CASE STUDIES OF RPS BEST PRACTICES

Solar Carve-Outs, SREC Tracking, and Thermal Inclusion

Prepared for

The RPS Collaborative

by

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About This Report

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Contents

Introduction

There are renewable portfolio standards (RPSs) in 29 states plus the District of Columbia as of July 2018. These policies require electricity suppliers to secure a certain share of their electricity from technologies and energy sources specified by the state. Iowa established the first RPS in 1983, but almost all of them date to the period from 1997 to 2008. With the exception of Vermont, all have been in place for at least ten years, although many have been modified one or more times.

With the large number of RPS programs and the many years of experience with them, there is a rich body of data about RPS practices and performance. The states have implemented RPS programs, learned from program experiences, and made adjustments and improvements over time. This makes it possible to study the various states' results with RPS programs and analyze what has worked well and what has been challenging.

The authors of this report looked across the wide range of RPS practices and innovations in order to identify specific instances where a state has implemented an RPS in a way that has been effective and can offer lessons for other states. This paper consists of case studies of three states that have been innovators in implementing specific RPS practices: Delaware's use of a carve-out for solar, New Jersey's tracking of solar renewable energy certificates (SRECs), and New Hampshire's inclusion of thermal output in its RPS. Of course, these are not the only examples of states that have been successful and leaders with their RPSs, but in these three cases there was sufficient data to write an extended case study on program results, and the topics are likely to be of interest to many other states.

Each of the case studies follows a similar format. First, the authors briefly summarize the RPS practice and what makes it a model for others. They then provide a history of the program and its results. They follow that with overviews of the program or practice's strengths and limitations. They end with lessons and recommendations for other states.

Case Study No. 1

Delaware's Solar Carve-Out

By Edward Holt[1]

Summary

To accomplish goals other than simply maximizing the total quantity of renewable energy generation, Delaware has included a solar carve-out in its RPS. This creates a special percentage target for solar generation within the larger RPS target. The Delaware RPS gradually ramps up to a requirement that covered utilities must source 25 percent of their electricity supply from eligible renewables by 2025-26. Within that, there is a 3.5 percent carve-out for solar energy.[2] This makes Delaware one of 22 states plus the District of Columbia that have carve-outs for either solar or distributed generation.[3]

The Delaware RPS was initially established in law in 2005. The solar carve-out was created in 2007, when the RPS was amended by the state legislature. The amendment established solar renewable energy certificates (SRECs) as the compliance mechanism for the solar carve-out. Starting in 2012, the non-profit Delaware Sustainable Energy Utility was given the task of conducting periodic procurements through which an eligible solar photovoltaic resource can bid for a long-term contract for its SRECs. The solicitations have been oversubscribed and the weighted average cost of SRECs has been significantly lower than the solar alternative compliance payment (SACP) price.

Program History

Legislation

In 2005, Delaware enacted SB 74, AN ACT TO AMEND TITLE 26 OF THE DELAWARE CODE RELATING TO RENEWABLE ENERGY PORTFOLIO STANDARDS.[4] This legislation required retail electricity suppliers to include a minimum amount of eligible energy resources in their total

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[1] Edward Holt is President of Ed Holt & Associates, Inc.

[2] Title 26 Public Service Commission 3008 Rules and Procedures to Implement the Renewable Energy Portfolio Standard (Opened August 23, 2005) http://regulations.delaware.gov/AdminCode/title26/3000/3008.shtml#TopOfPage. The compliance period or energy year (EY) begins on June 1 and ends May 31 of the following year, and is called by the calendar year in which it begins.

[3] Database for State Incentives for Renewables and Efficiency, accessed March 9 at http://ncsolarcen-prod.s3.amazonaws.com/wp-content/uploads/2017/02/RPS_carveout_4.pdf.

[4] http://legis.delaware.gov/BillDetail?legislationId=16743

retail sales. The requirement was for 1 percent in the first compliance period beginning June 1, 2007, and rose steadily to 10 percent in the compliance period beginning June 1, 2019.

Eligible energy resources are solar, wind, ocean energy, geothermal, anaerobic digestion biogas, hydro with a capacity of 30 MW or less, sustainable biomass, landfill methane under certain conditions, and fuel cells powered by renewable fuels.

The requirement applies to load served by retail electricity suppliers in Delaware except for municipal utilities. Rural electric cooperatives may opt out, and retail electricity sales to industrial customers with a peak demand in excess of 1,500 kW may be exempted.

Compliance must be demonstrated by renewable energy certificates (RECs) or alternative compliance payments (ACPs). The RECs must be issued by and retired in the PJM Generation Attribute Tracking System (GATS). RECs may be used for compliance for three years from the date created. Eligible resources must be located within the PJM region or be imported to PJM.

The ACP increases once a retail electricity supplier uses it. The first time a supplier relies on the ACP, the payment is $25 per MWh. If that supplier must resort to the ACP in a subsequent year, the ACP is $50. If a supplier has paid $50 and is short of RECs in a subsequent year, the ACP reaches its maximum of $80.[5] This is a compelling incentive to acquire the necessary RECs for compliance.

Just two years after the original adoption of the RPS, Delaware amended the law to increase the overall RPS target from 10 percent by 2020 to 20 percent by 2020.[6] The same 2007 legislation introduced a solar carve-out, requiring that 0.011 percent of sales be sourced from solar photovoltaics (PV) in energy year (EY) 2008 (i.e., the year beginning June 1, 2008) and increasing to 2.005 percent in EY 2019. Eligible solar is solar photovoltaic energy resources, defined as "solar photovoltaic or solar thermal energy technologies that employ solar radiation to produce electricity or to displace electricity use."[7]

To encourage local development of solar, the legislation provided a 300 percent credit multiplier that expired at the end of 2014 for customer-sited PV physically located in Delaware. Lawmakers made it clear that generation from small sources of 100 kW or less can be used for compliance, if appropriately metered and reported.

The 2007 RPS amendment also established solar RECs (SRECs) as the compliance mechanism for the solar carve-out, and set a solar alternative compliance payment (SACP) of $250 per MWh. However, if a retail electricity supplier has paid an SACP in any previous year, then its SACP increases in subsequent years.

[5] These ACPs were originally $25, $35, and $45, but were subsequently increased.
[6] SB 19, AN ACT TO AMEND THE DELAWARE CODE TO INCREASE THE RENEWABLE ENERGY PORTFOLIO STANDARD. http://legis.delaware.gov/BillDetail?legislationId=18476
[7] No solar thermal projects are currently certified in Delaware.

By increasing the RPS, creating the solar carve-out, and enabling Delaware citizens to sell SRECs, the legislation intended to increase the value of PV.[8]

In 2010, Delaware amended the RPS again, increasing the renewable energy minimums required.[9]

- The overall RPS was reset for EY 2010 at 5 percent, increasing to 25 percent by EY 2025, as shown in Table 1.1 below. The solar carve-out was reset at 0.018 percent in EY 2010, increasing to 3.5 percent in EY 2025. The idea, as expressed in the bill synopsis, was that increasing and extending the required minimum percentage will "provide stability for the development of renewable energy markets in the State of Delaware."

Table 1.1. Delaware RPS Targets: Schedule 1

Compliance Year (beginning June 1)	Cumulative Minimum Percentage from Solar Photovoltaics Energy Resources	Minimum Cumulative Percentage from Eligible Energy Resources
2007		2.0%
2008	0.011%	3.0%
2009	0.014%	4.0%
2010	0.018%	5.0%
2011	0.20%	7.0%
2012	0.40%	8.5%
2013	0.60%	10.0%
2014	0.80%	11.5%
2015	1.0%	13.0%
2016	1.25%	14.5%
2017	1.50%	16.0%
2018	1.75%	17.5%
2019	2.00%	19.0%
2020	2.25%	20.00%
2021	2.50%	21.00%
2022	2.75%	22.00%
2023	3.00%	23.00%
2024	3.25%	24.00%
2025	3.50%	25.00%

Note: Minimum Cumulative Percentage from Eligible Energy Resources includes the Minimum Cumulative Percentage from Solar Photovoltaics

- The legislation increased the SACP to $400 for a first-time use, $450 for a second-time use, and $500 for a third-time use and thereafter.

[8] SB 19, *op. cit*., bill synopsis.

[9] Senate Substitute 1 for Senate Bill 119, AN ACT TO AMEND TITLE 26 OF THE DELAWARE CODE RELATING TO THE RENEWABLE ENERGY PORTFOLIO STANDARDS. http://legis.delaware.gov/BillDetail?legislationId=19960. The Delaware RPS was also amended in 2008 to provide a 350 percent credit multiplier for offshore wind but this did not affect the solar carve-out.

- This legislation also provides credit multipliers for renewable energy projects that employ Delaware labor and locally manufactured products, specifically a 10 percent credit toward meeting the RPS for solar and wind sited in Delaware that is constructed or installed with at least 75 percent in-state workforce; and also a 10 percent credit for solar and wind sited in Delaware and with at least 50 percent of the cost of equipment manufactured in Delaware.

In 2011, SB 124, AN ACT TO AMEND TITLE 26 OF THE DELAWARE CODE RELATING TO DELAWARE'S RENEWABLE ENERGY PORTFOLIO STANDARDS AND DELAWARE-MANUFACTURED FUEL CELLS, was adopted.[10] This Act relieved non-regulated suppliers of the obligation to satisfy the RPS, beginning with EY 2012. Instead, Delmarva Power & Light (Delmarva) was made solely responsible for acquiring RECs and SRECs for all Delaware load, including that supplied by retail electricity suppliers.

This Act also allows the energy output from fuel cells manufactured in Delaware that *can* run on renewable fuels to be an eligible resource for the RPS, and calls for Delmarva to file a tariff for an eligible fuel cell project of 30 MW capacity, with possible expansion to 50 MW. This was part of an economic development program in which Bloom Energy Corporation would construct new natural gas-powered fuel cell baseload generation in Delaware.[11] This provision is relevant to the solar carve-out because the energy produced by an eligible fuel cell can be used to reduce the overall RPS-obligated load at twice the number of MWh produced by the fuel cell (for the first 15 years), thus reducing the number of RECs that must be acquired. Further, energy produced by fuel cell can fulfill a portion of the solar carve-out. Six MWh of fuel cell output can be counted as one SREC for the first 15 years of the fuel cell project, and three MWh of fuel cell output can be used as one SREC for years 16-21. Delmarva may fulfill no more than 25 percent of its annual SREC requirements using fuel cell generation in years 1-5, 30 percent in years 6-15, and 35 percent in years 16-21 of the project.[12]

Procurements

The 2010 amendments to the RPS required the formation of a Renewable Energy Taskforce charged with "making recommendations about the establishment of trading mechanisms and other structures to support the growth of renewable energy markets in Delaware," and specifically on:

- Establishing balanced markets mechanisms for REC and SREC trading;

[10] See http://legis.delaware.gov/BillDetail?legislationId=21606.
[11] Delaware PSC Regulation Docket No. 56, Order No. 8150 entered May 15, 2012. See https://depsc.delaware.gov/wp-content/uploads/sites/54/2017/03/8150.pdf.
[12] Delaware PSC Docket No. 11-362, Order No. 8079 (December 1, 2011). A number of states accept fuel cells reliant on natural gas for compliance with their RPS, but Delaware is the only one that accepts it for compliance with a solar carve-out.

- Establishing REC and SREC aggregation mechanisms…to encourage the deployment of renewable, distributed renewable, and solar energy technologies in Delaware with the least impact on retail electricity suppliers, municipal electric companies and rural electric cooperatives;
- Establishing revenue certainty for appropriate investment in renewable energy technologies, including, but not limited to, consideration of long-term contracts and auction mechanisms;
- Establishing mechanisms to maximize in-state renewable energy generation and local manufacturing; and
- Ensuring that residential, commercial, and utility scale photovoltaic and solar thermal systems of various sizes are financially viable and cost-effective investments in Delaware.[13]

A subcommittee of the Taskforce met intensively over the course of a year and recommended what became the SREC Procurement Pilot Program. This proposal was quickly agreed to by the Taskforce and approved with minor modifications by the Commission in late 2011.[14]

The purpose of the Pilot Program was "to assist in the creation of a market for SRECs in Delaware and to provide a mechanism for the procurement of SRECs to ensure that retail electricity suppliers meet the requirements set forth in [the RPS]."[15] To meet this goal, the program conducted a public solicitation to award 20-year contracts for the SRECs (but not the energy) in a predetermined quantity based on RPS SREC compliance needs.

Delaware's non-profit Sustainability Energy Utility (SEU) was recommended and approved to administer the bid process for each utility that decides to participate.[16] Delmarva Power is the only such participating utility since it became responsible, beginning with EY 2012, for acquiring RECs and SRECs for all Delaware RPS-obligated load. The SEU has continued to manage all subsequent SREC procurements.

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[13] Senate Substitute 1 for Senate Bill 119, AN ACT TO AMEND TITLE 26 OF THE DELAWARE CODE RELATING TO THE RENEWABLE ENERGY PORTFOLIO STANDARDS. http://legis.delaware.gov/BillDetail?legislationId=19960. The legislation specifies the makeup of the Taskforce, which comprises one representative each from the Department of Natural Resources and Environmental Control, the Public Service Commission, Delmarva Power & Light, Delaware Electric Cooperative, municipal electric companies, Delaware Sustainable Energy Utility, Delaware Public Advocate, Delaware Solar Energy Coalition, the renewable energy research and development industry, the local renewable energy manufacturing industry, and an environmental advocacy organization.

[14] Delaware PSC Docket No. 11-399, Order No. 8093, dated December 20, 2011. The Taskforce has continued to play an important role in crafting and refining the annual SREC procurement plans.

[15] SRECDelaware Program, retrieved from http://www.srecdelaware.com/documentation/background/pilot-program/pilot-application/

[16] The Sustainable Energy Utility (SEU) is a 501(c)(3) organization created in 2007 by the State of Delaware to promote affordable, reliable and clean energy and energy efficiency initiatives. The SEU is funded through the authority granted by the State of Delaware to issue tax-exempt bonds, invest Regional Greenhouse Gas Initiative funds, bank SRECS, and offer programs funded by Delaware energy providers.

Any eligible PV resource may bid for a long-term contract for its SRECs. The applicant must own, lease or control the solar project, or be the direct assignee of all SRECs created by that system. In the Pilot Program, projects of less than 100 kW capacity were required to be bid by someone who is bidding on behalf of at least two systems (e.g., an aggregator), but later procurements relaxed this rule to allow individual small projects to bid directly. The owner of any project, however, may designate an agent or aggregator to submit an application on their behalf.

As part of the application, projects must estimate the output of their generator, using a standard tool. If the project is selected, the SEU is obligated to purchase all the SRECs produced up to this maximum amount.

Bidding is significantly automated. Applicants bid on a software platform developed by a contractor, InClime. Bids may be entered over the course of about 11 days. The entire process, from announcing the terms of the solicitation to posting the results, spans about 6-10 weeks.[17]

To assure diversity of solar projects, SREC bids are solicited for different categories based on generator size and date of final interconnection approval. The terms of each solicitation describe the categories or tiers, which have remained fairly consistent, and within each category, the number of SRECs that will be purchased, as shown in Table 1.2.

Table 1.2. 2017 Delaware SREC Solicitation[18]

New Systems (final interconnection approval after June 10, 2016)		
Tier	**Nameplate Rating – (DC at standard test conditions)**	**SRECs in Tier**
N-1	Less than or equal to 25 kW	4,400*
N-2	Greater than 25 kW but less than or equal to 200 kW	2,300
N-3	Greater than 200 kW but less than or equal to 2 MW	3,300
N-4	Greater than 2 MW	0-10,000
Existing Systems (final interconnection approval before June 10, 2016)		
Tier	**Nameplate Rating – (DC at STC)**	**SRECs in Tier**
E-1	Less than or equal to 25 kW	4,400 Pool*
E-2	Greater than 25 kW but less than or equal to 2 MW	4,400 Pool*
E-3	Greater than 2 MW	0-10,000

*The lowest priced bids from tiers N1, E1, and E2 will all compete for the same pool of 4,400 SRECs.

Like the 2016 Program, Tiers N-1, E-1 and E-2 are a combined pool. For the purposes of acquiring the first 10,000 SRECs, Tiers N-1, N-2, N-3, E-1, and E-2 are competitively bid. Tiers N-4 and E-3 are excluded from the initial solicitation. Once the first 10,000 SRECs from the protected tiers have been procured Delmarva Power may procure up to 10,000 additional SRECs through the auction using the least expensive available SRECs from any tier, including N-4 and E-3.

[17] The schedule has varied each year. See http://www.srecdelaware.com/documentation/#pilot for information about the Pilot Program and all subsequent solicitations.

[18] For full details of the 2017 SREC Procurement Documentation (and any previous year's solicitation), see http://www.srecdelaware.com/documentation/#pilot.

Selection of bids is based on bid price alone. The bid price is paid only for the initial ten years of the procurement term, after which the project is paid a fixed price announced in advance as part of the solicitation. For example, in the Pilot Program, winning projects were paid the bid price for the first ten years of the procurement, and were paid $50 per SREC for the remaining ten years. More recently, the price paid has been the bid price for the first ten years and $35 for the remaining ten years (except that in 2017, projects larger than 2 MW received the lower of the bid price or $35 per SREC for the last ten years).

Results

The solicitation program piloted in 2012 has been repeated with refinements and adjustments in each subsequent year.

The annual solicitations overall have been oversubscribed. If a specific category is undersubscribed (which has happened on a couple occasions), program rules allow the lowest bids not selected in one category to be used to fill SREC requirements in the undersubscribed category, so there has never been a shortfall of SRECs.

The weighted average cost of SRECs acquired through the SREC Procurement Program has varied year to year but has been significantly lower than the SACP of $400.

In EY 2009 and EY 2010, SRECs traded in the range of $200 to $300 for use in the current year.[19] In EY 2011, Delaware SRECs traded between $40 and $100, and from EY 2012 to EY 2014, near $50. SRECTrade hints that the decline in value may have to do with the introduction of Delmarva Power as the single purchaser, which reduced the number of buyer participants.[20]

The 2017 Procurement was oversubscribed, "as an excess of bids were submitted to the auction due to oversupply of solar in the market. In effect, the overall weighted average bid price dropped to $21.26 from last year's $66.56."[21]

In contrast to the yearly average auction prices, the Delmarva compliance reports only present a composite of all past auctions and any power purchase agreements, and do not include the price of the most recent auction winners because the new projects are not built yet. RPS

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[19] SRECTrade, Historic Auction Prices, accessed March 9, 2018 at http://www.srectrade.com/auction. SRECTrade tracks SREC price trends for state markets in solar power.

[20] Accessed March 9, 2018 at http://www.srectrade.com/srec_markets/delaware. Washington Gas Energy Services, a participant in the Delaware SREC market, was more explicit, claiming that making Delmarva Power the sole party responsible for RPS compliance "effectively dissolved the SREC market" in Delaware. This, coupled with Delmarva's suspension of SREC purchasing in anticipation of the pilot program auction, had caused SREC trading to decline "drastically," as a result of which SRECs were now trading in the $70 range. Delaware Public Service Commission, Order 8150 dated May 15, 2012, citing WGES testimony, accessed March 7, 2018 at https://depsc.delaware.gov/wp-content/uploads/sites/54/2017/03/8150.pdf.

[21] Accessed March 9, 2018 at http://www.srectrade.com/blog/srec-markets/delaware/2017-de-srec-procurement-results. According to Commission staff, these auction prices are the yearly weighted averages taking into account the bonus multipliers, i.e., the expenditures divided by the purchased SRECs times their credit multipliers.

compliance reports by Delmarva for EY 2014, EY 2015 and EY 2016 show average compliance costs of $133/MWh, $93/MWh and $93/MWh, respectively, still well below the SACP.

Analysis by Lawrence Berkeley National Laboratory of compliance across all RPS states shows that Delaware fell slightly short of its overall RPS goal in the early years.[22] In the first Energy Year starting in 2008, compliance with the solar carve-out was 84%, in EY 2009 it was 94%, and in EY 2010 and 2011 it was 99%.[23] The early modest shortfalls may be a result of start-up of the solar carve-out, a lag in availability of eligible SRECs, and the fact that multiple retail electricity suppliers were competing for SRECs. The Berkeley Lab data shows that beginning with EY 2012, coincident with the introduction of a single entity obligated and the SREC Procurement Program, compliance with the solar carve-out has been 100%.

Delmarva Power files RPS compliance reports annually, and the three most recent are available for review on the Commission's website.[24] They show that for EY 2014, 2015 and 2016, the company achieved full compliance with both the overall RPS and solar carve-out requirements without resorting to alternative compliance payments, and did not use the Qualifying Fuel Cell Project output to meet the solar carve-out. However, the company did use (as permitted) the fuel cell output to reduce the overall load subject to the RPS, which means that the number of SRECs required is also reduced because the denominator of the calculated solar obligation is smaller.

Table 1.3 shows that several thousand solar projects have been certified as eligible. All but 27 of these solar projects are located in Delaware, and almost all certified solar projects within Delaware are small, with an average size of about 22 kW. The solar projects outside Delaware are larger, ranging in size from 1 to 30 MW. Including these, the average size of certified solar projects is slightly over 100 kW.

Table 1.3. Delaware Certified RPS-Eligible Projects

Fuel Type	Capacity (MW)	Percent of Total	Number of Projects	Average Capacity (MW)
Black liquor	154.0	1.8%	2	77.0
Landfill gas	2,043.0	23.8%	34	60.1
Sun	447.0	5.2%	4,245	0.1
Water	9.8	0.1%	6	1.6
Wind	5,925.2	69.1%	65	91.2
Total	8,579.0	100.0%	4,352	2.0

Source: Delaware PSC, List of Certified Eligible Energy Resources (10 Jan 2018).

[22] Lawrence Berkeley National Laboratory, Energy Markets & Policy Group, Renewables Portfolio Standards Resources, accessed March 9, 2018 at https://emp.lbl.gov/projects/renewables-portfolio. See RPS Compliance Data (XLSX) (last updated July 2017).
[23] Calculations are based on retired RECs and do not include compliance that may have been achieved using ACP.
[24] See Delaware's Renewable Portfolio Standard and Green Power Products, at https://depsc.delaware.gov/delawares-renewable-portfolio-standard-green-power-products/.

The large number of solar projects, and the small average capacity of those projects, obscures the fact that 86 percent of the solar capacity certified in Delaware is attributable to projects ranging in size from 2 to 80 MW, and most of this is located out of state. These 29 large projects represent only 0.6 percent of the number of certified projects.

The large number of small solar projects suggests that aggregators may be important to customer-sited projects participating in the application and bidding process. In fact, owner representatives were required in the 2012 pilot program but not thereafter. Consequently, the use of aggregators has significantly declined and the vast majority of bids are placed by system owners themselves. The reason is that registering and bidding in the auction is within the capability of a small participant. Most of the companies that offer aggregation services are some of the solar installers who bid into the auction as a service to their customers.[25]

Strengths of the Program

Delaware's RPS solar carve-out is effective for a number of reasons.

- The Taskforce was charged with recommending trading mechanisms and market structures to support the growth of renewable energy in Delaware. The planning process was transparent and involved diverse stakeholder groups, as specified in legislation. The Taskforce worked intensively, creating a detailed proposal in just under one year.
- Annual competitive solicitations based on RPS solar requirements created clear expectations and helped focus developers and owners on how they could participate. Anticipation of regular opportunities to bid encourages applicants to plan their projects completely and to be cost-effective.
- Long-term contracting is a boon to financing projects. The promise of a 20-year contract for SRECs with a creditworthy counterparty is a stimulus to getting winning projects built.[26]
- The annual solicitation is coordinated by one independent organization, in this case the SEU, a non-profit established by the State of Delaware. This approach lends itself to efficient administration and minimizes duplication of effort, especially in a small state.
- SREC procurement makes smart use of technology. Application and bidding is conducted via a software platform that simplifies the process for consumers and developers. It also makes the bid evaluation and selection process efficient and timely.

[25] Kevin Quilliam, InClime, comments on draft report.

[26] Ryan H. Wiser and Galen Barbose. Renewables Portfolio Standards in the United States: A Status Report with Data Through 2007. Report Summary (p. 30), 2008. Lawrence Berkeley National Laboratory. Accessed March 9, 2018 at http://eta-publications.lbl.gov/sites/default/files/presentation-lbnl-154e-ppt-revised.pdf.

- The eligibility, application, and bidding rules are detailed and clear, anticipating many questions.
- The solicitations seek diversity in project size, providing opportunity to small, medium, and large consumer segments. This helps support a diverse solar market in the state.
- The rules enable and encourage aggregators to assist small projects with applications and bidding. Any size project owner may designate an agent to apply on its behalf, either singly or with other projects.
- The designation of one major utility as the responsible party to satisfy RPS requirements for all load has the advantage of efficient bidding and competitive pricing with a built-in brake on overbuying, which helps avoid overbuilding and crashing SREC prices. It also makes sense in a small state that has only one regulated utility.

Limitations of the Program

A market with a single buyer may be perceived as a limitation because it is not a free market on the buyer side, but the auction is designed to remove the single buyer asymmetry. Since the single buyer has to buy a certain number of SRECs at the prices bid, it cannot exercise market power. The auction approach for a fixed quantity would yield the same results regardless of the number of buyers.

The use of credit multipliers that can be used for compliance with the solar carve-out could have the effect of reducing the number of actual MWh generation needed to achieve compliance with the RPS. It should be noted, however, that the only in-state manufacturer of solar equipment, Motech, ceased operations in Delaware in 2014. As a result, it has effectively not been possible to receive the credit multipliers for Delaware manufacturing and labor content since 2015 and as a result this has not had an impact on SREC quantities in recent years.[27] According to Delmarva RPS compliance reports, the Qualifying Fuel Cell Project output has not been counted directly against the SREC requirement, although it has been used to reduce the overall load subject to the RPS, which has an indirect effect on the number of SRECs required.

Lessons and Recommendations for Other States

Delaware has shown that a separate target for a specific resource or technology, such as PV, can be a very effective way to boost a new industry, create resource diversity, and capture economic and environmental benefits.

A successful solar requirement does not depend solely on establishing a solar carve-out with the RPS. As shown by this Delaware case study, success has come with good rules and other policy and programmatic support, including:

[27] Kevin Quilliam, InClime, comments on draft report.

- Clear expectations and a transparent process
- Long-term contracting opportunities
- Unified, centralized solicitation that controls the pace of development
- Fair participation opportunities for diverse market segments
- Support for aggregators to help small project owners overcome transaction costs

If a state seeks to create a successful solar industry, then other policies may also be important, such as simplified interconnection rules, public grants or incentives to stimulate solar business, stable and attractive net metering or value of solar policies, and no extra fees that are a barrier to self-generation. Credit multipliers can help lower the cost of achieving the solar carve-out targets, but they reduce the effective amount of new solar needed for compliance.

The designation of one major utility as the responsible party to satisfy RPS requirements for all load—although an efficient approach—could be difficult to emulate in states with multiple large utilities. Nevertheless, even with multiple procurers (or RPS-obligated entities), there could still be one central agency or entity that would coordinate regular solicitations. This would minimize duplication of effort, and help prevent the market from expanding too fast, creating overcapacity and depressing prices.

Case Study No. 2

New Jersey's Use of PJM-GATS for Solar Renewable Energy Certificates (SREC) Tracking: Automating Processes to Support Faster Solar Market Growth

By Jenny Heeter[28] and Sam Koebrich[29]

Summary

New Jersey's renewable portfolio standard (RPS) was one of the first with a significant solar carve-out. Because of this, there was a need to create a system to track solar generation and enable obligated entities to prove their compliance with the solar carve-out. The New Jersey Board of Public Utilities (BPU) invested in its own state tracking system, and then transitioned to supporting the creation of the PJM Environmental Information Services (PJM-EIS) Generation Attribute Tracking System (GATS).

GATS has created streamlined processes to reduce registration time, verify solar generation data, and integrate existing state data. These processes drive down administrative costs and provide an important service to state RPS administrators. Although more could be done to improve generation estimates and allow users to organize their SRECs within GATS, the system provides a good model for other states and regional REC tracking systems to follow.

Program History and Results

As states began to pass renewable portfolio standards (RPSs) in the late 1990s, a need for web-based renewable energy certificate (REC) tracking systems arose. The first web-based platform was developed in May 2001 for Texas, which began compliance in 2002. In 2002, Maine, Connecticut, New Mexico, and Pennsylvania had begun RPS implementation but without a REC tracking system in place. [30]

New Jersey established its RPS in 1999, with the first compliance year in 2001. Under the first RPS, the Load Serving Entity had to provide proof that it produced its own energy or secured it under a bilateral contract (33 N.J.R 2536(a)). The RPS was re-adopted in 2004 to give PJM time to develop a REC tracking system.[31] New Jersey's Board of Public Utilities (BPU) lead the way in developing a system. The BPU first contracted with Clean Power Markets, who developed the New Jersey Behind the Meter REC platform. The first tracking platform operated from 2004

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[28] Jenny Heeter is Senior Energy Analyst at the National Renewable Energy Laboratory.
[29] Sam Koebrich is a Policy Analyst at the National Renewable Energy Laboratory.
[30] https://www.sciencedirect.com/science/article/pii/S0301421502000952
[31] In addition, the State's solar carve out was not established until 2004, in the revised RPS rule.

through 2009. The platform served only New Jersey, and only tracked SRECs, not other RECs used to meet New Jersey's Class I and Class II requirements.[32]

This platform was developed as an interim solution while the BPU worked with PJM-EIS to develop the PJM-Generation Attribute Tracking System (GATS). PJM-EIS is a subsidiary of PJM Interconnection, the regional transmission organization (RTO) that covers all or parts of 13 states in the Mid-Atlantic, Midwest, and Southeast. On September 13, 2004, the BPU authorized the Office of Clean Energy to work with PJM to develop and implement a financing mechanism to develop a universal tracking system (GATS), which would cover PJM's region and track all renewable generation, not just solar, as the Behind the Meter REC platform did. The loan closed on March 24, 2005.

GATS evolved over the years, making improvements as states within the PJM footprint had different needs. In 2011, the GATS was touted as having SREC registration was "relatively quick", taking about two months (Burns and Kang 2012). [33] In 2018, registration time for a solar generator is more like a few days. Developers of proposed solar electric generation facilities must register with New Jersey, through the SREC Registration Program (SRP) Online Registration Portal prior to construction. Registrations are reviewed within four-to-five days after they are submitted. [34]

Once systems are registered, have completed construction, have been authorized to energize and have passed a QA/QC process with New Jersey, they can be registered in GATS. GATS created an auto-approval process that has streamlined this approval process. Previously, a GATS staff person was approving each request. With the auto-approval process, if all of the information entered into GATS matches what was given to New Jersey, then the registration is auto-approved that night. This helps GATS reduce its backlog of system registrations.

GATS is also reducing the BPU staff's administrative time by providing reasonability and validation checks on generation entered into the system. When a solar generation is provided to GATS, GATS checks to see whether that generation is within a reasonable range of expected output, based on the system's size and installation characteristics. To do this, GATS began pulling data through the National Renewable Energy Laboratory's PVWatts, through an application programming interface (API). The PVWatts API allows GATS to calculate the generation the system would likely produce.

GATS then compares this expected generation to the data provided by the generator. If the reported generation is more than 130 percent above the PVWatts estimate, then the system

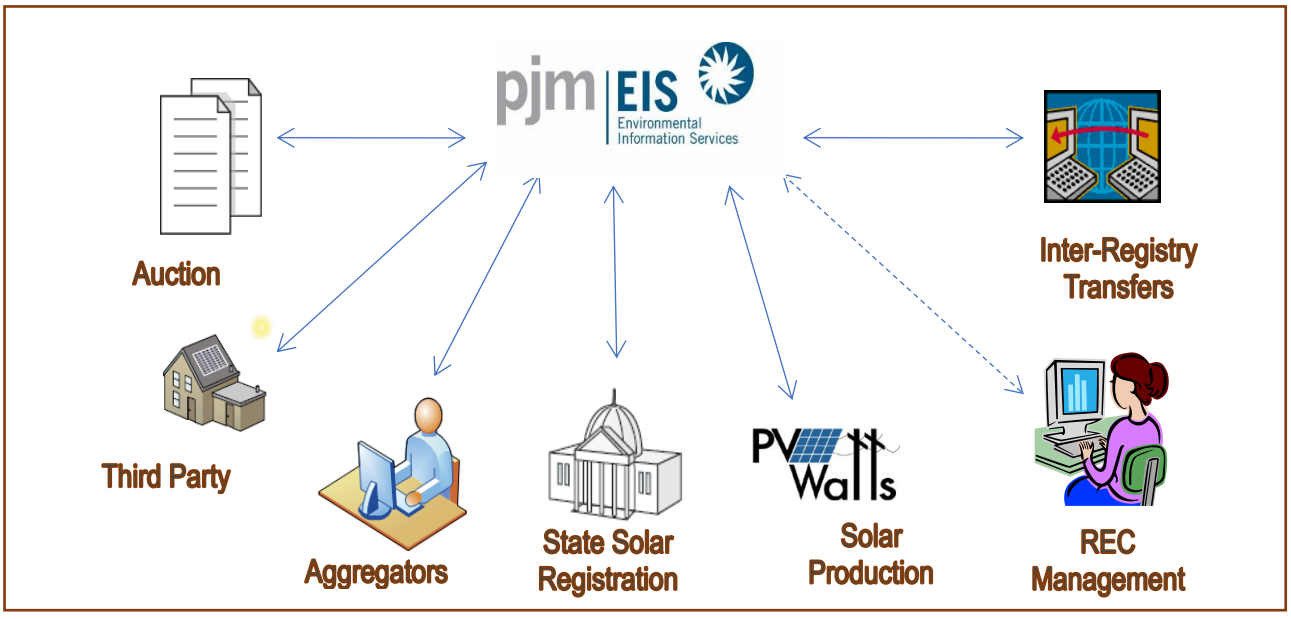
[32] Class I includes solar, wind, wave or tidal, geothermal, landfill gas, anaerobic digestion, fuel cells using renewable fuels, and certain forms of biomass. Class II includes hydropower facilities larger than 3 MW and less than 30 MW and approved municipal solid waste facilities located in New Jersey or located outside New Jersey in a state with retail competition and NJDEP makes an environmental compliance determination (N.J.A.C. 14:8-2.6)
[33] See https://www.sciencedirect.com/science/article/pii/S0301421512000717#bib38.
[34] See http://www.njcleanenergy.com/renewable-energy/programs/solar-renewable-energy-certificates-srec/new-jersey-solar-renewable-energy.

issues a warning to the user to double check their numbers. If the reported generation is 160% above the PVWatts estimate, a warning is issued and the system holds the generation until the subscriber can provide documentation to the GATS Administrators. Finally, if reported generation is 200% above the PVWatts estimate, the account holder is prevented from entering any generation and needs to contract the GATS Administrators to resolve any issues. Only if the issue can't be resolved is the BPU notified. BPU estimates that it only needs to send a staff member to a site a few times per year.

GATS is also using APIs to allow SREC aggregators to supply data. Previously, if a customer or aggregator[35] had multiple meters, they would total the generation and enter it as one system. That was problematic because it was difficult to identify reporting errors. Now, customers and aggregators can provide a bulk upload of meter readings via spreadsheet, using an API function. In 2017, there were 189 aggregators registered in GATS who served New Jersey). Aggregators supply a large portion of the New Jersey solar market: in 2017, 75 percent of the certified solar RECs in New Jersey were from systems within aggregator accounts.[36]

To help streamline processes, GATS has seven different interfaces for different types of generators and purposes. Interfaces exist with auction platforms, third party reporters, aggregators, state solar registration systems, PV Watts (solar production estimates), REC management systems, and inter-registry transfers (Figure 1).

Figure 1- GATS' Streamlined Processes



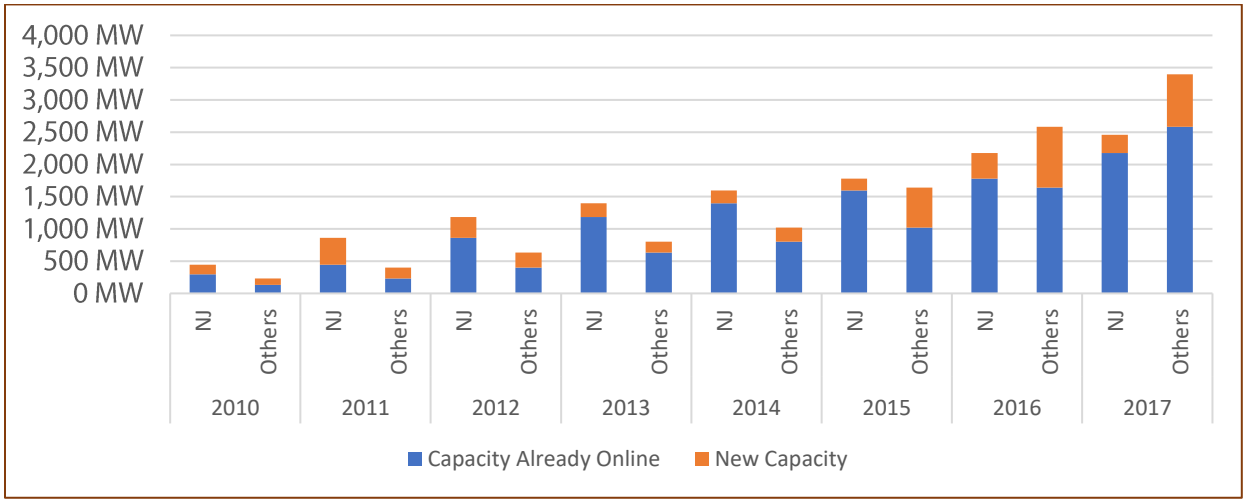
Source: PJM-EIS State Agency Advisory Committee Meeting Conference Call, January 11, 2018.

[35] Some individual customers may have multiple meters for one solar system.
[36] Data assumes that aggregators are account holders with 5 or more generators registered in their account.

Results

As of January 2018, 167,956 renewable generators were registered in GATS. Nearly half are located in New Jersey (80,100). Through 2015, New Jersey had more PV capacity than all other states in GATS. Even though that is no longer the case, New Jersey is still registering significant amounts of PV annually (Figure 2). While this growth in New Jersey cannot be attributed to GATS exclusively, had GATS not been so successful, deployment would likely have not have occurred as quickly.

Figure 2- Nameplate Solar Capacity in New Jersey and All Other States in PJM-EIS GATS by Year[37]



Source: PJM EIS-GATS

Although New Jersey's RPS requires SRECs to be located in New Jersey, other states allow (or have previously allowed) SRECs from out-of-state.[38] The ability of GATS to facilitate these transfers is shown in Figure 3 on page 20. While all the SRECs retired in New Jersey were generated in New Jersey, most of the SRECs retired in Pennsylvania were from out out-of-state generators (namely, North Carolina).

Strengths of the Tracking System

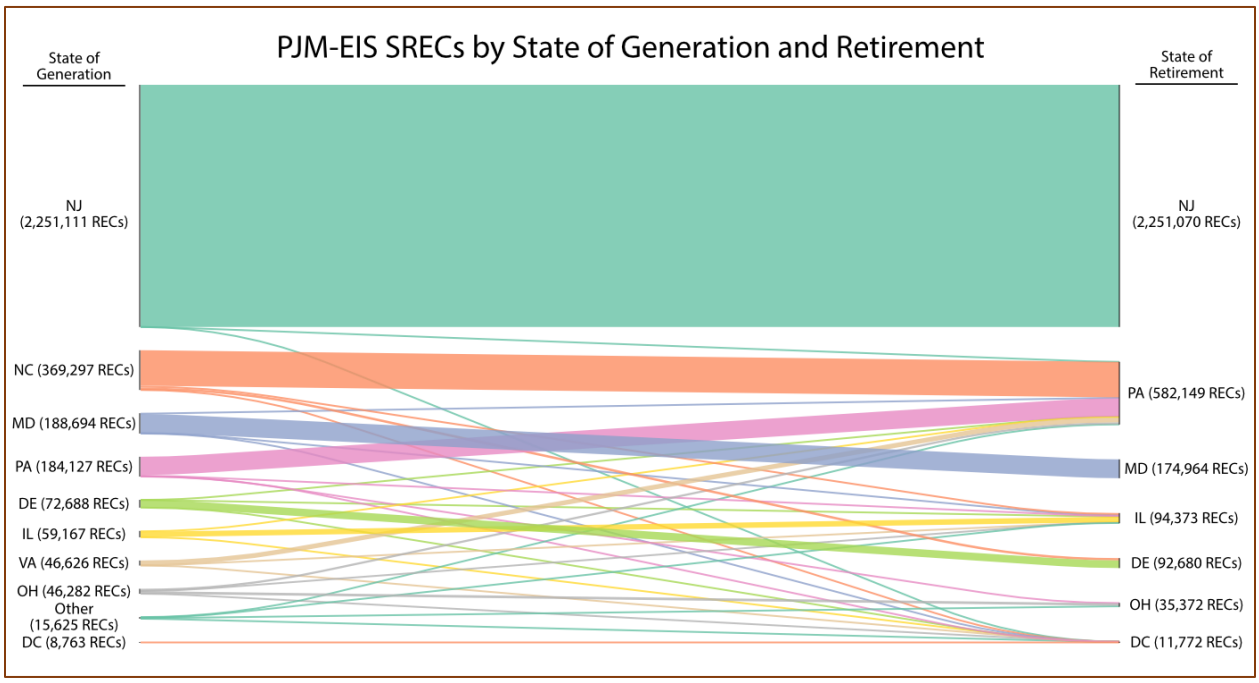
GATS has evolved over time and has multiple strengths:

- **Regional system drives down transactions costs**. BPU staff noted several benefits of moving SREC tracking from the state-based system into GATS, namely that developing a more regional tracking system reduced transaction costs and is easier to use for participants operating in multiple markets (SREC Tracking Order 2008).

[37] PJM EIS-GATS, "Renewable Generators Registered in GATS," Accessed March 23, 2018. https://gats.pjm-eis.com/gats2/PublicReports/RenewableGeneratorsRegisteredinGATS.

[38] More specifically, New Jersey's RPS requires that the solar facility be connected to the distribution system serving New Jersey.

Figure 3- GATS SRECs by State of Generation and Retirement[39]



Source: PJM EIS-GATS

- **System upgrade flexibility.** GATS makes updates roughly every 3-4 months. It hosts State Agency Advisory Committee conference calls to update states on the changes being made in the system. New Jersey BPU staff noted that GATS has been very accommodating in getting changes made in their system. For example, some New Jersey solar systems are coming to the end of the period when they are eligible for New Jersey SRECs. Instead, they can be used for Class I of the RPS. To notify these system owners of their upcoming expiration, GATS created an automated report that will notify subscribers on January 1 and April 1 if their system is no longer eligible for SRECs at the end of the current reporting year.
- **Use of automated systems.** GATS uses multiple automated systems, which lowers the time it takes to register systems, validate system generation data, and transfer RECs to other REC tracking system. As mentioned previously, GATS uses the PV Watts API for validation of reported generation. GATS also created a state agency API. This API allows GATS to talk to existing state systems, for example, to retrieve certification information directly instead of relying on receiving files or downloading data. The API also allows states to pull data directly from GATS. Finally, GATS has an API to transfer RECs between GATS and the New York Generation Attribute Tracking System (NYGATS) nightly.
- **Reasonability and validation checks.** GATS handles much of the data validation for PV systems on its own, leaving less for BPU to do independently after the systems are already

[39] PJM EIS-GATS, "RPS Retired Certificates for Reporting Year," Accessed March 23, 2018. https://gats.pjm-eis.com/gats2/PublicReports/RPSRetiredCertificatesReportingYear.

registered.[40] GATS is better poised than BPU to verify system data because it can use tools like the PV Watts API, to conduct validation at lower cost.

- **Tools for aggregators.** Allowing SREC aggregators to upload system data in bulk lowers the cost of aggregation and lowers administrative costs.

Limitations of the Program

While GATS has evolved over time and is continuously making improvements, there are currently some limitations to the program. In addition, because the solar market in New Jersey grew rapidly, there were some growing pains as GATS developed and transitioned to its more automated systems. One stakeholder observed, "It was a nightmare for a while." In addition, there are some ways in which the system could still be improved:

- **Improvements in generation estimates.** GATS currently uses estimates from PV Watts, which does not take actual weather conditions into account. A more accurate generation estimate would incorporate actual weather data. This would provide a more accurate picture of which systems were reporting inaccurate generation, resulting in potentially less need for follow-up by GATS.
- **Ability to organize SRECs into subaccounts**. When SREC marketers and other users retire SRECs, it would be more efficient if they could separate out their retirements into multiple subaccounts. For example, if an SREC marketer is retiring SRECs for 10 different entities, they would like to have one retirement account for each entity. This way, they could provide a GATS-generated report for each entity, noting the SREC retirement.

Lessons and Recommendations for Other States

GATS has been viewed by stakeholders as very successful in enabling large amounts of certification creation from PV to be verified, traded, and retired to meet state RPS requirements. Because of New Jersey's early investments in developing the system, GATS has learned a lot along the way. The biggest lesson learned from GATS is that where systems can be automated, they should be. Automation shortens processing time and provides more accurate inputs and outputs, at lower cost. Automation is essential not only for inputting system data into GATS, but also for the BPU, which needs to extract data from GATS efficiently.

Another key lesson from GATS is its state involvement. States are given regular updates from GATS and given opportunities to provide input into what system improvements should be made. From there, GATS determines if it is possible to make the improvement and if so, proceeds. Staff at the BPU indicated that GATS has been very accommodating to their requests for system updates.

[40] The BPU is much more involved with administering the SREC Registration Program (SRP).

Case Study No. 3

Thermal Inclusion in New Hampshire's Renewable Portfolio Standard

By Val Stori[41]

Summary

New Hampshire led the nation with the first eligibility for renewable heat in a Renewable Portfolio Standard (RPS). Landmark legislation enacted in 2012 created a carve-out for renewable thermal technologies—eligible woody biomass, geothermal, and solar thermal. Administrative rules were developed during 2013 and were codified in 2014. Renewable thermal facilities that were installed after January 1, 2013 and met the eligibility criteria defined in the Public Utilities Commission (PUC) rules could apply and become eligible to generate Class I thermal renewable energy certificates (RECs). The resulting thermal RECs are unique in that they are not equivalent to a generation unit of electricity, but rather involve electricity savings from renewable thermal energy resources. Thermal REC inclusion in the RPS has reduced New Hampshire's dependence on fossil fuels, supported a local forest-based economy, and provided economic and environmental benefits.

New Hampshire tackled the challenges of metering, monitoring, reporting, and verification procedures and created a system for quantifying thermal RECs from the "useful heat" produced by qualifying facilities. Since the start of the thermal program, over 40 megawatts of electric-equivalent renewable thermal capacity have been added through 38 projects.

The New Hampshire Renewable Portfolio Standard for Useful Thermal Renewable Energy Certificate (T-REC) Program has served as a model for other states contemplating adding thermal provisions to their RPSs.

Program History

In 2007, the New Hampshire legislature created the state's first RPS for eligible electric renewable energy for the purposes of diversifying the state's fuel supply, decreasing the state's dependence on fossil fuels, providing an opportunity to source local renewable fuels, keeping energy and investment dollars in the state, reducing emissions, and lowering future energy costs.[42] Advocacy for thermal provisions began in 2005, when the original RPS legislation was introduced, but when the final bill passed in 2007, thermal provisions were left out. The 2007 statute included a requirement that the New Hampshire PUC conduct a review of the RPS in

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[42] See New Hampshire RSA 362-F (http://www.gencourt.state.nh.us/rsa/html/NHTOC/NHTOC-XXXIV-362-F.htm)

2011, 2018, and 2025. The statute required the first of those three reviews to include an evaluation of the potential inclusion of thermal energy as part of the RPS.

The initial New Hampshire RPS directed electricity providers to procure renewable energy by purchasing renewable energy certificates. Each REC is created from one megawatt-hour (MWh) of electric generation, or thermal equivalent, from qualified renewable projects. If an electricity provider cannot obtain the RECs it needs in a given year to comply with its RPS obligation, then the provider must make alternative compliance payments (ACPs) into the state's Renewable Energy Fund. New Hampshire's RPS has four classes and an ACP option for each class. From the start, Class I was technology neutral—an especially wide range of renewable technologies was eligible for RECs, including the displacement of electricity from solar hot water systems. By 2025, each electricity provider must obtain 25.2 percent of its load from renewable sources.

The 2007 statute designated ACPs to fund the Renewable Energy Fund, a special fund used to support renewable energy projects, including renewable thermal.[43] This provision not only helped create a market for renewable thermal technologies, it also introduced and familiarized many stakeholders in the state and PUC staff with renewable thermal technologies.

Through a stakeholder process conducted by PUC staff, the potential for the addition of renewable thermal technologies to the RPS was explored as part of the 2011 RPS review. The process assessed two options—the creation of a thermal-only class or the creation of a combined heat and power (CHP) class. The PUC issued two thermal recommendations: it recommended further study of renewable thermal inclusion in the RPS and consideration of thermal output from CHP systems on an energy equivalent MWh basis. As part of its evaluation, the PUC also studied REC market conditions and found a downward trend in Class I REC prices, indicating a large supply of Class I RECs relative to the demand for them. It recommended maintaining the existing obligations, rather than increasing the RPS class obligations.[44]

The PUC also looked at the Renewable Energy Fund's distributions, including a special commercial/industrial sector RFP released in February 2011 from which five grants were awarded. Two of the grants were for thermal applications—an institutional wood pellet heating system and a CHP project at a landfill facility. After the stakeholder review, the PUC concluded that the Fund should strive to establish a technology-neutral rebate program.

The 2011 RPS review spurred the New Hampshire House of Representatives' Science, Technology and Energy Committee and the Senate's Energy and Natural Resources Committee to introduce and enact legislation (SB 218) to modify the RPS to include thermal technologies.[45] That legislation incorporated some, but not all, of the recommendations from the 2011 review.

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[43] The ACP rate for 2008 was set by statute and then adjusts annually to half the consumer price index. The average ACP cost in 2008 was $29.

[44] See http://www.puc.nh.gov/Sustainable%20Energy/RPS/2011-review-rps-law.html.

[45] See http://www.gencourt.state.nh.us/legislation/2012/SB0218.html.

SB 218 had wide bipartisan support, including from industry groups. Bill supporters made a strong case for thermal's economic, environmental, and ratepayer benefits. The bill came at a time when New Hampshire's forest-based industry was struggling due to the closure of paper mills, and stakeholders saw the potential inclusion of wood (pellet or chip) biomass heating technologies in the RPS as an opportunity to revive the distressed industry.

The legislation included a Class I renewable thermal carve out, which took a portion of the existing Class I target and allocated it to thermal projects. Under SB 218, by 2017, at least one percent of the Class I mandate was to be given to thermal energy. Thus, the bill did not propose new utility obligations—in fact, the bill proposed that the ACP that utilities would have to pay for not meeting the thermal target be valued at roughly half the Class I ACP rate. The proposed changes to the RPS were seen as a win-win for New Hampshire ratepayers, the local economy, and the environment. It easily passed in the Senate (23-0) and the House (292-52) and was signed by Governor John Lynch on June 19, 2012.

SB 218 required electricity providers to purchase "useful thermal energy," defined as useful thermal energy that can be metered and that is delivered as direct heat, steam, or hot water directly to the New Hampshire consumer and used for heating, cooling, humidity control, process (manufacturing) use, or other valid thermal end uses.[46] The useful thermal energy must displace fuel or electricity that would otherwise be consumed. Useful thermal energy is purchased as thermal RECs or "T-RECs." Any facility generating T-RECs must be located in New Hampshire and must deliver the useful thermal energy in-state.

In 2014, electricity providers were required to purchase T-RECs for 0.2 percent of their load. Follow-on legislation in 2013 (SB 148) adjusted the thermal obligation with an increase to 0.6 percent in 2015, 1.3 percent in 2016, and then annually by 0.1 percent from 2017 through 2023, after which the obligation remains unchanged. PUC docket #DE 16-850 in 2016 delayed the increase for Class I thermal obligations for one year. In 2017, the Class I thermal obligation was 1.0 percent of the total MWh supplied. Electricity providers can purchase T-RECs or make an ACP payment to the Renewable Energy Fund.[47] The ACP prices are defined by statute for each class; the thermal ACP was initially set at $25/MWh in 2013.[48] The PUC annually adjusts the ACP by one-half of the change in the consumer price index; the ACP rate for thermal is roughly equivalent to half the Class I ACP rate. The ACP rate acts as a price ceiling for T-RECs.

[46] "Useful thermal energy" as defined in RSA 362-F:2, XV-a, means a "renewable energy delivered from Class I sources that can be metered and is delivered in New Hampshire to an end user in the form of direct heat, steam, etc." PUC 2500 Electric Renewable Portfolio Standard amendments, adopted rule 1-29-18.

[47] Electricity providers can choose not to purchase RECs; if they choose not to purchase RECs, they must make alternative compliance payments. The ACP rates are defined in the statute and adjusted annually by the PUC by either the consumer price index or one-half of the consumer price index, depending on Class.

[48] The Class I ACP rate is adjusted annually by half the consumer price index (Class I RECs are roughly twice the price). In 2014, the thermal ACP rate was $25.17/MWh; the 2018 rate is $25.69. http://www.puc.state.nh.us/sustainable%20energy/renewable_portfolio_standard_program.htm

According to the statute, Class I thermal generation projects can produce T-RECs from geothermal (ground source heat pumps), eligible biomass technologies, and solar thermal.[49] House Bill 542 (2013) added CHP facilities as T-REC eligible when upgrades or replacements are made to the thermal portion of the facility. Any size facility can participate in the RPS—both small residential systems and large industrial systems can generate T-RECs. The useful thermal energy produced is measured on an "electric equivalency" basis; this allows the T-RECs to be sold and tracked on the New England Power Pool Generation Information System—the regional tracking system.

T-RECs are generated according to the following widely accepted equivalency formula:

3.412 million BTUs of useful thermal energy = 1 MWh

In addition to establishing an electric equivalency so that T-RECs could participate in the RPS market, the PUC had to develop rules for project documentation procedures, project commissioning and monitoring, metering standards, and reporting procedures. Furthermore, SB 218 stated that the thermal program must not add any administrative costs to the PUC and that no new staff could be hired to implement the bill. The rules became official in December 2014, but were retroactive to January 1, 2013.

All renewable thermal projects that would like to receive T-RECs must meter and report the useful heat/thermal energy produced. To limit on-site metering costs, the final rules differentiated metering requirements by system capacity or "size threshold." Systems with capacity up to and including 1MMBtu can be metered by fuel input metering, heat output, or run time combined with certified performance data, depending on technology. Larger systems (over 1,000,000 BTU/hr, 83-ton equivalent) require heat meters, which must be installed according to accurate metering protocols and metering specifications for accuracy.

Despite striving to keep metering requirements simple and affordable, the metering requirements for both system sizes are still relatively complex and expensive. In addition, both small and large systems require a site inspection, quarterly independent monitoring of monthly production, an engineer stamp, and a metering stamp (large systems only).[50] The on-site inspection and engineer stamp requirements are part of the application process and may be arduous and slow.[51] An independent third-party is required to monitor and verify energy production at least quarterly.[52] Large systems must meter heat output, which requires expensive meters that optimize energy production and efficiency; for large systems, the

[49] Biomass thermal facilities must meet NOx and PM emissions requirements. These requirements depend on the size of the generation unit.

[50] "Geothermal RECs in New Hampshire." Presentation by Matt Davis for the Renewable Thermal Alliance, 16 Feb. 2018.

[51] Ibid. The site inspection and application fee is $120; the annual reporting fee is $60. Likewise, the presentation also mentioned that stakeholders find the process "slow."

[52] Independent monitors verify production quarterly and confirm accurate production to NEPOOL GIS each quarter. NEPOOL then mints the production as eligible RECs for sale during the next trading period.

metering requirement is not an obstacle to participating in the T-REC market.[53] Small systems can meter fuel input and calculate thermal production instead of installing heat metering equipment. (See examples of system sizes and T-RECs in side bar.[54])

The statute requires that the PUC conduct a review of the RPS again in 2018 and 2025.

Results

Qualifying projects that came on-line on or after January 1, 2013 are eligible for T-RECs. Approximately 38 projects have submitted applications and have become eligible to generate and sell T-RECs. Most of the projects are large commercial or industrial wood biomass facilities; two large and seven small geothermal projects are also generating T-RECs, but no solar thermal projects have applied. Keene State College is currently the only facility generating T-RECs from a biofuel project.[55]

The predominate RPS thermal market appears to be the public sector—municipal buildings, public schools, and hospitals across the state have installed wood biomass heating and are using T-REC revenue to offset capital costs.[56] The 21 operating woody biomass projects generated 43,094 thermal RECs in 2017, which have, in turn, generated an estimated $991,162 in gross revenue for the system owners.[57] In addition, the combined projects displaced an estimated 1,500,851 gallons of #2 heating oil in 2017. Most of these systems are larger than 1 mmBtu/hr (83 tons). For example, the Holderness School replaced its propane-fired central steam boiler with a 5 mmBtu/hr biomass boiler system in 2015.[58] The system uses locally-sourced woodchip fuel and reduces the school's yearly fossil fuel use by

Examples of System Sizes and T-RECs Generated

Sample System One: A 4-ton capacity residential ground source heat pump will generate approximately 18-20 MWh/yr of useful thermal energy. This will generate 18-20 T-RECs. At the current price of $25/T-REC, a homeowner could expect to receive $450-$500 of T-REC revenue a year.

Sample System Two: A 300-ton capacity precision dry chip biomass boiler will generate approximately 900 MWh/yr of useful thermal energy. This will generate approximately 900 T-RECs. At the current price of $25/T-REC, a commercial/ industrial institution could expect to earn $22,000 of T-REC revenue annually.

[53] Ibid. A basic meter that meets meter accuracy requirements can cost up to $5000. The PUC offers rebates to help defray the costs of the metering requirement.
[54] http://groundenergysupport.com/wp/nh-thermal-recs-need-know/
[55] Keene State College uses a plant-derived biomass fuel called LR100, which was approved by the PUC.
[56] There is little incentive for a residential system to participate in the thermal REC market, because the T-REC revenue would likely be insufficient to cover the application, metering requirements, and monitoring fees, plus the aggregator's fees.
[57] An analysis of the revenues generated from the sale of T-RECs was completed by Charlie Niebling of Innovative Natural Solutions LLC in June 2018.
[58] Personal communication with Charlie Niebling, Principal & Partner at Innovative Natural Resource Solutions, LLC.

111,000 gallons of oil and 10,000 gallons of propane—a $300,000 savings in avoided costs.[59] This system generates approximately 3,500-4,300 T-RECs annually.[60] Similarly, a larger project at Plymouth State University provides heat and hot water to a new sport center with two dry hardwood chip boilers of approximately 2 mmBTU/hr each. This system includes a thermal storage tank and electro-static precipitators to catch particulates.[61] The University is displacing 55,000 gallons of #2 heating oil annually and generates approximately 1,430 T-RECs annually.

These projects have created an opportunity for local economic growth and have helped sustain the low-grade wood supply market. Since 2015, 21 wood biomass projects have qualified for T-RECs, representing an installed boiler capacity of 22.31 MW.[62] These facilities use locally sourced wood, including wood pellets, dried and refined wood chips, and green wood chips. While the cost of #2 heating oil has been low ($2/gal in 2017) and the woody biomass thermal market growth has been slow (approximately ten projects are applying for T-RECs annually), the thermal RPS program has had a positive impact on the forest industry. The wood biomass purchased by these facilities totals an estimated $1,720,395; the majority of this wood is sourced from New Hampshire.[63] The expenditures through the T-REC program multiply through the economy, providing an estimated $8,385,014 in beneficial impact on the regional economy in 2017.[64]

Strengths of the Program

New Hampshire was the first state to include thermal provisions in its RPS. As the first thermal RPS program in the nation, it not only provided innovation, but also acted as a starting point for New Hampshire and other states to improve upon. The original RPS statute directed the PUC to conduct an evaluation of thermal's potential during its 2011 RPS review; once the thermal Class I carve-out was passed, the thermal requirements became part of the RPS's periodic review. The thermal provisions are now included in the periodic RPS review, leaving room for program improvements and stakeholder feedback.

The PUC must undertake statutorily required periodic review of the RPS program to ensure that the program goals are being met; it is also required to evaluate new technologies, allowing new technologies to be phased in over time. For example, the statute required the evaluation of thermal provisions for the RPS in 2011. The 2018 review may include an opportunity to consider methane and landfill gas for T-RECs; similarly, the PUC is currently evaluating which fuels qualify as "biofuel."

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[59] See https://www.holdernessbiomass.org.
[60] Personal communication, Charlie Niebling, Principal & Partner at Innovative Natural Resource Solutions, LLC
[61] http://www.frolingenergy.com/portfolio-item/allwell-center-plymouth-state-university/
[62] The economic analysis in this paragraph, showing the economic impacts from the development of wood biomass heating facilities, was completed by Charlie Niebling of Innovative Natural Solutions LLC in June 2018.
[63] Ibid.
[64] Ibid.

Including the thermal requirements as a carve-out from the existing Class I tier ensured no additional ratepayer costs for the new program. Furthermore, assigning a lower T-ACP value (roughly half the Class I ACP price) reduced the overall costs of the RPS program. These cost-saving measures may have helped SB 218 move forward in a bipartisan legislature.

Other program strengths include the metering size threshold and the easy-to-use electric equivalency for heat output. To ease the financial burden of its metering requirements, in 2016 the PUC added a provision to its Renewable Energy Fund (REF) biomass program for commercial pellet boiler projects to receive a $5,000 rebate to underwrite proper metering. Any facilities using the rebate are required to register for T-REC eligibility.

The thermal RPS lowers heating costs at hospitals and many publicly funded institutions, such as schools, county facilities, and municipal buildings. It has support among many stakeholders interested in those institutions.

Limitations of the Program

Due to the low price of oil, the thermal REC value is often insufficient to encourage project development—the payback economics can be poor, removing the major incentive for financing a renewable project. The ACP is the maximum price for the T-RECs and is adjusted annually by half the consumer price index. Currently, the ACP price is $25.69/MWh. Because project development has lagged, there is an insufficient supply of T-RECs. The PUC's Renewable Energy Fund 2017 Annual Report indicates that ACPs for Class I Thermal in 2016 were $1, 237, 644, indicating that a large portion of the RPS thermal obligation was met by paying the ACP.[65] In fact, as part of the 2018 RPS review, the PUC looked at the percent of the thermal requirement met by ACPs vs RECs and found that the NH Class I thermal tier has the least compliance of all RPS programs in New England.[66]

Although all projects are facing financing challenges because of low T-REC prices, the problem is especially acute for geothermal projects. Unlike Massachusetts' thermal provisions in its Alternative Portfolio Standard, the New Hampshire RPS does not have incentive adders for technologies like geothermal.

The PUC has sought to rectify the thermal REC shortage by providing additional grant dollars for large thermal projects and Class I eligible projects within the commercial and industrial sector. The approved projects must be metered and qualified to produce RECs. Six Class I thermal

[65] The ACP sales for Class Thermal were $1,237,644 for 2016, which is roughly equivalent to 49,000 ACPs, which means that roughly 75% of the thermal obligation was met through ACPs. See PUC annual report at https://bit.ly/2Iodili.

[66] See slide 6: https://www.puc.nh.gov/Sustainable%20Energy/RPS/2018-rps_review_051018_stakeholder_session_2_linowes_slides.pdf.

projects were approved for grant funding totaling $930,000 in 2017. Once installed and certified, the six projects will create approximately 6,265 T-RECs.[67]

Small systems face greater financing challenges than larger systems. Due to costly administrative and compliance requirements, it is expensive for small projects to reap benefits from T-RECs. Generally, 700,000 BTU/hr-size systems (250-300 kW systems) are the minimum threshold for financial viability.[68] Below this threshold, it is too expensive to aggregate T-RECs, so homeowners do not participate in the T-REC market. However, the PUC administers an alternative funding stream through the REF that provides direct financial support for renewable energy projects, including residential projects. This rebate program awards funding for two thermal technologies: solar water heating and wood pellet furnace/boilers.[69] As the thermal REC program undergoes review in 2018, the PUC and stakeholders may consider whether any changes can be made to allow smaller systems to participate.

Lessons and Recommendations for Other States

New Hampshire developed an innovative program for thermal eligibility in the state's Class I tier of its RPS by creating entirely new mechanisms for including thermal production in a program created to track electricity production. However, these new procedures for metering, verification, and reporting could not—as required by statute—place further administrative costs on the PUC staff. As a result, renewable thermal facilities must hire independent monitors to verify and report generation to NEPOOL GIS, and third-party aggregators are often needed to participate in the renewable thermal REC market. Other states have had the benefit of New Hampshire's lead, incorporating lessons learned as they structure their own rules and procedures for qualifying thermal facilities. Massachusetts, for example, will take on the independent monitoring and reporting itself, and it will help customers set up accounts to access and submit RECs to NEPOOL GIS.

Some of the program's challenges regarding participation could be overcome with more outreach to and training of installers. Installers may be motivated to help renewable thermal customers with the REC application if they were aware of T-REC program's financial benefits and if they had tools to make the application process easier. Installers have indicated that a streamlined application process could also reduce costs.[70]

[67] See https://bit.ly/2Iodili.
[68] Residential systems are typically smaller than 25kw (<86,000BTU/hr) systems.
[69] The REF rebate program is administered by the Sustainable Energy Division of New Hampshire's PUC. For more information, visit https://bit.ly/2HGmlRb
[70] Presentation by Matt Davis for the Renewable Thermal Alliance, 16 Feb. 2018. Geothermal RECs in New Hampshire.




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