The Implications of a Vertical Demand Curve in Solar Renewable Portfolio Standards

Frank A. Felder

ffelder@rci.rutgers.edu

Center for Energy, Economic and Environmental Policy

Bloustein School of Planning and Public Policy

Rutgers University

New Brunswick, New Jersey 08901

and

Colin J. Loxley

Colin.Loxley@pseg.com

Asset Management & Centralized Services

Public Service Electric & Gas

Newark, New Jersey

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Abstract

Several states have solar renewable portfolio standards that require load serving entities to purchase a specified amount of solar renewable energy credits (SRECs) within a given time period. These requirements are fixed, i.e., do not depend on the price of SRECs, although they typically increase annually. As a result, SREC prices are unnecessarily volatile, result in uncompetitive market outcomes, increases in the cost of solar financing and therefore the cost of SRECs, and make it more difficult to evaluate solar policy. The resulting "boom-bust" cycles are very problematic for policymakers. Proposed fixes such as setting a floor price for SRECs, increasing the solar requirement, and long-term solar contracts do not address the fundamental problem and raise a moral hazard problem. Instead a downward sloping solar demand curve should be implemented, which may be achieved through adjusting the life of SRECs based upon market conditions.

Keywords

Solar, Renewable Portfolio Standard, Renewable Energy Credits, Vertical Demand Curve

1. Introduction

Renewable portfolio standards (RPS) are a popular policy to support the deployment of renewable energy technologies, although the policy is relatively new with limited experience (Wiser et al., 2011). RPS impose a requirement that utilities or load serving entities procure a given amount (or percentage) of qualified renewable power or pay a penalty or alternative compliance payment (ACP). The ACP must be set higher than the cost differential between the marginal renewable and conventional resources in order to induce investments in renewable resources. A system of tradable renewable energy credits (RECs) is established to create a market, so that developers can finance their projects and load serving entities can satisfy their requirements, in a flexible and efficient way. In short, RPS are a *floor-and-trade* system similar to installed electric capacity markets and the mirror image of *cap-and-trade* systems for carbon dioxide, sulfur dioxide and nitrogen oxide (Felder, 2011).

Typically RPS annual requirements are fixed and they do not vary with the price of RECs, although they may increase over time, The result is that REC prices are unnecessarily volatile, result in uncompetitive market outcomes, increase the cost of solar financing and therefore the cost of RECs, and make it more difficult to evaluate solar policy (Morthorst, 2000; Berry, 2002; Chupka, 2003; Marchenko, 2007; Kildegaard, 2008). Within an RPS framework, some jurisdictions pursue technology diversification either by using *set-asides* (also called bands, tiers, or carve-outs) or *credit multipliers*, and this practice is commonly used to deploy solar (Wiser et al., 2011). Solar set-asides result in solar renewable energy credits, (SRECs) that are produced, traded and sold to meet mandated solar requirements. Fixed annual solar requirements lead to a vertical demand curve and the above mentioned problems. SREC price volatility is greater than REC price volatility because of the much higher solar capital costs, solar's very low marginal cost, and their generally smaller and fragmented markets compared to other renewable resources. Sometimes, the solar requirement is adjusted through a trigger mechanism; such mechanisms increase the annual requirement if prices drop a specified amount in a certain amount of time (e.g., New Jersey Solar Energy Advancement and Fair Competition Act). The ability to bank SRECs (i.e. use them in multiple years) affects the supply-demand balance, and also must be considered in analyzing SREC pricing.

The implications of vertical demand curves are also well known outside the context of RPS. Installed electricity capacity markets originally had vertical demand curves but were replaced with a downward sloping one (Paynter, 2004; Cramton and Stoft, 2005; Hobbs, 2005; The Brattle Group, 2008; Stoddard and Adamson, 2009). Another well known critique of electricity markets is that retail demand is essentially price inelastic, not due to fixed regulatory requirements but due to lack of price signals at the retail meter (e.g., Borenstein et al, 2002). The consequences, however, are fundamentally the same.

The remainder of this paper is organized as follows. First, solar RPS is described in some detail. The paper then considers the relative merits of proposals to address volatile SREC prices including a SREC price floor, increasing the solar requirement, long-term contracts, and a downward sloping demand curve using New Jersey as a case study. The final section concludes with policy recommendations and areas for further research.

2. The Economics of Solar Renewable Portfolio Standards with Set-Asides

2.1. General Results on SREC Pricing

One economic policy rationale for solar RPS is that solar resources provide positive externalities that are not captured in current electricity pricing. Other policy rationales include economic development and energy security. To address this inefficiency by internalizing these environmental externalities, a floor-and-trade system is one option. It consists of a mandate imposed by a government or regulatory entity, backed by a financial penalty in the form of a solar alternative compliance payment (SACP) which incentivizes buyers to purchase SRECs, which incentivizes developers to build and operate solar resources. Some other approaches include subsidizing solar production, which also occurs in combination with RPS, such as in the U.S., which has solar tax incentives, or using a feed-in tariff without an RPS, such as in Germany. This is not to say that there are not other more efficient ways to address these positive externalities, such as a carbon tax or carbon cap-and-trade system.

Solar RPS policies are similar to installed capacity markets in their underlying economics. Both use a floor-and-trade system to internalize positive externalities (Jaffe and Felder, 1996). SREC prices should never be below zero (a producer of an SREC can always choose not to sell it so it would never do so for a negative price, assuming that any tax credit it obtains is tied to production of solar power not the sale of the associated SREC). SREC prices should never exceed the financial penalty or SACP because buyers can always choose to pay the SACP

(Morthorst, 2000). Thus, it is important that the SACP is set sufficiently high so that buyers purchase, and suppliers produce, SRECs (Morthorst, 2000). Although there is an important distinction between financial penalties and SACP, for brevity this paper assumes that a SACP is the enforcement mechanism. In jurisdictions that allow SRECs to substitute for RECs but not the reverse (i.e., only an SREC can be used to meet the solar requirement but SRECs can also be used to meet RPS requirements, the price of RECs should never exceed the price of SRECs. Since solar technologies are typically more expensive than other renewable energy resources, SREC prices are higher than REC prices even after accounting for the fact that solar, on average, receives a higher revenue stream per megawatt-hour than other renewable resources in the wholesale electricity market since electricity demand is high when the sun is shining.

Figure 1 presents the common depiction of the vertical demand curve but adjusted for a solar carve-out.

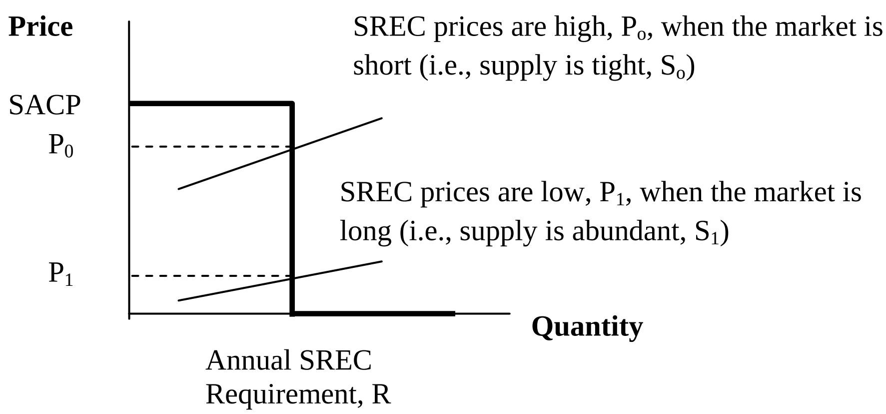

Fig. 1. The Vertical Demand Curve for NJ SRECs Results in Volatile Prices

As Figure 1 illustrates, with a vertical demand curve, a small change in the supply of SRECs can dramatically move prices. It also makes the market for SRECs more susceptible to market power. With a vertical demand curve it only takes a small reduction in supply, for example from withholding, to drive SREC prices towards the SACP. Similarly, modest changes in supply costs or technology can create a "whipsaw" effect. In theory, there is no equilibrium price between the extremes of zero and the SACP.

A standard formula from economics, called the Lerner index[1], makes this point clear. The Lerner index measures the amount that an actual market price, P, exceed the price that would occur in an efficient market based where price equals the marginal cost of producing the last good, P_E. The larger the Lerner index, the higher the market price is above the efficient price. The Lerner Index is proportional to the ratio of the market concentration and the price elasticity

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[1] Abba P. Lerner, "The Concept of Monopoly and the Measurement of Monopoly Power," The Review of Economic Studies, 1934, 1 (3), pp. 157-175.

of demand[2]:

Lerner Index $= (P-P_E)/P$

$= \text{(Market Concentration/Price Elasticity of Demand)}$[3]

A concentrated market, i.e., few competitors, results in actual prices being much higher than would occur if the market were competitive. But even if a market has lots of competition, actual prices may be higher than efficient prices due to extremely low price elasticity of demand. With a vertical demand curve, the demand price elasticity is zero, meaning that actual prices would be infinitely higher than the efficient price.

2.2. New Jersey Solar Market

Hart (2010) provides a recent review of New Jersey's solar policies. In recent years, the price of SRECs in New Jersey has proved to be volatile, both dropping significantly and increasing dramatically. For example, one environmental exchange operating in New Jersey reported a decrease in the 2012 SREC prices from $400 in July 2011 to less than $200 in August 2011, more than a fifty percent drop.[4] This same website reported in both 2011 and 2010 changes in SREC prices from $650 to $450 and then back to over $600. The New Jersey Clean Energy Funding Work Group reported a drop in SREC prices from $400 to $160.[5] In February 2012, the New Jersey Electric Distribution Company program sold SRECs at $172 in its auction.[6]

A major factor causing volatile New Jersey SREC prices is due to how the policy is structured. The amount of SRECs that load serving entities (LSEs) must buy is stipulated by legislation and these amounts increase each year.[7] For a given year, however, the requirement is fixed, regardless of SREC prices.

2.2.1 Demand Side

The properties of vertical demand curves are well understood. Given fixed demand, the supply curve determines price. Any significant change in supply will cause price to change significantly. The result is volatile prices due to the boom-bust cycle, and higher investment

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[2] The price elasticity of demand is the percent change in the quantity of demand given a one percent change in prices. Since demand almost always decreases with prices, the price elasticity of demand is almost always negative. The exceptions are Giffen and Veblen goods, in which as prices rise demand also rises.
[3] Since the price elasticity of demand is negative, the convention is to drop the negative sign in this formula. The standard (e.g. FERC) measure of market concentration is the Herfindahl–Hirschman Index (HHI), which is the sum of the square of market shares of each supplier expressed in percentages.
[4] Flett Exchange, http://markets.flettexchange.com/new-jersey-srec/ , assessed October 7, 2011.
[5] Report of the Clean Energy Funding Work Group, October 10, 2011, p. 63 available at http://www.nj.gov/emp/pdf/20111011Clean_Energy_Funding.pdf.
[6] See http://www.solarrec-auction.com/index.cfm?s=background&p=previousResults
[7] New Jersey Solar Energy Advancement and Fair Competition Act, January 17, 2010.

costs because investors associate price volatility with increased risk.[8] This will also increase the likelihood of the exercise of market power.

Fixed demand also creates policy flux. When SREC prices drop, there is an outcry from solar developers to change the rules to buttress prices; when SREC prices jump up, ratepayers and consumer advocates press for changes to lower prices since it is ultimately ratepayers that purchase SRECs. Moreover, volatile SREC prices make it difficult for policymakers to assess what is occurring in the solar market.

This poses some classic issues in *moral hazard*, i.e., the tendency to take undue risks because the costs are not borne by the party taking the risk. In this case, a party (e.g. solar developer) makes a decision about how much risk to take, while another party (the State Utility Commission or ratepayers) bears the costs if things go badly, and the party insulated from risk behaves differently from how it would if it were fully exposed to the risk. Given the strong desire to achieve solar policy goals, and the equally compelling arguments for economic benefits and jobs, it is relatively easy to see how the solar industry could reasonably expect to "capture" the regulator, and expect policy changes that would provide a "bail out" in the event of a building boom that produced an excess supply.

Further contributing to this moral hazard problem is that existing regulators or legislators cannot credibly commit not to change policies in the future. Today's policymakers can tell the solar industry that they will not take any more action in the future to buttress SREC prices, but the very fact that the solar RPS was created by policymakers and that policymakers have adjusted policies in the past, reveal that such statements are meaningless. This solar policy dynamic is currently occurring in New Jersey.[9]

In addition, since solar suppliers are not regulated, the regulator has great difficulty with *asymmetric information.* It is for all practical purposes impossible to 'pierce the veil' and know what the true supply economics are for the many different players. Nor is the industry itself homogeneous: at a minimum, there is a fault line developing between the traditional small, local, behind-the-meter installations which utilize "net metering" (i.e. the customer avoids paying the full retail rate, including taxes, wire charges and delivery charges) and the national and international firms developing large-scale so-called "solar farms" which often sell the power at wholesale.

As part of New Jersey's solar renewable portfolio standard (RPS), a specified amount of SRECs must be bought by LSEs each energy year.[10] This requirement, R, increases over time and is measured in gigaWatt-hours (GWh). If LSEs fail to purchase their pro rata share of the total requirement, they must pay a Solar Alternative Compliance Payment (SACP), set substantially

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[8] Some members of the Clean Energy Funding Working Group recognized that the current system results in "boom or bust cycles" but did not articulate the specific attributes of the current system that cause this effect. See the Report of the Clean Energy Funding Work Group, October 10, 2011, p. 64.

[9] SeeNew Jersey Board of Public Utilities, Office of Clean Energy, Solar Transition website: http://www.njcleanenergy.com/renewable-energy/program-updates-and-background-information/solar-transition/solar-transition, accessed April 16, 2012.

[10] In New Jersey, the energy year stars in June and ends in May. Energy year 2012 is from June 2011 to May 2012.

higher than the total cost of solar per MWh. New Jersey SACPs are set for each energy year and decrease over time. For energy year 2012 (EY 2012), which ends on May 31, 2012, the NJ SREC requirement is 442 gigaWatt-hours (GWh) and its SACP is $658 per MWh.[11]

The decision criteria used by LSEs to purchase SRECs is straightforward. Collectively, they are unlikely to buy more SRECs than required by the annual solar RPS. Since limited banking of New Jersey SRECs is permitted (for up to two additional years after the energy year for a total life of three years),[12] they may purchase more in one energy year than needed in that year for future use, for example, if they were to expect a large price increase over the next two years. If the price of SRECs plus the transaction cost of acquiring them exceeds the SACP, LSEs will pay the SACP instead.

For individual developers of solar projects, producing excess SRECs risks incurring costs for SRECs that cannot be sold (although they may be banked for a limited period, as discussed above), and collectively developers risk substantially reducing the price they can obtain for all of the SRECs that they produce. SREC prices should never be less than the marginal cost of producing a MWh, but the marginal cost for solar once installed is low, if not for all practical purposes zero. Between zero, the current floor, and the SACP, the effective cap, there is a lot of room for prices to roam. This wide range combined with the vertical demand curve results in dramatic SREC price volatility as Figure 1 shows.

When the market for SRECs is short, then SREC prices are high and gravitate near the SACP. When the market for SRECs is long, then SREC prices drop dramatically. SREC prices are capped by the SACP so they cannot become infinite, but they can certainly be extremely high. In New Jersey, for many months SREC prices have traded close to the SACP but have also dropped substantially as shown in Figure 2. Therefore, increasing the amount of competition and the maturing of SREC markets, although desirable, will not substantially reduce periods of high SREC prices or decrease their volatility because of the characteristics of the vertical demand curve.

New Jersey SREC prices reported by PJM Generation Attribute Tracking System (GATS) (Figure 2) include SRECs for a given energy year, e.g., energy year 2012, that were sold in months to years prior, e.g., sold in calendar year 2010 and 2011. As a result, SREC prices in PJM GATS may be higher than the current spot price for SRECs when the market has transitioned from shortage to surplus, as is the case now, or lower than the current spot price when the market transitions from shortage to surplus. As part of their energy bill, ratepayers pay the average price for SRECs not the current spot price.

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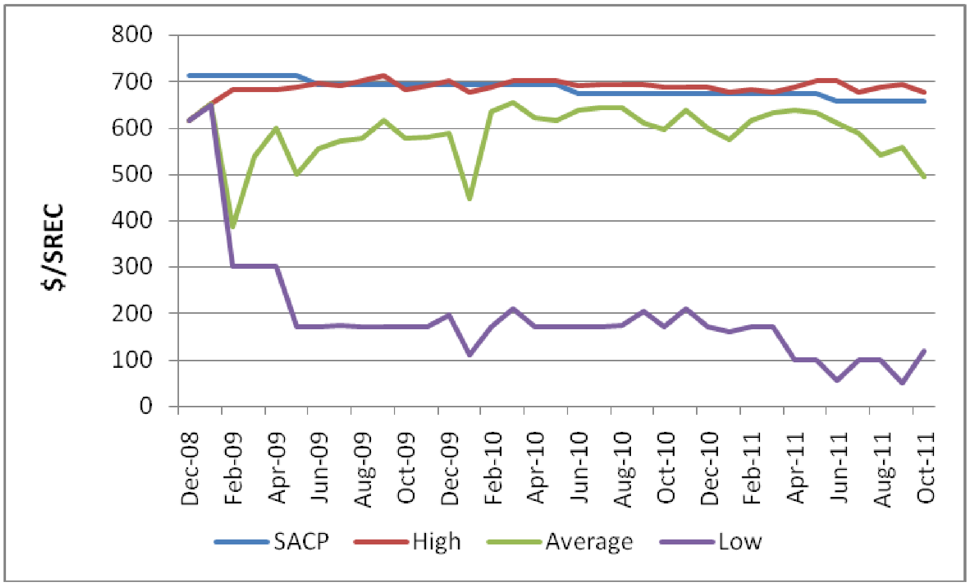
[11] See http://www.pjm-eis.com/program-information/new-jersey.aspx. One GWh equals 1,000 megaWatt-hours (MWh).
[12] http://www.flettexchange.com/pdf/specs/NJ_SPECS.pdf.



Note: Based upon PJM GATS (accessed on October 20, 2011, 7:20 am)

Fig. 2: Historical Average NJ SREC Prices (High, Average, Low) and SACP from December 1st, 2008 through October 10th, 2011

As noted above, numerous analysts have recognized that vertical demand curves result in volatile prices, increased susceptibility to market power, and increased investment costs due to the risks associated with price and therefore revenue volatility. This same situation occurred in wholesale electricity markets with installed capacity and was recognized by the Federal Energy Regulatory Commission (FERC).[13]

In 2011 SREC prices have apparently dropped from just over $600 to around $200. What is remarkable about this is that so many sellers were able to get such high prices through April. If true, it suggests that buyers were taken by surprise at the abundant supply and had expected high prices to continue for some time. Interestingly, there has been a similar (albeit less dramatic) trend in Pennsylvania (Figure 3):

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[13] FERC Docket ER05-1410-001 et al, December 22, 2006.

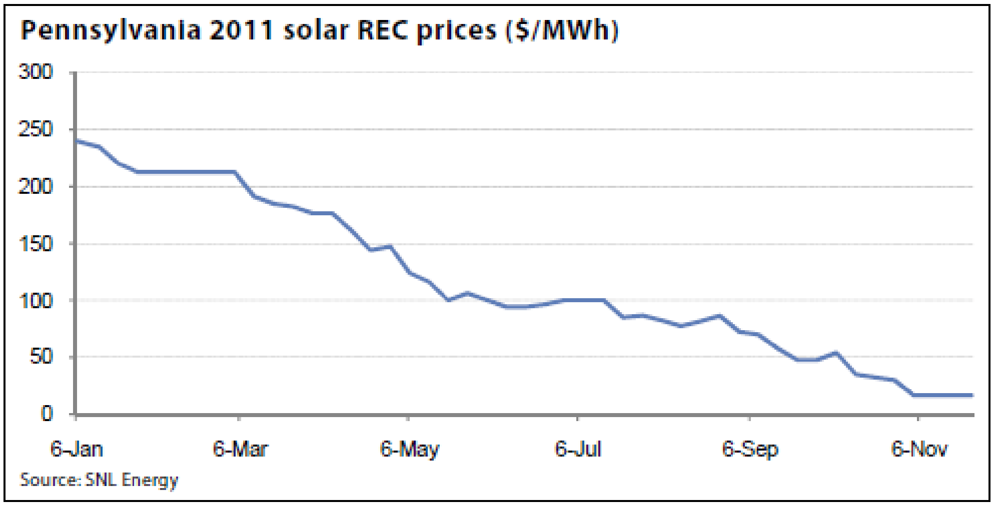

Fig. 3: Pennsylvania 2011 Solar REC Prices ($/MWh)

2.2.2 Supply Side Issues

Of course, even if demand is inelastic, equilibrium prices will still be affected by supply conditions. So, for example, in the case of a perfectly elastic short-run and long-run supply curves (i.e., each additional unit costs exactly the same to produce, marginal cost equals average cost) then the fact that the annual short-run demand curve is fixed will have no impact on price in a competitive market as Figure 4 illustrates

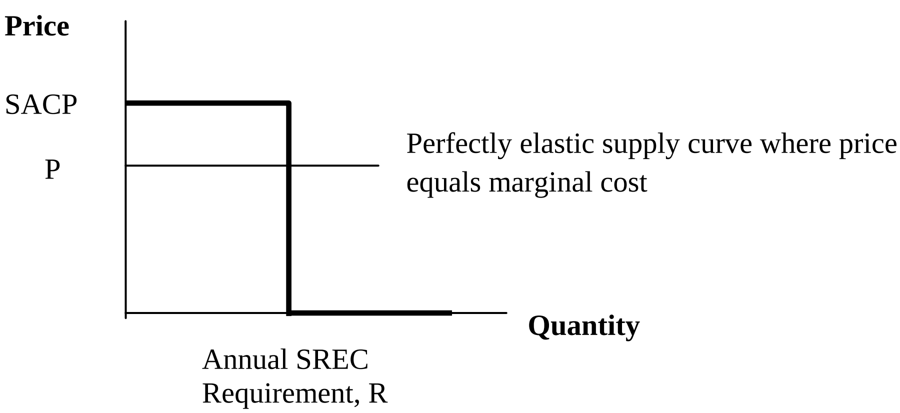

Fig. 4: Perfectly Elastic Supply Curve (either short-run or annual)

As always, with perfectly competitive supply assumptions, the equilibrium market price equals marginal cost. Movements in SREC prices would only reflect movements in the supply curve due to e.g. raw material or labor costs, technology shifts, global (Chinese) panel prices, etc. However, in this case, where we are looking at annual short-run supply and demand, then not only is the annual demand curve vertical but the annual supply curve is also (almost) vertical as shown in Figure 5..

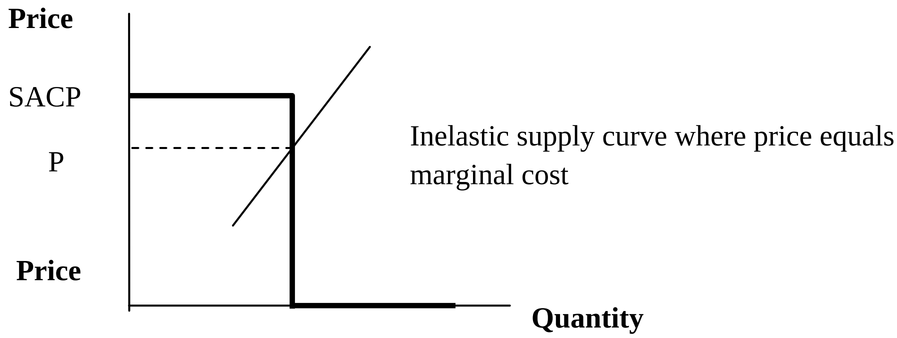

Fig. 5: Inelastic Supply Curve (either short run or annual)

This is the case because a given solar PV installation has an inelastic production of SRECs, determined by the installed capacity of the panels connected and operational. Since it generally takes longer than a year to develop and install a new site, the only means to increase short-term supply is to either accelerate a project or to increase its capacity by adding panels. However, due to economies of scale and the lead times involved, developers already have an incentive to maximize size and minimize construction times, so the ability to flex output in response to price is limited. The bulk of today's SREC supply thus reflects last year's installed capacity, and will be sold at any price above zero. There may be some additional supply at higher prices, e.g. from electric service providers who discover they have an excess of SRECs. As a result, if both curves are inelastic, small shifts in supply and demand will produce relatively large movements in price in the short-run, i.e., one year period.

3. Discussion of Possible Solutions

Addressing the problems created by a vertical demand curve is straightforward. The SREC annual fixed requirement should be replaced with a downward sloping demand curve: the requirement should be increased within a given year if SREC prices fall, and decreased if SREC prices rise. This is how markets for typical goods and services work. When prices rise, people buy less of a good and when prices fall they buy more, all else equal. Similarly, most goods can be stored, and thus expectations about future prices will affect short-term demand as well.

3.1 SREC Price Floors

There have been other proposed fixes to address the volatility in New Jersey of SREC prices. One alternative is to set a floor price for SREC prices that is above the current floor of zero.[14] Doing so, however, will not reduce the volatility but only limit the movement of SREC prices between the SACP and the proposed floor as Figure 4 illustrates. A floor price also does not reduce the SREC market susceptibility to market power. Another problem with setting a non-zero price floor for SRECs is that in the future, if solar costs continue to decrease such that the cost of solar is below the floor, then ratepayers are paying for SRECs at the higher floor price.

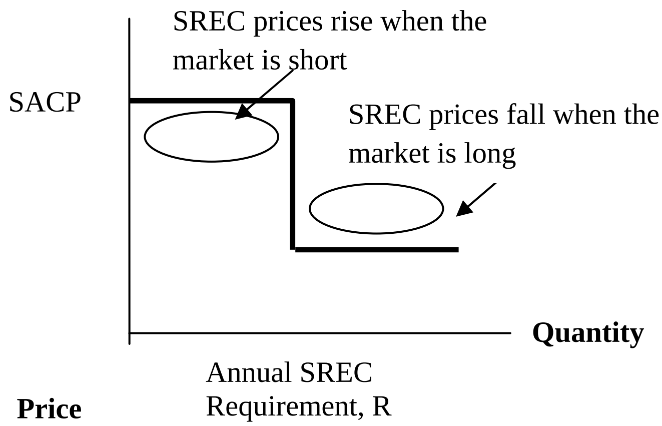

Fig. 6: A SREC Price Floor Only Reduces the Range of SREC Price Movements but Not Their Volatility

3.2. Increasing Solar Requirements

Another proposal is to increase the demand for SRECs when prices drop.[15] Once again, this does not result in reducing the volatility, only driving SREC prices towards the cap as illustrated in Figure 7. As the SREC requirement is increased from R_0 to R_1 under this proposal, SREC prices would increase dramatically when the amount of SRECs becomes less than R_1. Increasing demand but still retaining the vertical demand curve does not solve the problem; it just restores SREC prices to near SACP levels. Further, the higher level of R and the return of higher prices will induce more supply leading to a sharp drop in price bringing the boom-bust cycle back again.

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[14] Report of the Clean Energy Funding Work Group, October 10, 2011, p. 61.
[15] Report of the Clean Energy Funding Work Group, October 10, 2011, p. 61.

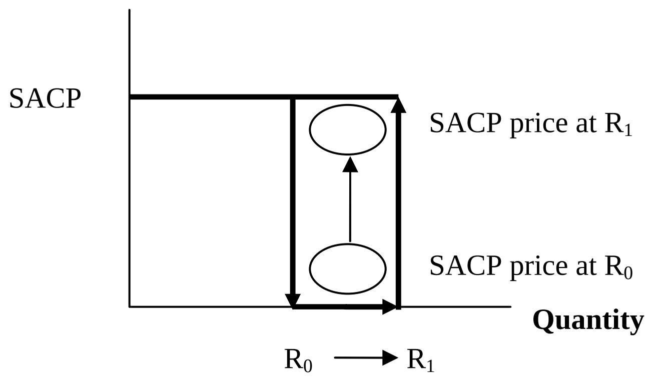

Fig. 7: Increasing the SREC Requirement Will Increase SREC Prices but Not Reduce SREC Price Volatility

At present it appears that the preferred New Jersey political/regulatory solution is to legislate a short-run increase in demand by accelerating the number (or percent) of SRECs required to be surrendered by each load serving entity. This apparently would be accomplished by moving forward the levels from a future year and lowering them towards the end of the mandated timeframe. By establishing a higher level for a few years, prices would increase back to a level that would sustain the current high level of development activity…at least temporarily. This approach is clearly not without risk. First, it is very easy (one might even say likely) for the politician/regulator to misjudge the true supply-demand imbalance and inadvertently set demand too high, thereby driving the price sharply higher. This not only results in higher costs to NJ consumers but would also fail to provide the desired price stability. It would simply produce above-normal profits ("monopoly rents") for existing solar owners and encourage more high-cost installations. The inevitable result would be a resurgence of excess supply and a future collapse of prices after the temporary 'stimulus' converges back to the previous quantity. So this does not solve the problem. It simply guarantees it will be postponed and reoccur.

This policy option clearly produces a 'moral hazard' issue. And, by shifting regulatory policy, it creates more uncertainty for the long-run. It raises the age-old problem of regulatory commitment: by changing the rules in response to pressure from a small group of stakeholders, the New Jersey policymakers bring into question whether the rules will get changed again, perhaps to reduce demand and lower prices if the cost of the solar program becomes politically unacceptable. After all, this is exactly what happened to the Regional Greenhouse Gas Initiative. Participants who had invested in producing or purchasing RGGI certificates saw the value of their investments or holdings abruptly reduced to near-zero. Changes in political/regulatory regimes and "rules" should be minimized if possible and with as little impact as possible if efficient investment is to be encouraged.

3.3. Long-term Solar Contracts

New Jersey has implemented several programs to provide long-term pricing certainty to solar developers. Three New Jersey Electric Distribution Companies, ACE, JCP&L and Rockland Electric, operate a joint solar solicitation program which is administrated through NERA

Economic Consulting (NERA). The solicitation takes the form of an RFP process within which the solar developers offer SRECs for at a set price over the life of the contract (10-15 years). The offers are anonymously ranked based on net present value by the solicitation manager. The most-competitively priced projects are awarded up to the program size for each utility. Once the projects are installed and operational they begin producing SRECs which are transferred to the EDC for the agreed-upon price. The EDC sells the SRECs through a semi-quarterly auction managed by NERA. Any net revenue from the auctions is used to reduce the ratepayer impact.

PSE&G's first solar financing program (Solar Loan I) was filed with the BPU in April 2008, before the official order requiring them to develop such a program. However, PSE&G updated their solar loan program (Solar Loan II) in November of 2009 to make the program more market-based. The Solar Loan II program awards long-term loan contracts covering 40-60% of the cost of qualifying projects with loan repayment in the form of either cash or SRECs, at the borrower's discretion. PSE&G then auctions the SRECs through a semi-quarterly auction managed by NERA in conjunction with the other three EDCs. Any net revenue from the auctions is used to reduce the ratepayer impact. The program will promote market-based solar generation through establishing a floor SREC price, or a guaranteed minimum value that PSE&G will apply to SRECs submitted as loan payment.[16]

Prices accepted in the solicitations have track spot SREC prices presumably because solar developers submit proposal in the solicitations that reflect what they think they could obtain, subject adjusting for the value of having long-term SREC price certainty, in the spot SREC market. As a result, increasing the amount of long-term solar contracts would reduce the number of SRECs procured in the spot market but would not affect the spot market price volatility.

3.4 Market Regionalization

To an economist, the state-level data suggest an obvious solution: one way to address unstable prices in New Jersey would be to expand the market to a regional one where SRECs from several states (or PJM generally) would be equally valid and could be used to meet any individual state's requirement. By aggregating multi-state supply and demand curves, we would expect to see greater elasticity of both demand and supply, and thus more stable pricing. This would also be the most efficient outcome, since – as is obvious from the PA prices in Figure 4 – NJ prices are higher, and thus expanding to include other states would tend to drive prices down towards the market equilibrium level- the marginal cost of the most efficient providers. Over the long term, if NJ power prices remain above the regional average, as seems likely, then NJ developers would still expand in NJ to the extent that their location has differential power revenues that at least equal the higher cost of construction, land, permitting, etc. to be expected in the State. However, SREC prices could stabilize but at levels that NJ Developers find unattractive.

Unfortunately, we know that politically such regional markets are frowned upon, because (to the extent that inter-state commerce laws allow) state policy makers want to ensure that the higher costs paid by New Jersey consumers (SRECs are a subsidy that is, in essence, a tax paid by all)

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[16] The SREC price for the purpose of loan repayment will be the SREC Floor Price or the SREC market value, whichever value is greater.

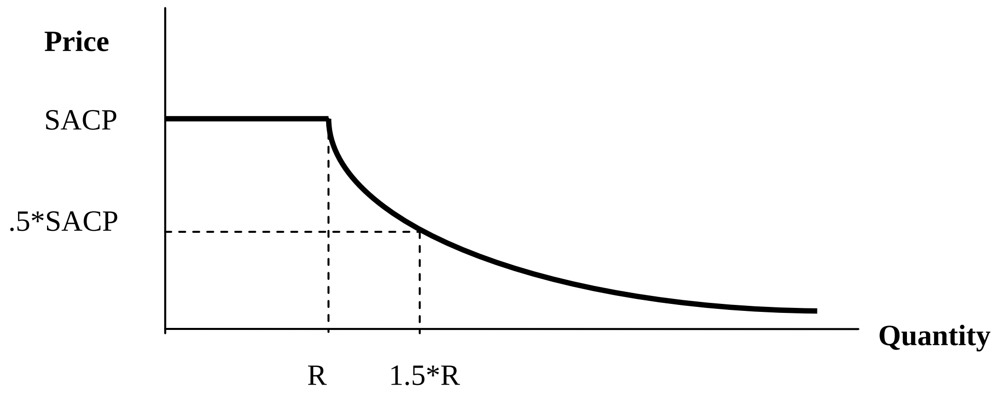
are in part offset by the economic benefits (jobs, income) generated in the State. Inter-state SREC trading, while economically efficient and beneficial in aggregate, does not guarantee that NJ would "capture" these benefits.

3.5 Encourage Banking & Trading

Another option that exists is to address the short-run vs. long-run supply-demand balance by extending the lives of the SRECs. At present, SRECs are given only a 3 year life before expiration. So the demand curve is slightly more elastic (non-vertical) than shown above because if today's price drops below my expectation of the future prices, then I will buy in excess and "bank" the surplus. Also, both buyers and sellers will be attracted to the market as financial traders, i.e. there will be more trading in SRECs (greater liquidity) by people who do not physically produce or use SRECs. However, with only a 3-year window the stabilizing effect of banking and trading is strictly limited: one market participant was quoted as saying that today's capacity was already sufficient to supply requirements through 2013.

What if future SRECs were given a 15 year life instead? Since current interest rates are so low, the carrying costs of buying and holding SRECs are very low at present. Then the rational calculation would be to compare today's price with the discounted expected long-term price over the full 15 year period. Annual fluctuations in price would then result in more trading of SRECs by moving them in/out of the "bank"- in other words, we would have an inventory price-stabilization scheme just like many commodities that can be stored. This approach would resemble the very successful SO2 Allowances trading scheme, that resulted in SO2 reductions that exceeded the statutory requirements at prices only a fraction of those originally estimated. It is especially valuable as an approach if there are "lumpy" capacity additions that would otherwise produce short-run discontinuities. In this particular case, having long-lived SRECs would encourage larger-scale installations that otherwise would produce a short-term excess supply. Since there appear to be significant economies of scale even with the PV technology, this would be an efficient way to procure the desired levels of solar generation.

It is not entirely clear why this approach has not received more attention. The only cost would appear to be the necessary tracking and auditing mechanisms to ensure that ownership is unambiguous and that there is no double-counting- but presumably those are already required. In addition, some extra effort to monitor the markets for any sign of attempts to "corner" the market or otherwise manipulate prices could be required.



Note: Figure not drawn to scale.

Fig. 8: Implementing a Sloping Demand Curve for NJ SRECs

3.4. Downward Slopping Demand Curve

As noted above, when volatile and uncompetitive prices occurred in installed capacity markets, regulators replace the vertical demand curve with one that had some slope to it. The same approach can be used for New Jersey's annual solar requirement. Instead of having a single requirement in each energy year, a sliding scale or sloping demand curve should be established.

If over the course of an energy year, the amount of SRECs produced exceeds the annual requirement, R, then LSEs would have to purchase more SRECs, but the SACP would be reduced. Figure 8 provides one such possible way of doing this by keeping the maximum amount that ratepayers would pay constant, and therefore the maximum amount of revenues the industry could possibly earn, the same. For instance, if 50% more SRECs are produced than the energy year requirement, R, then LSEs must purchase these additional SRECs but the SACP decreases by 50%.[17] Of course, actual SREC prices may be below the reduced SACP.

One way to think about having a downward sloping demand curve is that it is a sliding scale version of either establishing an SREC price floor or increasing demand. A downward demand curve solves the problem that both of these alternatives are trying to address, which is avoiding drastic drops in SREC prices without introducing the problems discussed above that the two alternatives have.

[17] To achieve the objective of ensuring that ratepayers would never potentially pay more than under the situation with a vertical demand curve for all possible outcomes, a decaying exponential demand curve is needed as illustrated in Figure 2. This implies a price elasticity of -1, holding total revenue (price times quantity) is constant over the range of the demand curve. Linear demand curves could be used if this payment constraint is relaxed.

4. Rational Expectations and the Long-Term

What about the longer term? Then the supply curve for SRECs would be expected to be more elastic; indeed, it may be that it will be downward sloping as new technology and learning economies develop in response to cost pressures and increased activity. Thus, even though the aggregate demand curve is still "fixed" the rational price expectations of market participants would be that prices will be flat or falling in the future. In addition, since SREC values provide the revenue stream over and above those from the wholesale power market (or net metering, if applicable), if energy and capacity prices increase in the future we would expect downward pressure on SREC prices. This would suggest that profit-maximizing developers are rushing to get projects online to get higher prices today, in the expectation that prices may drop in the future. So the current over-supply and consequent depression of prices appears to be both rational and what would be expected from a competitive market. Just like many markets, especially commodities, supply has a tendency to over-react and drive prices down.

5. Policy Recommendations and Areas for Future Research

New Jersey has determined that it should significantly increase the amount of solar generation in the state using a solar carve-out as part of its renewable portfolio standard. A fixed annual requirement (even if it increases over time) results in a vertical demand curve. The outcome is volatile SREC prices and the potential for SREC prices to trade near the SACP for periods of time as well as to drop substantially. To reduce this volatility and to make the SREC market similar to that of typical goods and services, a downward sloping demand curve should be introduced. This technical fix has successfully worked in other energy-requirement markets to address the very same issues that are now occurring in New Jersey's SREC market.

Reducing SREC price volatility would help reduce investment costs, provide more stable prices that benefit both buyers and sellers, mitigate market power, and enable policymakers to evaluate the market without substantial pressure from one group or another to constantly change the rules as SREC prices whipsaw between low levels and the SACP.

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