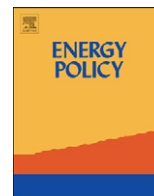




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Making, breaking, and (partially) remaking markets: State regulation and photovoltaic electricity in New Jersey

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ABSTRACT

This paper describes the development of the U.S. state of New Jersey's policy to accelerate the growth of photovoltaic electricity generating capacity over the past ten years. It provides insights that may be of use to scholars and policy-makers who seek to understand how markets for photovoltaics and other renewable energy technologies may be created and sustained, and it adds to the growing set of detailed historical case studies on these issues. Aggressive state policy measures have put New Jersey second to California among the U.S. states in installed photovoltaic capacity. That growth was achieved in a series of stages. New Jersey initially experienced a boom and bust as generous up-front rebates catalyzed rapid growth in demand and exhausted the program's budget. A shift in 2007 to a policy that emphasized Solar Renewable Energy Certificates failed to sustain the growth in capacity. In response, the state began to require regulated transmission and distribution utilities to provide up-front financing for photovoltaic systems. This approach has restarted the momentum of the market, but it shifts the policy's costs into the future, while empowering a new set of players with uncertain interests over the long term.

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1. Introduction: a learning opportunity

Over the past decade, the installed capacity of grid-connected photovoltaic electricity generation (PV) has grown very rapidly. According to [International Energy Agency \(2009, p. 37\)](#) estimates, less than half a gigawatt (GW) of PV capacity was operating in the world's leading economies in 2000; in 2008, the figure was about 12.7 GW, a compound annual growth rate of over 50%. In the U.S., installed capacity grew over the same period from just 40 megawatts (MW) to about 800 MW, a growth rate of over 45% ([IEA, 2009, p. 4](#); [IEA, 2001, p. 5](#)). These rates are not simply attributable to a low base period; in fact, they have been accelerating. Global growth was 76% from 2007 to 2008, and U.S. growth was 58% in that year.

The rapid growth of PV capacity has been driven almost entirely by public policy. Although system costs have declined steadily ([Wiser et al., 2009](#)), PV remains one of the most expensive sources of electricity. Without public subsidies, few electricity producers would buy PV systems. Policy-makers hope that subsidizing PV's deployment will induce scale and learning economies and technological innovation that accelerate cost reduction and ultimately yield systems that are cost-competitive

with conventional sources, especially if a price is imposed on carbon emissions.

While governments around the world share the goal of cost reduction through policy-induced diffusion of PV technology, the strategies that they have enacted in pursuit of that goal have been diverse. For example, Germany, the largest PV market in the world over the past decade, relies primarily on a feed-in tariff, which guarantees PV system owners that they can sell excess power to the grid for a fixed price for many years. Spain, which temporarily surpassed Germany in PV installations in 2008, also provided a feed-in tariff, but offered system owners options that varied in price and duration. California, which comprises more than half of the U.S. market, has experimented with a variety of policies to promote PV since the 1970s. The most recent of these policies, the California Solar Initiative, which was instituted in 2006, provides performance-based incentives to system owners over a five year period.

The diversity of PV policy strategies creates a learning opportunity. Energy policy analysts can exploit the variation to understand which approaches work well and why. There is a ready market for their findings not only among researchers, but also among policy practitioners, since many nations, provinces, utilities, and localities are contemplating, enacting, or revising PV policies. Nine states and three cities in the U.S., for instance, have recently enacted feed-in tariff policies that encompass PV, and they have looked to the European experience for guidance to some extent ([Cory, 2009](#)). The U.S. Congress, too, is considering

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legislation that would seek to accelerate the diffusion of renewable energy technology, including PV.

The learning opportunity created by cross-sectional and longitudinal variation in PV policy has not lain unexploited. A number of papers (such as Reiche and Bechberger, 2004; Rowlands, 2005; Muñoz et al., 2007) have compared the strengths and weaknesses of various European programs. A similar literature (including Gouchoe, 2002; Hoff, 2006; Barbose et al., 2006; Wiser and Bolinger, 2007) focuses on policies in the U.S. states. A smaller literature, such as Laird and Stefes (2009), looks at the U.S. and Europe together. Researchers have also produced historical case studies that provide more granular information and explore change over time within a single jurisdiction. Recent examples include González (2008) on Spain, Frondel et al. (2008) on Germany, and Taylor (2008) on California.

This paper contributes to the latter genre. In it, I trace the history of the U.S. state of New Jersey's PV policy over the past decade. New Jersey now has a larger installed PV capacity (more than 100 MW) than any other U.S. state besides California, which is much larger and much sunnier. The state has been recognized for its policy innovations, most recently by the 2009 State Leadership in Clean Energy Award (Clean Energy States Alliance, 2009), which honored its pioneering Solar Renewable Energy Certificate (SREC) program. Yet, New Jersey's pathway to this position has been a crooked one, and it faces significant current and future challenges, awards notwithstanding.

Few researchers have had a chance to learn about the New Jersey experience. To some extent, it reinforces lessons that can be derived some cases, like Spain, that have garnered more attention. For instance, New Jersey experienced a boom and bust when its generous rebate program quickly exhausted the budget set aside for it. In other respects, however, especially in its heavy reliance on SRECs, the insights from the New Jersey case are more original. SRECs alone did not provide an adequate incentive to meet the state's PV deployment objectives and so it has conscripted regulated transmission and distribution utilities to fund solar projects. This solution shifts the policy's costs into the future and makes them less transparent, while empowering players whose incentives may or may not be aligned with the goals of the policy over the long term.¹

The core of the paper is made up of four sections of empirical narrative. The first of these sections outlines the restructuring of the New Jersey electricity market in 1999, which laid the institutional basis for later PV policy. I then turn to the state's Customer On-Site Renewable Energy rebate program, which was initiated in 2003 and catalyzed explosive growth in the PV market. The troubled PV policy transition that began in 2006, which was brought about by fiscal constraints on the state, is covered in the third narrative section. The fourth and final narrative section focuses on the state's increasing reliance on transmission and distribution utilities to support the state's PV market since 2007. In the conclusion, I sum up the story and expand on the insights offered above.

2. The end of business as usual: utility restructuring in New Jersey, 1999–2002

The stage was set for the development of New Jersey's PV policy by electricity restructuring in the late 1990s. The idea of

¹ I do not attempt in this paper to evaluate the cost-effectiveness of the state's PV policy relative to other potential sources of energy nor to assess whether the policy has achieved the goal of driving PV technology down its cost curve. I focus primarily on whether the state has been able to meet the goals that it has set for itself, at what cost, and by what means.

“restructuring” (a term that came to have many divergent definitions) captured policy-makers' attention around the U.S. during that decade. New Jersey's version, embodied in the Electric Discount and Energy Competition Act of 1999, reorganized the institutional landscape for electricity generation. Although this legislation had many elements and motivations – not the least of which was cutting the cost of electricity (Prior, 1995; Twyman and Johnson, 1999) – it set in motion processes that would lead to the formulation of ambitious and, ultimately, expensive goals for renewable energy and especially solar power.

The state's recent Energy Master Plan (State of New Jersey, 2008, p. 16) describes well the *status quo* before restructuring:

Electric utilities generated most of the electricity in the State, under the regulation and oversight of the Board of Public Utilities (BPU). The utilities built, maintained, and operated power plants, with the expectation that the BPU would allow them to recover their prudently incurred costs from electricity customers, plus an opportunity to earn a specified rate of return. In this arrangement, the utilities were insulated against the risk of loss that State-approved investments in electric generation might prove unwise; electricity customers bore that risk. In exchange, the utilities bore an obligation and a responsibility to generate, transmit, and deliver electricity to serve those customers.

The most fundamental change made by the 1999 restructuring was to vertically disintegrate the market for electricity generation from the market for electricity distribution. Unregulated electricity generators (which I will refer to as “independent power producers” or IPPs) take on the risk of building and operating power plants. (Please see Table 1 for a list of abbreviations used in this paper.) Their output is sold through a multi-state wholesale market. The main wholesale buyers for New Jersey are four transmission and distribution (T&D) utilities, which remain regulated by the BPU under state law. Each year, these buyers agree to three-year contracts for roughly one-third of their retail customers' baseload power needs.

A second crucial element of the restructuring for the solar industry was the creation of a provisional Renewable Portfolio Standard (RPS). The RPS required otherwise unregulated independent power producers to provide a designated fraction of their load from renewable energy sources. IPPs could choose to fulfill this responsibility by purchasing Renewable Energy Certificates (RECs) that had been issued to other generators who operated systems powered by renewables, including PV systems. If RECs were too expensive or simply unavailable, an alternative compliance payment (also known as a penalty) would be imposed on the IPPs (see Fig. 1). The RPS went into effect in 2001 with a target of .5% for that year and a schedule to rise to 4% in 2012.

The third and final feature of the restructured institutional landscape was a Societal Benefits Charge. This charge provided a mechanism for funding renewable energy development and other

Table 1
List of abbreviations.

BPU	Board of Public Utilities (New Jersey regulatory agency)
IPP	Independent power producer
OCE	New Jersey Office of Clean Energy (state agency within BPU)
PSE&G	Public Service Gas & Electric (transmission and distribution utility)
PV	Photovoltaic
REC	Renewable Energy Certificate
RPS	Renewable Portfolio Standard
SREC	Solar Renewable Energy Certificate
T&D	Transmission and distribution

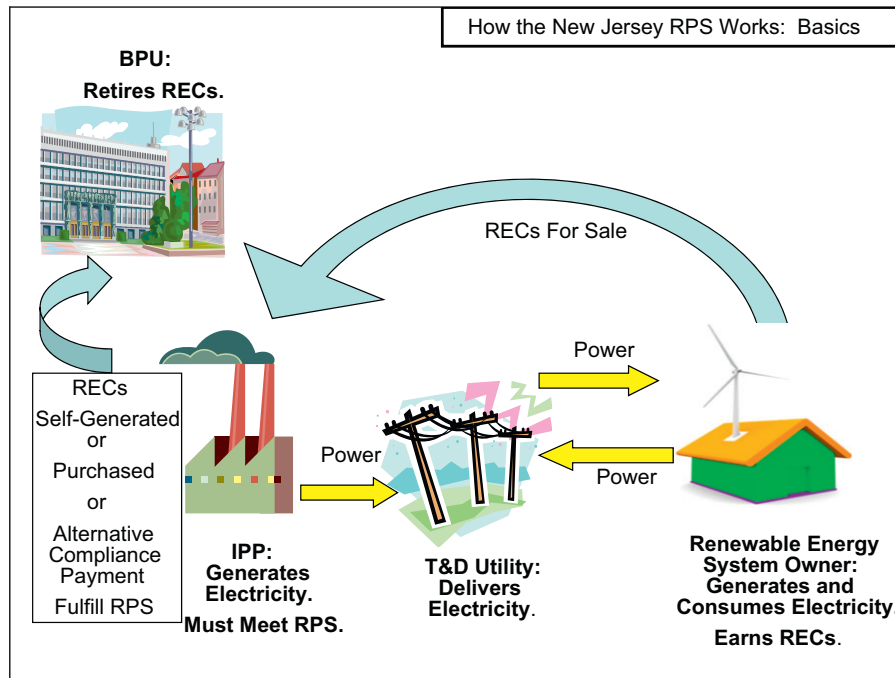


Fig. 1. How the New Jersey RPS works: basics.

activities that policy-makers anticipated would be squeezed out of the regular budgets of IPPs and T&D utilities by the new forces of competition (Kushler et al., 2004). Levied through the monthly electricity bills, the charge was expected to produce about \$1 billion over the first eight years after restructuring, some of which would be directed to programs that would help to fulfill the RPS (Covert, 2000).²

A conflict quickly emerged for control of these funds. A coalition led by an environmental group and the state's largest T&D utility called for the T&D utilities to administer energy efficiency and renewable energy programs, many of which they were already running, on a coordinated statewide basis. An alternative proposal, developed by the state's Ratepayer Advocate and its allies, argued that the responsibility should be placed with a new office within the state government (Covert, 2000, interview). After a year's delay, the former position prevailed. The BPU approved on March 9, 2001, a \$358 million, three year energy efficiency and renewable energy plan to be carried out by the T&D utilities (Business Wire, 2001; AP, 2001).

3. Making markets: the solar RPS "carve-out" and state rebate program, 2002–2006

In January 2002, partisan control of the New Jersey governorship shifted. The new governor won wide support from environmentalists in his campaign (Halbfinger, 2001). His appointee to the presidency of the BPU seized the opportunity that restructuring had created to build the PV market. Between 2002 and 2006, the new BPU president brought the administration of the programs funded by the Societal Benefits Charge into the agency and aggressively developed and expanded them, especially the rebate program for PV systems sited on customer

premises. The response of suppliers and customers to this new policy was rapid and widespread. The state provided rebates for just 37 PV systems in 2002; in 2006, the figure was 867 (OCE, 2009c).

Not long after the new governor took office, his appointees began laying the groundwork for shifting the administration of the state's renewable energy programs from the T&D utilities to the BPU itself. The first step was an audit that harshly criticized utility management of these programs. This step was followed by a report from the Clean Energy Council, an advisory body to the BPU made up of stakeholder representatives and chaired by the BPU president, that recommended the shift to state control (OCE Annual Report, 2003; Ress, 2001; Sullivan, 2002). That recommendation was carried out in 2003 with the establishment of the New Jersey Office of Clean Energy (OCE) as an operating arm of the BPU and with administrative responsibility for the renewable energy program.

This administrative shift was a prelude to a substantive one, in which the RPS was dramatically expanded and PV given precedence in New Jersey's renewable energy policy. The new design for the RPS derived from the work of the Governor's Renewable Energy Task Force, which was chaired by the BPU president and dominated by renewable energy advocates. Its April 2003 report called for the 2008 RPS requirement to be doubled to 4% (the level that had been previously set for 2012) and to hit 20% in 2020. The task force also recommended "that a comprehensive set of policies be developed that will enable substantial levels of photovoltaic solar generation capacity to be developed in New Jersey..." (Renewable Energy Task Force, 2003, p. 5). It declined to make a more detailed recommendation, but one of the options that it considered, "mandating that a minimum percentage of the RPS Class 1 requirement be met with renewable energy produced from photovoltaic solar sources," was, in fact, adopted by the BPU, beginning in 2004 (OCE Annual Report, 2004).

This solar "carve-out" within the RPS or "solar RPS" became the foundation for subsequent policy-making. The solar RPS mandated that 90 MW of PV system capacity should be installed in New Jersey by New Year's Day of 2009 (OCE Annual Report,

² Vertically integrated electric utilities had been authorized before the restructuring to impose charges for purposes similar to those of the Societal Benefits Charge. The restructuring legislation reorganized the process for setting the charge and using the funds generated.

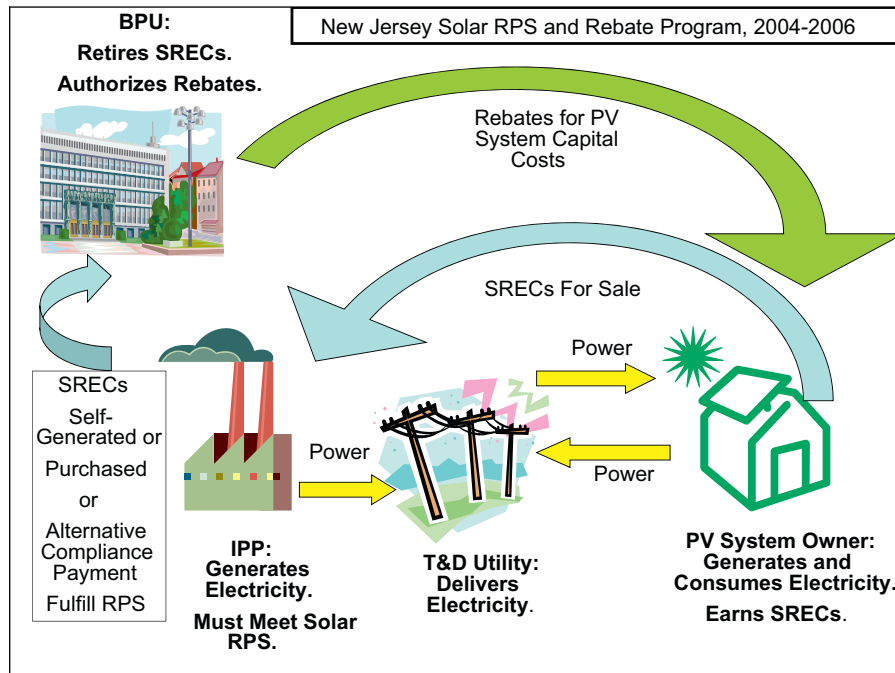


Fig. 2. New Jersey solar RPS and rebate program, 2004–2006.

2004). A later revision specified that 2% of the state's electricity generation should be provided by solar power in 2020, expanding installed PV capacity to an estimated 1500 megawatts by that date³ (OCE, 2006a). The state's renewable energy budget, comprised almost entirely of PV-related programs, quickly surpassed its energy efficiency budget, which had been three times larger when the T&D utilities managed these programs (OCE Annual Report, 2003, 2004; Business Wire, 2001).

The Societal Benefits Charge was raised to support this spending (Johnson, 2005). In late 2004, the BPU approved a four year budget for energy efficiency and renewable energy of \$745 million, roughly 50% larger on an annual basis than the budget of the prior administration. Those interviewed for this paper generally agreed that New Jersey's leaders shared a vision of the state's electricity system in which its carbon footprint grew more slowly, the power of the T&D utilities was reduced, and system reliability was improved. They differ as to why the state focused so heavily on PV to achieve these goals. Among the reasons offered were the effective advocacy of the solar industry and the relative ease of siting and building PV systems, particularly compared to windmills, especially windmills along or off the shore, where New Jersey's wind resources are concentrated.

At the core of the new solar policy was a rebate program that aimed to reduce the capital placed at risk by buyers of PV systems (see Fig. 2). This risk was a central barrier to the development of the PV market. A PV system that would power a typical home or small business required an investment of \$50,000 or more, which was steep hurdle for most home or business owners. The program initially provided rebates of up to 70% of a PV system's installed cost. Over time the rate was stepped back, so that by the end of 2006, the highest subsidy level had declined to about 50% of the installed cost.⁴

³ The 2008 New Jersey Energy Master Plan calls for the solar carve-out to be defined in terms of absolute capacity, rather than as a share of capacity. See Table 2.

⁴ Summit Blue Consulting (2008, 6) calculated that the average cost of the rebate per watt over the program's lifetime was \$3.88. Total installation costs remained flat throughout the program, averaging around \$8 per watt.

The rebates varied according to the type of owner and size of the system. This design was intended to roughly level final unit costs of installation across the various categories of ownership and size. Larger systems received lower rebates per installed watt of capacity, because unit costs decline as systems get larger. Public schools and other public projects received higher rebates than private projects at every system size, since their owners were unable to access federal tax incentives that supplemented the state rebate for many private PV system owners.

The rebate program's budget was divided into several segments that corresponded roughly with the categories used to set subsidy levels. Segmentation served an important political purpose. Solar power's most vocal supporters were small system installers and activist residential customers. If the policy had allocated funds to the least expensive projects on a cost per watt basis, this segment would likely have been excluded because of their high unit costs. That in turn would have weakened the coalition behind the solar RPS policy. The rebate program's segments also aligned with the ratepayer classes used in regulating electricity prices, so that the charges imposed on each ratepayer class to support the program were perceived to flow back to that class through the rebates.

The rebate program greatly facilitated access to project financing. An applicant for a rebate submitted to the state a signed contract to install a PV system and a technical worksheet. If these documents met the program criteria and as long as funding was available within the appropriate segment, the applicant received a commitment letter from the state, certifying eligibility. This letter, in turn, could be used to secure bridge financing, often from the equipment vendor, for the amount to be rebated. Once the system had been installed and inspected, the rebate paid back the bridge loan.

Even with the up-front capital subsidy provided by the rebate program, most PV systems would not have been financially viable unless their owners could sell any excess power that they generated to the grid. A residential system owner who is at work on sunny weekdays would lose much of her system's output without this option, or would have to buy expensive storage capacity. A commercial system owner, similarly, benefits greatly

from being able to sell power to the grid on the weekend when his office is closed.

“Net” metering made this two-way flow possible. PV-generated power that is not used by the system owner flows out to the grid and drives the owner’s electric meter backward. When the owner needs more power than the PV system can provide, the meter runs forward, like that of any other customer. In the optimal case, the “net” in net metering is zero, which means that the PV system owner avoids paying for any electricity at all.⁵ Electricity rates rose about 30%, from about 10 cents per kWh to 13 cents per kWh between 2002 and 2006, enhancing this incentive (Summit Blue, 2008, p. 46). Ease of interconnection was also a necessary condition for the success of the rebate program. The use of equipment precertified for safety, minimal fees, and rapid processing of applications by the interconnecting T&D utility all facilitated PV adoption and cut costs (Network for New Energy Choices, 2007).

By all accounts, the BPU did an excellent job of establishing and implementing net metering and interconnection standards. The U.S. Solar Energy Industry Association labeled these standards “far and away the best framework” for other states to adopt (OCE, 2005). The annual “Freeing the Grid” report of the Network for New Energy Choices (2007, 2008) gave New Jersey the highest grade of any U.S. state. Installers interviewed for this paper agreed that the interconnection and net metering process had become routine. The state encouraged commercial and public agency participation in the program by allowing relatively large systems to be net-metered, which was not the case in many other U.S. states.

New Jersey policy-makers provided an additional financial supplement to PV system owners by creating a market for solar RECs (SRECs). IPPs were required to fulfill the solar RPS by buying SRECs, just as they met the RPS as a whole by buying RECs (which might be generated by wind, biomass or other renewable energy systems).⁶ For each megawatt-hour of electricity that a PV system generated, the owner earned one SREC. The BPU successfully established the infrastructure for SREC issuance and trading. The trading platform went live in August 2004 (Summit Blue, 2008, pp. 54–57). SREC trading volume grew steadily, as would be expected with the expansion of PV generating capacity.⁷ Prices ranged from the equivalent of about 10 cents per kWh (about the same as the avoided electricity cost) to about 26 cents per kWh (roughly twice the value of the avoided electricity cost) between the beginning of trading in 2004 and the end of 2006 (OCE, undated-c).

Although the promise of eliminating electricity bills and profiting from SRECs in the future figured into PV system purchasing decisions (see Fig. 3), there is no doubt that the rebate dominated these calculations. A 2006 survey found that rebate program participants:

indicate that the rebate played a pivotal role in their decision to install a renewable energy system. Only 26% of survey respondents said they would have installed the system if the rebate was just 25% less than they received, and 94% of respondents indicated that the rebate made it possible for the investment to meet their simple payback requirements (Summit Blue Consulting, 2008, p. 52).

⁵ A PV system’s size is typically limited in New Jersey so that it produces no more than the annual consumption of the customer installing it. In other words, the net meter cannot run in the customer’s favor over the course of a year.

⁶ IPPs could also earn SRECs by installing their own solar systems or pay the alternative compliance payment (also known as the penalty payment) to meet their RPS obligations. See Fig. 2 and Section 4 below.

⁷ Summit Blue Consulting (2008, p. 56) notes that many owners of PV systems apparently do not sell their SRECs.

The establishment of the rebate program, net metering and interconnection standards, and SREC trading stimulated rapid growth in the PV market between 2004 and 2006. The number of projects tripled in 2004, while the capacity installed and dollar value of rebates approximately doubled. These indicators quadrupled in 2005 and doubled again the following year, even though rebate levels were reduced four times during these two years. About 18 MW of solar PV generating capacity was installed in New Jersey during the program’s last full year of operation, with the help of more than \$78 million in state rebates (OCE, 2009c).

The rebate program brought a solar installation industry into being in New Jersey almost instantaneously. National and regional solar energy firms with experience in California, New York, and other states quickly extended their business models to New Jersey. Existing New Jersey firms in businesses like construction and HVAC (heating, ventilation, and air conditioning) added PV systems to their portfolios (interview). Little new knowledge was required to do so; indeed, do-it-yourself installation was feasible for householders with a free weekend and a little mechanical skill (interview).

In addition to PV hardware and installation services, the industry provided customers with information and reassurance as they considered spending large sums of money on a technology that had been something of a novelty item in the past. Solar firms reached out to communities to find customers. They explained the intricacies of New Jersey’s policy to customers and took care of the state’s paperwork for them. They helped customers gain confidence in the policy as well as the technology.

Financial considerations predominated amongst both residential and commercial customers, with environmental motivations serving at most as a secondary rationale (interview). Buyers judged the investment in a PV system to be a good value, thanks especially to the rebate program. Those who did not have the cash to cover the remainder of the cost after the rebate accessed financing in a variety of ways. Residential buyers often took home equity loans (interview). In the commercial sector, which could typically take advantage of federal as well as state incentives, loans and leases were the most common financial structures. Relatively few systems operated under power purchasing agreements in which an investor owns the PV system and the owner of the property on which it sits agrees to buy its output for an extended period of time.

The outsized response of the market to the availability of generous public subsidies and easy, reliable PV system installation proved to be the undoing of New Jersey’s policy. The proximate cause of the bust phase of this boom-and-bust cycle was the exhaustion of the rebate program’s nearly \$500 million, four-year budget. Despite the steady decline in the value of the rebate on a unit basis, the total value applied for quickly exceeded the amount budgeted. In February 2006, OCE began to require solar rebate applications for private projects to wait in a queue, pending available funding. In December, 2007, the BPU finally ordered the program suspended, because the amounts requested by applications in the queue totaled more than the funds that remained. By then, the Board was well along in an exploration of new ways to sustain the growth of the market that it had created.

4. Breaking markets: the solar policy transition, 2006–2008

The budget crisis in the New Jersey PV rebate program sparked an intense debate about how to maintain the momentum that the state’s solar policy had created and thereby fulfill the state’s ambitious renewable energy goals. The BPU resolved this debate by adopting what the BPU president termed “a fiscally responsible market-based approach to solar financing that strives to achieve

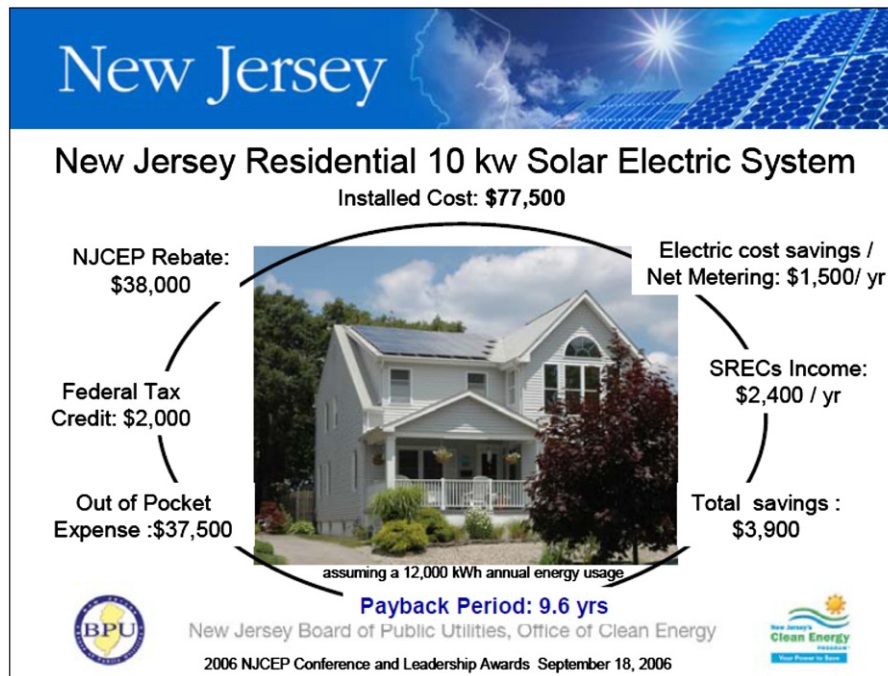


Fig. 3. New Jersey solar financing model as presented by the State's Office of Clean Energy, September 2006. Source: Winka, 2006.

Table 2
Actual PV capacity installed and New Jersey RPS goals (in MW).
Sources: OCE, 2009c (for actual data); OCE, 2009b (for RPS goals).

	Incremental		Cumulative	
	Actual	RPS goal	Actual	RPS goal
EY2001–2005	4.5		4.5	5.2
EY2006	10.4	4.3	14.9	9.5
EY2007	17.6	20.3	32.5	29.8
EY2008	17.7	29.6	50.2	59.4
EY2009	26.1	57	76.3	116.4
EY2010	49.7 ^a	44.4 ^b	126.0 ^a	160.8 ^b
EY2011		61.1 ^b		221.9 ^b
EY2015		104.8 ^b		556.6 ^b
EY2021		206.6 ^b		1542.4 ^b

^a EY2010 actual through December 31, 2009 only (i.e. first seven months of the energy year) and includes systems that have been certified, are being processed, or have selected qualified contractors.

^b Future RPS goals reflect proposed revisions based on the 2008 Energy Master Plan.

solar RPS at the lowest annual cost to ratepayer” (OCE Annual Report, 2007, p. 2). The Board’s new approach relied primarily on SRECs and significantly reduced rebates. The transition to the new approach was not smooth. The state’s “self-inflicted wounds” (in the words of one observer) stalled the PV market’s growth, damaged some participants, and left the state far short of its 2009 solar RPS goal. (see Table 2).

Mathematically minded observers of New Jersey solar policy anticipated the rebate program’s budget troubles even as the program’s proponents lauded its success. Summing up the situation in September 2006, the director of the state Office of Clean Energy estimated that relying on rebates to reach 1500 MW of solar capacity by 2020 would cost about \$500 million per year and raise electricity rates by 5–7%. Given that PV would be supplying only 2% of the state’s electricity in this scenario, the anticipated cost was perceived by the BPU to be too far out of line. “Clearly,” he wrote, “it is not an option to simply ‘buy’ our way to the RPS goals” (Winka, 2006, p. 3). A BPU member echoed this

sentiment, pledging that the PV market would not be “a bottomless pit where government money is wasted” (Johnson, 2007).

Downward revision of the RPS was not on the table in 2006. If anything, the political and environmental rationale for an aggressive state renewable energy policy had grown stronger. A new state governor, who was elected in 2005, promised in his campaign to meet the “20% by 2020” RPS target and to reduce the state’s total energy consumption by 20% by 2020 as well (Diskin, 2005). The governor followed up by signing legislation mandating reductions in the state’s greenhouse gas emissions in 2007 (Electric Power Daily, 2007) and implementing New Jersey’s participation in a regional cap and trade system in 2008 (Platts Commodity News, 2008). The state’s Energy Master Plan, released in October 2008, reaffirmed the commitment “to place New Jersey at the forefront of a growing clean energy economy” (State of New Jersey, 2008, p. 6) and called for the RPS goal to be raised to 30% by 2020 while holding energy demand at 2008 levels.

In May 2006, the BPU established an RPS Transition Working Group to develop solar policy options that would be less reliant on rebates. The group identified two basic alternatives for sustaining the PV market, SRECs and a feed-in tariff. As discussed in the introduction to this paper, a feed-in tariff would require T&D utilities to purchase PV-produced electricity at a higher-than-market rate for a specified period of time. Potential enhancements to the expected revenue stream provided by SRECs considered by the Working Group included (1) guaranteeing a minimum price for SRECs through long-term contracts (2) auctioning SRECs directly to IPPs (who are responsible for meeting the RPS) in shorter-term contracts, and (3) expanding the allowable scale of projects receiving SRECs. Various combinations, permutations, and refinements of these elements were discussed by policy-makers in the wake of the Working Group’s report (OCE, 2006b; Summit Blue, 2007).

Both SRECs and a feed-in tariff would have shifted the fiscal burden of the solar RPS from the present to the future and placed it within the electricity rate structure, rather than the state budget. The approaches differed in the certainty that they offered PV system owners for eventually recouping their investments.

A feed-in tariff would lock in the return on a fixed schedule. The value of SRECs, however, would only be determined by the market for SRECs at a stream of future dates. BPU staff and consultants (Summit Blue, 2007) worried that this market risk would undermine the SREC policy's effectiveness. "In order to allow for a market-based system," wrote the director of the state Office of Clean Energy, "the BPU will need to set the floor price below which all buyers must pay a certain price and no lower" (Winka, 2006, p. 4).

But, after more than a year of debate, the BPU settled on a policy that relied primarily on SRECs and left their value to be determined largely by the market (BPU, 2007). The policy's most important innovation was to raise the alternative compliance payment for IPPs (also known as the "penalty payment") that failed to meet the solar RPS and did not buy enough SRECs to make up their shortfall. The penalty payment rose from \$300 to \$711 per megawatt-hour, which effectively became a price ceiling for SRECs.⁸ The Board also continued the rebate program for small PV systems, but at a much lower level than in the past (declining from \$3 per watt in 2009 to 75 cents per watt in 2012) and with a much smaller budget (\$53 million over four years).⁹ Also notable was what the BPU did not do: it did not create a contracting or auction mechanism that would yield a price floor for SRECs, nor did it remove the cap on system size to take greater advantage of economies of scale (OCE, 2007).

Those interviewed for this paper were uncertain about the exact motivations for this decision. For some, it reflected a market-oriented mentality flowing from the governor. Others sensed an unspoken imperative to limit the perceived cost of the policy, a view supported by the inclusion of a "circuit-breaker" in the new policy that would freeze the program if its rate impact exceeded 2%. In addition, state policy-makers perceived the proposed feed-in tariff as a form of taxation that created a political vulnerability, even though this approach was strongly supported by some of the state solar industry's most prominent leaders (interviews).

The implementation of the new policy in 2007 realized the pessimistic predictions of the BPU staff and consultants, rather than the optimistic hopes of the Board's leaders. Many lenders took a conservative view of future SREC earnings and so refused to finance new systems against those earnings. As one solar industry executive put it, the New Jersey solar market went on a "hiatus" (interview). The residential market was particularly hard hit, dwindling, by one account, to a few cash-rich customers who were willing to self-finance their projects (interview). The transition "wreaked havoc" on small businesses that had placed residential PV installation at the core of their business model (interview).

Federal tax incentives that were put in place in 2006 buffered the commercial market somewhat from the downdraft caused by the new state policy. The investment tax credit, which was raised from 10% to 30% and supplemented by the ability to depreciate the investment on an accelerated schedule, allowed some projects to reach viability without the state rebate and without an SREC floor price.¹⁰ This market was also aided by "financial innovation"

(Bolinger, 2009) which created vehicles that allowed investors with "tax equity" to match up with project developers.¹¹ However, the state's decision to limit any entity from earning SRECs from more than two MW of solar generating capacity, as well as the relatively low rates (wholesale prices) paid by the T&D utilities for PV-generated power, limited the reach of this innovation in New Jersey (interview).

The BPU apparently hoped that IPPs generating power by conventional methods would provide financing for some solar projects by agreeing to purchase their SRECs on a long-term basis. Such deals would fix the IPP's cost of compliance with the RPS and hedge against fluctuations in the SREC market. However, because New Jersey rebids its base electricity load every three years, generators cannot be confident that they will need SRECs over a longer period than that. "Securitization" of SRECs, as this financing model was called, proved to be a mirage.

Anecdotal reports of cancelled projects and failed businesses congealed into hard data as the new policy was implemented. New Jersey's initial "20 by 2020" RPS schedule called for 90 MW of solar capacity to be installed by the end of energy year 2008 (May 31, 2008) and another 50 MW to be installed in energy year 2009 (OCE, undated-a). By early 2009, it was clear to all observers that the state was "behind schedule" (interview) at a minimum. A recent accounting from OCE stated that about 50 MW of PV capacity were installed between the beginning of the state's program and the end of energy year 2008, and another 26 MW were certified during energy year 2009. Meanwhile, the RPS goals were quietly scaled back, because the recession depressed electricity sales and the solar carve-out is based on a percentage of these sales. In addition, the state assumed that the "no growth scenario" for electricity sales after 2008 laid out in its Energy Master Plan would be realized in the coming four years, reducing the goals for those years (OCE, 2009b). (After 2013, the state expects to shift to a fixed solar capacity requirement, rather than a percentage of sales, which, if achieved, would put capacity growth on a trajectory to surpass the original goal for 2020.) Yet, even at the lower levels, the EY, 2009 shortfall was about 40 MW of installed capacity or a third of the total (OCE, 2009c) (see Table 2).

RPS shortfalls should trigger penalty payments. If SRECs stay at the price that prevailed in early 2010, which is at or near the penalty level (a "gold mine" for current system owners, in the words of one system installer), more investors will sense an opportunity in New Jersey solar projects.¹² However, the mismatch between the three year time horizon held by IPPs that are selling baseload power to New Jersey and the ten year time horizon that the BPU used to calculate the penalty level means that the IPPs are unlikely to fill the financing gap even with the threat of penalties hanging over them. The penalties are simply too small to warrant them taking the risk of financing PV systems.

The evaporation of tax equity as a result of the financial crisis that began in 2008, which wiped out most of the profits against which tax credits had been taken, eliminated that source of funding as well. The federal stimulus package was seen by some in New Jersey as a potential source of funds for solar projects in early 2009, but its direct impact proved to be modest. The BPU, in any case, was not content wait and see whether its "self-inflicted wounds" would be healed either by federal intervention or by the SREC market. Instead, it sought to revive the market by tapping

⁸ An eight year declining schedule was established for the penalty payment on the assumption that system prices would also decline over that period.

⁹ The rebate levels have recently been revised downward to a range of \$1.00 to \$1.75 per watt for eligible PV systems. See OCE, 2009a.

¹⁰ The investment tax credit was renewed for a year in late 2007 and then for eight years in 2008. The uncertainty associated with these renewals created temporary disruptions in the market during part of this period. The 30% investment tax credit was capped in 2006 at \$2000 for residential systems, which was too small a share of the total cost of most residential systems to significantly impact the financing decision. The cap was removed in 2008. Accelerated depreciation is known formally as the Modified Accelerated Cost Recovery System (MACRS).

¹¹ "Tax equity" is a presumptive tax liability that investing in a solar project allows the investor to avoid. Financial institutions accruing large profits in this period, such as banks and investment houses, were typical tax equity investors.

¹² Monthly prices can be reviewed on the OCE website at <http://www.njcleanenergy.com/renewable-energy/programs/solar-renewable-energy-certificates-srec/pricing/pricing>. Many trades during 2009 were reported in the high \$600 range.

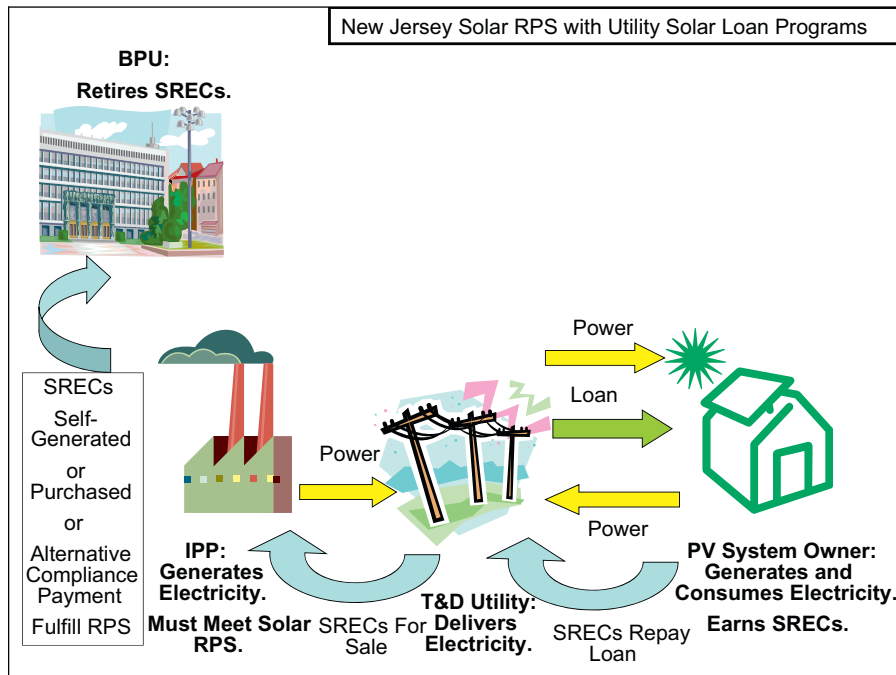


Fig. 4. New Jersey solar RPS with utility solar loan programs. (Note: As noted in the text, a small state rebate remains available for residential systems through 2012, but this program is not represented in the figure. It is also possible that PV system owners would generate more SRECs than are required to cover loan repayment; these could be offered for sale by the owner.)

Source: Author.

into the only off-budget source of funding that it had available: the T&D utilities that it regulates.

5. Remaking markets? the T&D utilities, “patient capital,” and solar policy, 2008–2009

New Jersey’s T&D utilities began the decade of the 2000s at the center of the state’s energy efficiency and renewable energy programs. Even after restructuring, they administered these programs, which were now funded by a charge that appeared on every ratepayer’s bill. However, the change of partisan control of the state government in 2002 led to their removal from this position, leaving them with only a few small efficiency-related programs (interview). The solar RPS shortfall that emerged in energy year 2008 led the BPU to rethink the role of the T&D utilities, even as the state’s largest T&D utility, *Public Service Electric & Gas (PSE&G)* (2009), sought a larger role in the solar RPS program. The BPU turned to what it called the “patient capital” of the T&D utilities to bridge the solar financing gap created by uncertainty about future SREC pricing. PSE&G, for its part, proposed building PV capacity that it would own and operate as well as financing others’ systems. Its effort revived the New Jersey PV market during the 2009 calendar year.

Within a few months after settling on the new SREC-intensive policy in September, 2007, the BPU felt “the gravity and urgency of the situation” it had created. New Jersey’s solar market had become frozen due to a lack of financing for new PV systems. The credit squeeze, which dated back to the beginning of the transition debate in early 2006, was not eased by the Board’s policy decision, creating pressure for policy-makers to do something more. Yet, the BPU was not ready to reopen the core issues. “We have our model,” stated one BPU member in May 2008, “and the Board will not consider a feed-in tariff or any other non-competitive mechanism involving fixed pricing. We...are

focused on developing a securitization solution expeditiously” (BPU, 2008a).

A central element of that solution was already in sight, in the form of PSE&G’s “solar loan” program. First broached with the BPU in April 2007 and officially announced by PSE&G in April 2008, the program put aside \$105 million to fund up to 30 MW of PV generating capacity over two years. PSE&G agreed to take repayment of these loans in SRECs, and, crucially, it set a floor price of \$475 for each SREC that it would receive over the ten year life of each loan. PSE&G proposed to aggregate these SRECs and sell them to IPPs, which could then use them to meet the RPS. (See Fig. 4.) If the SREC market price at the time of sale (which must be within two years of the date of SREC’s issuance) was below the \$475 floor, PSE&G would lose money on the transaction. PSE&G made clear that it would not try to maximize its own gains in the SREC market, but would instead sell SRECs in a transparent auction process and credit borrowers with the market price if it was above the \$475 floor (PSE&G, undated-e).

The PSE&G solar loan program built on several precedents established by the state’s solar rebate program. It offered to fund 40–60% of the capital cost of each system. It divided the market into customer segments that bore a strong resemblance to those used by the rebate program and allocated specific shares of the budget to each. (In fact, residential PSE&G solar loan borrowers generally remained eligible to receive state rebates at the new reduced rates from 2009 to 2012.) As in the rebate program, PV system scale was limited by interconnection and net metering rules and by the customer’s historical annual energy usage (PSE&G, undated-b, undated-c, undated-d).

PSE&G’s motivation for offering this program, which seemed to promise at best to break even and at worse to lose money, may have been political. With the state moving toward implementing a mandatory greenhouse gas emissions reduction policy, the company may have wanted to create the public perception that it shared the state’s environmental commitment, even at the risk of taking a modest financial loss. Any loss would ultimately be

recouped through the rate base, although that facet of the program was not made explicit immediately. The company may also have seen the solar loan program as a way to learn more about the solar industry and to build business relationships as it considered entering the industry directly. At the same time, PSE&G may well have anticipated that, because the T&D utilities were the only deep-pocketed entities within the reach of the BPU, it would be required to take some action to address the crisis in solar policy and therefore sought to set the terms of such a requirement preemptively.

Whether PSE&G, the solar industry, or the state was the first mover in creating the new arrangement, the BPU institutionalized it with an order at the end of July, 2008, that applied to all four of the state's T&D utilities. The Board required the T&D utilities to finance 60% of the incremental PV capacity called for by the RPS in 2009, 50% in 2010, and 40% in 2011. The financing was to be provided through long-term contracts for SRECs at prices that would give system owners a payback period of about ten years (BPU, 2008b).

The three smaller T&D utilities (those other than PSE&G) chose to comply with the Board's order by setting up what amounted to a reverse auction, rather than setting a fixed floor price for SRECs as PSE&G had. Each PV system developer who wants to participate in these firms' programs proposes a minimum acceptable SREC price. The T&D utilities then offer long-term contracts to purchase SRECs from those projects for which the costs over the term of the contract will be lowest, until they meet their Board-mandated capacity quotas (which total 61 MW through 2012). They will recover any costs of this program (net of SREC revenues) through a separate charge on all customers. The program is limited, by BPU order, to systems under 500 kW in size, and the companies have agreed to an "aspirational goal" that 25% of the capacity in the program be comprised of systems of 50 kW or less. Like PSE&G, the other T&D utilities will sell SRECs to IPPs through a transparent auction process (interview, BPU, 2009b; OCE, undated-b).¹³

These T&D utilities would prefer that the size limitation and the associated aspirations to serve the smaller system market that were imposed by the BPU be removed altogether (interview). Larger systems have lower unit costs, and therefore their developers should be able to accept a lower SREC price. A smaller number of contracts with developers of larger projects should also lower the programs' administrative burden. PSE&G's experience to date with its solar loan program reveals a bias toward larger systems as well. Although the initial allocation to the residential segment of the program when it was announced was 6 MW out of the 30 MW total, the company reported that it actually funded 28.7 MW of non-residential systems when the program was concluded in late 2009 (PSE&G, undated-a).

The BPU approved this reallocation from smaller systems to larger ones, presumably to try to close the solar RPS shortfall as quickly as possible. Through the first seven months of energy year 2010 (June 1–December 31, 2009), some 50 MW of PV capacity were installed or had been contracted for (OCE, 2009c). That is nearly twice the capacity installed in the entire previous year (see Table 2). The Board's accession to the financial and administrative logic of relying on larger PV systems is also suggested by the fact that nine of the ten largest PV systems in the state (all larger than 1 MW) were approved in calendar year 2009 (OCE, 2009c). The Board's reluctance to accept this logic altogether (as evidenced by

the size limitation and "aspirational goal"¹⁴) probably reflects concern over the fate of smaller solar industry firms (interview), who remain suspicious of the T&D utilities.

Perhaps the most consequential move toward large systems made by the BPU was its removal of the two MW limit on solar generating capacity from which a single entity was permitted to earn SRECs (BPU, 2009a). This decision coincided with PSE&G's announcement of a \$515 million, five year program to build 80 MW of PV capacity that it would own and operate (see Fig. 5). Most of these "in-front-of-the-meter" systems will be built on brownfield sites owned by the company or placed on 200,000 electric poles around the state (Holly, 2009).¹⁵ PSE&G expects to build this capacity at a cost of \$6.44 per watt, 22% less than the \$8.25 per watt it estimated that projects funded by the earlier rebate program cost (PSE&G, 2009). It plans to partner with independent developers on some of the new systems, although it will also use its own personnel.

With this announcement, PSE&G joined a select group of electric power companies around the U.S. that are making substantial investments in distributed solar power (Wang, 2008). The federal government encouraged this trend in the October 2008 TARP bill, which, in addition to extending the 30% investment tax credit for solar power through 2016, permitted utilities to claim the credit for the first time. If, however, federal subsidies and SREC sales fail to allow PSE&G to make back its investment, the investment will be recovered from ratepayers through a separate charge (PSE&G, 2009; BPU, 2009c). This program not only enhances PSE&G's "green" public image, it also puts the firm back into the power generation business in a relatively risk-free manner. In pursuit of the RPS goals, the BPU has reversed – albeit in a very small way for now – the vertical disintegration imposed by the restructuring of the New Jersey electricity market in 1999.

6. Conclusion: sustaining markets for PV electricity

In November, 2009, the voters of New Jersey elected yet another new governor. As a candidate, the new governor affirmed that he would "push hard on renewable energy," but he also stated that he would remove the issue from the BPU's purview and focus solar policy on projects at landfills and in rural areas (Birretteri, 2009). This change in control of the governorship, which may well bring another turn in the history of New Jersey's PV policy, provides a convenient stopping point for this case study. In this section, I touch on the key points of the narrative and highlight insights that may be applicable to other jurisdictions across the U.S. and elsewhere as well.

The case unfolded in four phases. The first phase witnessed the establishment of institutions that were not necessarily designed to support PV market development but which would later be drawn upon for that purpose: a vertically disintegrated electricity sector, a protected market for renewable electricity generators, and a mechanism for subsidizing renewables through a charge on ratepayers. In the second phase, which began with the inauguration of a new governor in early 2002, New Jersey made a strong

¹³ The first reverse auction for this program was held in September, 2009, and yielded contracts for 1.6 MW of solar capacity, about 10% of what had been anticipated (Powers, 2009).

¹⁴ In PSE&G's second solar loan program, which was approved by the BPU in November 2009 and will fund 51 MW over two years, the 500 kW size limitation and allocation of capacity across categories were reinstated (BPU, 2009d). The floor prices for SRECs in this program will also decline over time.

¹⁵ PSE&G originally proposed another 40 MW of capacity that it would build for municipalities and school districts, but this component of the program was rejected by the BPU. 15 MW of the 80 MW approved will be placed at third party locations and in urban enterprise zones.

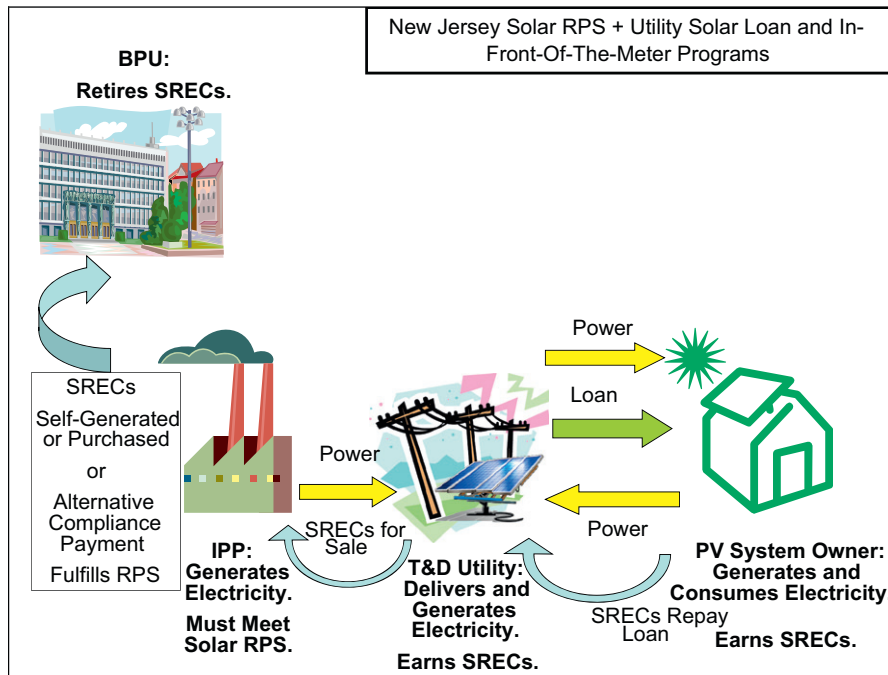


Fig. 5. New Jersey solar RPS+utility solar loan and in-front-of-the-meter.
Source: Author.

commitment to PV, far stronger than it made to any other renewable energy technology, stronger even in budgetary terms than its commitment to energy efficiency. The state quickly established a highly effective net metering and interconnection regime and a trading platform for SRECs, which were essential prerequisites for the growth of the PV market.

The most crucial step in this phase, however, was the enactment of a generous rebate to cover much of the up-front cost of PV system installation. As in other settings, notably Spain, calibrating the subsidy to produce fiscally sustainable growth proved to be difficult. Multiple reductions in subsidies just months apart failed to stem the market's explosive growth. One may speculate that relatively high subsidies were necessary to surmount social psychological barriers to market acceptance of PV systems. Simple ignorance on the part of some potential customers and the image of solar power as unreliable held by others may have deterred them from thinking carefully about its costs and benefits. Once solar power had been legitimated by the subsidy – especially in the context of rapidly rising oil prices – the decision suddenly became easy for many customers. This interpretation suggests that the diffusion of PV technology depends as much on positive feedback effects within social networks as on rational calculation. The high subsidy that may be required to get customers to take solar power seriously means budget trouble once they do.

Faced with a demand for rebates that outran the program's budget, the state turned to a policy that relied primarily on SRECs in the third phase of this case study. Many participants in the PV market and in PV policy, including the BPU's own staff and consultants, anticipated that this approach would not provide sufficient security to lenders whose money was needed to sustain the market. Yet, the BPU seems to have been compelled for political and ideological reasons to pursue the SREC-intensive approach as a "market-based" alternative to a feed-in tariff. Even at its relatively modest scale in 2006, the rebate program was provoking a backlash from ratepayers and fiscal conservatives. The ratepayer burden was amplified by the perceived political necessity of subsidizing smaller systems that had the highest unit

cost. There was no solution to the capital gap, in this interpretation, other than to take a chance on SRECs.

In the event, the BPU's SREC-intensive approach left New Jersey well short of its solar RPS goals. PSE&G's double step forward during the ensuing crisis, in the form of the 2008 solar loan and 2009 in-front-of-the-meter programs, created the key innovation that distinguishes the final phase of the story to date. The apparent enthusiasm of the state's largest T&D utility for PV technology provided the basis for the Board to extract comparable funds from other T&D utilities. The T&D utilities' "patient capital" has erased much of the solar RPS shortfall in the short run.

In the long run, the T&D utilities will be able to recover their costs from the ratepayers. If the market price of SRECs remains high, those costs will be modest, since they will depend on the difference between the T&D utilities' advance guarantee and the market price at the time of sale. Ironically, that outcome would indicate that the state's policy is not inducing very much PV capacity growth. On the other hand, if the market price comes down because PV power is more abundant – perhaps because its cost has declined, as proponents hope – then the costs will be significantly higher. In any case, today's ratepayers are shielded from these costs, while those in the future are committed to pay them.

The T&D utilities may eventually become supporters of New Jersey's PV policy, especially if PSE&G's in-front-of-the-meter program proves to be profitable. Their involvement might drive technological progress in PV forward more rapidly, especially by providing scale economies that drive down installed costs. They may also be able to join forces with the existing solar industry by partnering with key firms in project development and implementation. This "solution," though, brings with it its own risks. Guaranteed cost recovery is a disincentive to cost reduction. Some competition with independent, large-scale solar "farms" seems necessary to prevent T&D utility-generated solar power from traveling the well-trodden path of "goldplating" that plagued the vertically integrated electric power industry before restructuring. Finally, as I suggested above, one value of New Jersey's policy for its T&D utilities may be the prospect of undoing that restructuring and reintegrating generation with transmission.

The idea that T&D utilities may become core members of a pro-PV coalition may be difficult for many who have supported PV policy in the past to accept. Utilities have typically been highly conservative in their attitudes toward renewable energy. Yet, it is worth bearing in mind that many technological transitions are hastened when old-technology incumbents gain a share of the opportunities offered by new technologies. At a minimum, they relax or cease resistance to change. In some cases, they become active proponents of innovation, even if they do so only in order to shape the terms of the transition to their benefit. Whether that will prove to be so in this case remains to be seen. The larger question of whether that transition can succeed to the point of “grid parity” (in which PV and other forms of electricity are equal in price) also remains open. Many more markets the size of New Jersey’s will need to be created and sustained before the answer will be known.

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References

- Associated Press (AP), 2001. Public utilities board approves plan for new energy program. March 1.
- Barbose, G., Wiser, R., Bolinger, M., 2006. Designing PV Incentive Programs to Promote Performance. Lawrence Berkeley National Laboratory, Berkeley.
- Birritteri, A., 2009. Chris Christie responds to key business questions. *New Jersey Business*, October 1.
- Board of Public Utilities (BPU), 2007. Decision and order regarding solar electric generation. September 12.
- BPU, 2008a. NJ Board of Public Utilities reaffirms commitment to securitization of New Jersey’s solar market (press release). May 13. Available from <<http://www.njcleanenergy.com/main/press-room/press-releases-2008>>, accessed 3 January 2010.
- BPU, 2008b. NJ Board of Public Utilities issues solar financing order to promote solar growth in New Jersey (press release). July 30. Available from <<http://www.njcleanenergy.com/main/press-room/press-releases-2008>>, accessed 3 January 2010.
- BPU, 2009a. Notice. February 11. Available at <http://www.njcleanenergy.com/files/file/program_updates/NOTICE-RPS_rule_adoption_of_provisions_implementing_the_solar_transition.pdf>. accessed 13 May 2009.
- BPU, 2009b. JCPL and ACE solar financing order. March 27. Available at <http://www.njcleanenergy.com/files/file/CS_Marketing/JCPL_ACE_petition.pdf>, accessed 13 May 2009.
- BPU, 2009c. Solar4All order. July 29. Available at <<http://www.njcleanenergy.com/files/file/Utility%20Info/Board%20Order%20approving%20PSEG%20for%20Solar%204%20All%20Stipulation-S4A%20Order.pdf>>, accessed 31 December 2009.
- BPU, 2009d. Solar loan II order. November 10. Available at <<http://www.njcleanenergy.com/files/file/Board%20Orders/SLII%20Order.pdf>>, accessed 3 January 2010.
- Bolinger, M., 2009. Financing Non-Residential Photovoltaic Projects: Options and Implications. Lawrence Berkeley National Laboratory, Berkeley.
- Business Wire, 2001. New era in New Jersey for renewable energy and energy efficiency launched at energy futures forum. April 18.
- Clean Energy States Alliance, 2009. SLICE awards 2009 (press release). January 13. Available at <http://www.cleanenergystates.org/slice_awards.html>, accessed 19 February 2010.
- Cory, K., 2009. Renewable energy feed-in tariffs: lessons learned from the U.S. and abroad. Presentation to the National Summit on RPS, Chicago. November 18.
- Covert, J., 2000. Utilities, consumer groups square off over funds in New Jersey program. *Dow Jones Business News*, February 11.
- Diskin, C., 2005. Environmentalists back Corzine. *Bergen County Record*, October 15.
- Electric Power Daily, 2007. New Jersey OKs bill to cut GHG emissions. June 25.
- Frondel, M., Ritter, N., Schmidt, C.M., 2008. Germany’s solar cell promotion: Dark clouds on the horizon. *Energy Policy* 36, 4198–4204.
- González, P.R., 2008. Ten years of renewable electricity policies in Spain: an analysis of successive feed-in tariff reforms. *Energy Policy* 36, 2917–2929.
- Gouchoe, S., 2002. Effectiveness of State Financial Incentives. North Carolina Solar Center, Raleigh.
- Halbfinger, D., 2001. Sierra Club endorses McGreevey for Governor. *New York Times*. August 23.
- Hoff, T.E., 2006. Photovoltaic Incentive Design Handbook. National Renewable Energy Laboratory, Denver.
- Holly, C., 2009. New Jersey boosts solar profile with PSE&G project. *Energy Daily*. July 31.
- International Energy Agency (IEA), 2001. Trends in Photovoltaic Applications. IEA, Paris.
- IEA, 2009. Trends in Photovoltaic Applications. IEA, Paris.
- Johnson, T., 2005. Consumers will fund state’s promotion of technologies. *Newark Star-Ledger*, January 5.
- Johnson, T., 2007. Officials approve Jersey’s solar push – the system is part of goal to reduce state’s pollution. *Newark Star-Ledger*. September 13.
- Kushler, M., York, D., Witte, P., 2004. Five years in: an examination of the first half-decade of public benefits energy efficiency policies, American Council for an Energy Efficient Economy (ACEEE) Report U041. ACEEE, Washington April.
- Laird, F.N., Stefes, C., 2009. The diverging paths of German and U.S. policies for renewable energy: sources of difference. *Energy Policy* 37, 2619–2629.
- Muñoz, M., Oschmann, V., Tábara, J.D., 2007. Harmonization of renewable electricity feed-in laws in the European Union. *Energy Policy* 35, 3104–3114.
- Network for New Energy Choices (NNEC), 2007. Freeing the Grid. NNEC.
- Network for New Energy Choices, 2008. Freeing the Grid. NNEC, New York.
- Office of Clean Energy (OCE). Annual Report, 2003. OCE, Trenton.
- OCE Annual Report, 2004. OCE, Trenton.
- OCE Annual Report, 2007. OCE, Trenton.
- OCE, 2005. Nation’s best standards bring solar boom to New Jersey (press release). April 25. Available at <<http://www.njcleanenergy.com/misc/about-njcep/pr-nations-best-standards-bring-solar-boom-new-jersey>>, accessed 6 May 2009.
- OCE, 2006a. New Jersey leads the nation with expanded commitment to solar and clean, renewable energy (press release). April 12. Available at <<http://www.njcleanenergy.com/misc/about-njcep/pr-new-jersey-leads-nation>>, accessed 5 May 2009.
- OCE, 2006b. White Paper Series: New Jersey’s Solar Market Transition to a Market-based REC Financing System. Trenton, OCE. September 25.
- OCE, 2007. FAQ: NJ solar financing program (December 17, 2007). Available at <[http://www.njcleanenergy.com/files/file/SOLARTransitionFAQs121707fnl2\(2\).pdf](http://www.njcleanenergy.com/files/file/SOLARTransitionFAQs121707fnl2(2).pdf)>, accessed 13 July 2009.
- OCE, 2009a. Renewable Energy Incentive Program Guidebook. Trenton, OCE. January 9. Available at <http://www.njcleanenergy.com/files/file/Renewable_Programs/CORE/REIPGuidebookfinal0202mq.pdf>, accessed July 13, 2009.
- OCE, 2009b. Discussion only draft RRP5 rule amendments solar. July 9. Available at <<http://www.njcleanenergy.com/files/file/Committee%20Meeting%20Postings/inx/DISCUSSION%20ONLY%20DRAFT%20RPS%20Rule%20Amendments%20Solar%20060909%20drft.pdf>>, accessed 3 January 2010.
- OCE, 2009c. NJ solar installations as of 123109. Available at <<http://www.njcleanenergy.com/renewable-energy/project-activity-reports/installation-summary-by-technology/solar-installation-projects>>, accessed 19 February 2010.
- OCE, undated-a. Latest OCE estimate of RPS-driven demand for RECs & SRECs. Available at <http://www.njcleanenergy.com/files/file/Current_NJBPU_20by2020.pdf>, accessed 2 January 2010.
- OCE, undated-b. SREC-based financing FAQs. Available at <http://njcleanenergy.com/files/file/Utility_Info/SREC_FAQs_4-20-09.pdf>, accessed 13 May 2009.
- OCE, undated-c. SREC pricing. Available at <<http://www.njcleanenergy.com/renewable-energy/programs/solar-renewable-energy-certificates-srec/pricing/pricing>>, accessed 6 May 2009.
- Platts Commodity News, 2008. New Jersey lawmakers pass GHG bill over green groups’ objections. January 7.
- Powers, M., 2009. Two New Jersey utilities receive eight proposals in first solar certificate program. *Electric Utility Week*. October 5.
- Prior, J.T., 1995. Modifying the monopolies: utilities embrace deregulation. *New Jersey Business*. September 1.
- Public Service Electric & Gas (PSE&G), 2009. Solar 4 all petition. February 10. Available at <<http://www.pseg.com/solar/Attachments/Solarpetition.pdf>>, accessed 13 February 2009.
- PSE&G, undated-a. Current capacity commitments. Available at <<http://www.pseg.com/customer/solar/forecast.jsp>>, accessed 22 December 2009.
- PSE&G, undated-b. Frequently asked questions (FAQ) – non-residential. Available at <http://www.pseg.com/customer/solar/faq_non-residential.jsp>, accessed 3 February 2009.
- PSE&G, undated-c. Frequently asked questions (FAQ) – residential. Available at <http://www.pseg.com/customer/solar/faq_residential.jsp>, accessed 3 February 2009.
- PSE&G, undated-d. Program rules. Available at <http://www.pseg.com/customer/solar/pdf/program_rules.pdf>, accessed 3 February 2009.
- PSE&G, undated-e. PSE&G solar loan program. Available at <<http://www.pseg.com/customer/solar/index.jsp>>, accessed 13 May 2009.
- Reiche, D., Bechberger, M., 2004. Policy differences in the promotion of renewable energies in the EU member states. *Energy Policy* 32, 843–849.
- Renewable Energy Task Force, 2003. Report Submitted to Governor James E. McGreevey. April 24.
- Ress, D., 2001. Price of New Jersey’s cleaner power programs is 1 percent rate hike. *Knight Ridder Tribune Business News*. March 2.
- Rowlands, I.H., 2005. Envisaging feed-in tariffs for solar photovoltaic electricity: European lessons for Canada. *Renewable and Sustainable Energy Reviews* 9, 51–68.
- State of New Jersey, 2008. Energy Master Plan, October.
- Sullivan, J., 2002. Trying to save energy may come at a price. *New York Times*, June 16.
- Summit Blue Consulting, 2007. Preliminary Review of Alternatives for Transitioning the New Jersey Solar Market from Rebates to Market-Based Incentives. Summit Blue, Boulder.

- Summit Blue Consulting, 2008. Assessment of the New Jersey Renewable Energy Market, vol. I. Summit Blue, Boulder.
- Taylor, M., 2008. Beyond technology-push and demand-pull: lessons from California's solar policy. *Energy Economics* 30, 2829–2854.
- Twyman, A., Johnson, T., 1999. Energy shopping bill takes key step – republicans speed utility deregulation. *Newark Star-Ledger*. January 8.
- Wang, U., 2008. Duke Energy eyes residential rooftops. *Greentech Media*. June 9. Available at <<http://www.greentechmedia.com/articles/duke-energy-eyes-residential-rooftops-985.html>>, accessed 18 February 2009.
- Winka, M., 2006. White paper, in: White Paper Series: New Jersey's Solar Market Transition to a Market-based REC Financing System. OCE, Trenton, September 25, pp. 2–7.
- Wiser, R., Bolinger, B., 2007. Renewable Portfolio Standards: an Opportunity for Expanding State Solar Markets. Lawrence Berkeley National Laboratory, Berkeley.
- Wiser, R., Barbose, G., Peterman, C., 2009. Tracking the Sun: the Installed Cost of Photovoltaics in the U.S. from 1998–2007. Lawrence Berkeley National Laboratory, Berkeley.