropriate financial incentives, such as REC pricing and trading mechanisms that provide long-term contracts, as well as a more streamlined permitting process, it will be difficult for municipalities or third-party developers to transform brownfields into brightfields.

Since the completion of the Brockton project, an overhaul of the Massachusett's energy laws and new incentives have helped spur proposals for construction of large solar farms on brownfields and municipal landfills which could generate in total some 10 megawatts. The Green Communities Act (GCA) of 2008 has reformed the rules that govern renewable electricity. The GCA strengthened incentives for the development of renewable energy by requiring 15 percent of electricity to be supplied by new green power facilities, such as solar arrays, landfill gas, biomass, and wind by 2020.

The Green Communities Act of 2008 also provided the opportunity to develop a specific solar target under the existing state Renewable Portfolio Standards. The legislation required the state to develop a carve-out for renewable energy generators smaller than two Megawatts (MW). In the course of developing regulations, officials decided that the carve-out will focus exclusively on photovoltaic systems. The goal is to have 400 MW of installed capacity by 2020, nearly a twenty-fold increase from the current PV capacity of 22 MW[12]. The solar carve-out works by requiring utilities to buy a certain percentage of their power from owners of qualifying solar systems through the creation of special solar renewable energy credits (SRECs). The credits have a price floor of $300 per MWh, nearly ten times the price of other renewable energy credits utilities must buy. If utilities are unable to comply with the requirements of the carve-out through SREC purchases, they are required to pay an alternative compliance payment (ACP) of $600 per MWh. In other words, the ACP price serves as a price ceiling for the Massachusetts SREC market.

The new SREC carve-out, in conjunction with federal tax credits for the construction of solar installations and accelerated tax depreciation, has invigorated interest in constructing solar facilities in the state. Developers, for example, can sell solar renewable energy credits to electricity providers and turn what previously were borderline projects into ones that are more financially feasible.

Not all of the increases in solar capacity, however, will come from private sector developers. According to Massachusetts state officials, the Green Communities Act is driving municipal interest in brightfield development. Some 20 to 30 municipalities are considering or

[11] http://www.fatspaniel.com/fat-spaniel-in-action/live-sites/

[12] Hilary Flynn *et al.,* System Dynamics Modeling of the Massachusetts SREC Market, *Sustainability,* **2010**, *2*, 2746-2761

have issued a request for proposals for the development of solar facilities on brownfields and/or landfills. Since most towns don't have the expertise or resources to undertake the development themselves, they typically require that a third-party solar energy company be responsible for obtaining the necessary permits, constructing the installation, and on-going operations. Typically a town will sell or lease the land to the company and sign a power purchase agreement (PPA) to buy all the power generated by the installation at a reduced price.

For the town there are no up-front capital costs, project risks are born by the private entity, and the town typically obtains predictable electricity costs through a long-term contract with an annual escalator. For example, in June 2010, the Massachusetts town of Greenfield signed an agreement with a private entity to construct a two-MW solar photovoltaic facility on a closed landfill. The town will pay only $0.01 per Kwh, which is a greatly reduced rate from standard electrical charges, and anticipates that it will save approximately $250,000 in electrical costs during the first full year of operation. The solar energy companies will finance the deal by the sale of SRECs to utilities and make use of federal and state incentives (*e.g.,* tax credits, accelerated depreciation, renewable energy loan guarantees, tax deductions) to obtain a better return on investment.

There is some uncertainty about the long term operation of the state's solar credit scheme if the supply of RECs eventually outstrips demand. However, with a solar-carve out in place, more efficient solar technologies emerging in the market, and the interests of municipalities to assess the redevelopment potential of closed landfills, Massachusetts brightfields are poised to spread quickly over the next decade.