Maine Distributed Solar Valuation Study

Volume III: Implementation Options

Introduction

Background

Act to Support Solar Energy Development in Maine. P.L Chapter 562 (April 24, 2014) (codified at 35-A M.R.S. §§ 3471-3473) ("Act") sought information on options for distributed solar energy implementation. This volume provides analysis of options for increasing investment in or deployment of distributed solar generation that are used in other states or jurisdictions. In particular, it concentrates on experience with solar implementation approaches in states with similarities to Maine in market structure (deregulated) and economic opportunity (driven by insolation, land use, electricity prices, etc.), including New England, New York and select PJM states. The authors have also provided general guidance to help the Legislature consider which options, approaches or models may be appropriate for Maine, considering the State's utility market structures.

Approach and Structure

In conducting this analysis, the authors first identified a baseline of current solar-related policies in Maine. Next, the authors reviewed solar PV implementation approaches in place in states with similarities to Maine in geographic location, market structure, and economic opportunity. In addition, the authors conducted a review of recent literature (published in 2012 – 2014) on solar implementation approaches and best practices, distributed generation (DG) policies and utility DG tariff design conducted by a variety of national and state renewable energy policy research organizations and policymakers. Through the literature review, the authors established a list of solar implementation options adopted in the selected states. The implementation options were organized into relevant categories within a comprehensive framework. The authors examined these options, their strengths and limitations in the view of different constituent groups, and how they interact with policies and programs in place. The authors then analyzed the different options, and identified some key characteristics and approaches that would be appropriate for consideration in Maine give the current state of policy and market.

As the volume of distributed solar installations nationwide has rapidly expanded over the past few years, a tremendous amount of experience in solar implementation is becoming available on how legislators and policymakers may make choices that enable, shape or limit that deployment. In reviewing this volume, readers should take into consideration that the field of distributed solar implementation is evolving rapidly, and new studies and approaches are appearing, being proposed or put into practice almost daily in the laboratory of the states. In addition, many implementation options have only been in effect for a limited time and in a few locations. The available data may not be readily extrapolated in all instances. In addition, there are important regional differences – in amount of sunshine, market structure, level of retail and wholesale rates, load growth patterns, and transmission

and distribution system characteristics, which could impact the interpretation of that experience. Finally, as the Legislature considers solar implementation options, while an environment of policy stability is important in attracting private investment, most state policies examined have been adjusted and modified during the first few years of implementation, so a spirit of experimentation may be warranted.

Solar Implementation Options

This volume provides a broad overview of implementation options used in other states and jurisdictions to increase investment in or deployment of distributed solar generation. We started by identifying a thorough list of solar implementation option in widespread use. To organize and facilitate discussion of the wide range of implementation options identified, we organized the range of implementation options into four major categories - **Instruments Used to Incentivize Solar; Financing Enabling Policies; Rules, Regulations and Rate Design;** and **Industry Support** – as well as a number of subcategories, as laid out in Table 38. The list includes a broader set of implementation options than are fully evaluated in this volume. Each of these implementation options is described in Section 0. Options in shaded rows were identified as commonly used implementation options but of less potential interest for legislative consideration, and are only discussed briefly in Section 0, while all others are more fully described and characterized.

Table 38 – Summary of Solar Implementation Option

Category	Subcategory	Implementation Examples
Instruments Used to Incentivize Solar	Direct Financial, Up-front Incentives (nameplate capacity-based or denominated)	Grants, Rebates, or Buy-Downs
	Direct Financial, Performance-Based Incentives (PBIs) (energy-based or	Feed-In-Tariffs, Standard Offer[43] PBI Contracts or Tariffs, or PBIs (RECs, Energy, or Capacity)
		Competitive Long-Term PPAs

[43] The use of the term "standard offer" in this report is not to be confused with Maine's application of the term "standard offer service." In this report, "standard offer" refers to an incentive option that offers pre-determined, fixed incentives (such as up-front incentives like rebates, or long-term fixed prices, like a feed-in tariff) to any eligible generator. Maine refers to "standard offer service" as electric generation service provided to any electricity consumer who does not obtain electric generation service from a competitive electricity provider or who has terminated service from a competitive electricity provider. (Maine Public Utilities Commission, n.d.)

Category	Subcategory	Implementation Examples
	denominated)	Long-Term Value of Solar Tariffs
		Technology-Specific "Avoided Costs"
	Indirect Financial Incentives	Emissions Markets
	Expenditure-Based Tax Incentives	Investment Tax Credits
	Production Tax Incentives	Production Tax Credits
	Demand-Pull/Solar Minimum Purchase Mandates	Renewable Portfolio Standards (RPS)
		Solar Set-Asides in RPS (SREC markets)
	Net Metering	Net Metering Crediting Mechanism
		Virtual Net Metering Crediting Mechanism
		Community-Shared Solar
Financing Enabling Policies		Solar Load Programs (Non-Subsidized or Indirectly Subsidized)
		On-Bill Financing
		PACE Financing
		Green Bank – Institutions and Suite of Other programs (e.g. Interest Rate Buy-Downs, Loan-Loss reserves, Loan Guarantees, Public Financing)
		Utility Ownership
		Solar Lease and/or Third-Party Ownership Enabling Policies or Eligibility in Other Policies
Rules, Regulations and Rate Design	Removing Institutional Barriers	Interconnection Standards
		Solar Access Laws
		Business Formation/Financing Laws (e.g. Securities Registration, Innovative Market Structures, such as Crowd-Funding, Cooperatives, Community Solar, etc.)

Category	Subcategory	Implementation Examples
		Permitting Standardization, Simplification, and Streamlining, and Other "Soft-Cost Reduction" Strategies
	Building Codes	Solar-Ready Building Standards, Zero-Energy Capable Home Standards
	Tax	Property Tax Exemption or Special Rate
		Sales Tax Exemption
		Property Tax/PILOT Standardization or Simplification
	Grid Modernization	Policies Enabling Microgrids, Smart-Grid and Other DG-Friendly Grid Architecture
	Rate Design	Time-varying rates, rate design, fixed charges and minimum bills
Industry Support		Incentives for Companies, Technology Development Funds, or Economic Development Funds
		Local Content Bonus Or Mandate
		Customer Acquisition Cost Reduction (e.g. Solarize Initiative)
		Outreach/Education/Public Information/Voluntary Market Encouragement
		Public Sector Leadership and Demonstration (e.g. Solar on Schools)
		Creation of Public Good Funds to Support Solar Programs/Policies
		Installer and Inspector Training and Certification

Organization of This Volume

This volume is organized as follows:

Section 0 summarizes the current solar implementation mechanisms in Maine.

In Section 0, solar implementation options adopted in states in the Northeast United States are identified using the categorization framework outlined in Table 38. The major implementation options are described, along with their objectives, target markets, key structural variations, impacts on different stakeholders, implementation issues, and typical interaction with other approaches.

Section 0 identifies illustrative implementation objectives designed to identify which approaches are potentially appropriate for consideration in Maine. The section also summarizes lessons learned from other states and the authors' literature review regarding solar PV implementation. Finally, the section presents a list of factors the legislature may wish to consider when designing an implementation approach. .

A summary of references is also included.

Current Solar Implementation Mechanisms in Maine

Maine has adopted a broad range of policies related to renewable resource development. These policies primarily focused on utility-scale renewable energy resources, such as biomass, hydroelectric, onshore wind, and offshore wind and tidal generation, as well as enabling distribute generation more generally. Although some of these policies do apply to solar, Maine does not currently have a suite of policies specifically targeting solar energy. The current suite of policies, in combination with regional Renewable Portfolio Standard demands, have stimulated some degree of distributed solar PV installations in Maine, particularly in the last few years.

Solar Rebates

To reduce the up-front cost of solar PV, the state, between July and December, 2010, offered residential and business customer rebates for solar systems 100 kW or smaller through the Efficiency Maine Trust. (P.L. 2009 Ch. 372, 2009). The program provided rebates at 0.005¢/kWh. The program was repealed effective December 31, 2010 (35-A MRS § 10112, n.d.).

Net Metering

Net metering for solar PV has been available in Maine since the early 1980s. As of the end of 2014, the utilities report that Maine had an aggregate net-metered installed capacity of about 21 MW, with about 11.7 MW being solar PV. Under Maine's net metering rules, investor-owned utilities are mandated to provide net metering to owners[44] of eligible systems (including solar PV, fuel cells, wind, geothermal, hydroelectric, biomass, landfill gas, anaerobic digestion, micro-combined heat and power facilities) with an installed capacity of 660 kW or smaller.[45] Consumer-owned utilities are only required to provide net metering to systems up to 100 kW in installed capacity, but can choose to increase the system cap limit to 660 kW at their own discretion. Net metering customers are credited for the excess generation as a reduction in energy usage for the following months for up to twelve months. Any accumulated unused credits will expire at the end of the twelve-month period. Unlike many other nearby states, Maine does not have an aggregate program cap, but utilities are required to inform the Commission when the total net-metered capacity reaches 1% of the utilities' peak loads. (Maine Public Utilities Commission, 2009).

[44] The Commission rules are flexible to accommodate arrangements similar in nature to ownership (such as certain lease-type arrangements), but not sufficient to allow for 3rd-party sales arrangements.
[45] Unlike many states, generation need not be behind-the-meter to receive net metering credits.

Shared Ownership Net Metering

In 2009, the Maine Legislature authorized shared ownership net metering, which allows up to ten customers to share ownership interest in a single facility. Under the shared ownership rules, the net metering customers must be owners of or have "legally enforceable rights and obligations" in the net metered facility. Similar to Maine's regular net metering, customers are credited for a percentage of the excess generation of the facility on their utility bills in proportion to their ownership interest of the facility. (Maine Public Utilities Commission, 2009). This provision effectively enables community-shared solar ownership, a model that has become increasingly common in recent years. Based on utility net metering reports to date, there is one shared ownership net metering arrangement in operation for solar PV.

Shared ownership is a form of virtual net metering. Many other states have virtual net metering rules that, unlike Maine, allow sales or transfer of net metering credits to offset billed charges of parties who do not have an ownership in the net metered facility.[46]

Renewable Portfolio Standard

Maine's version of the policy implementation approach commonly referred to as a Renewable Portfolio Standard (RPS) was created in phases. To support pre-restructuring grid-scale renewable energy facilities, the Maine Legislature adopted a 30% eligible resource portfolio requirement that became effective in 2000 (35-A M.R.S. § 3210(3)). This requirement mandated that retail electricity providers source 30% of their supply from eligible renewable energy generators of any vintage. Since Maine's legacy eligible resource fleet exceeded the 30% standard by a wide margin, this requirement has been in surplus since its inception, with market prices for renewable energy certificates (RECs) used for compliance trading at a very low price (typically in the range of $1/MWh) insufficient to support any new renewable energy development.

In 2007, the Legislature enacted a "new" renewable resource capacity portfolio requirement (35-A M.R.S. § 3210(3-A)). This new requirement, referred to as the Class I RPS (the previous RPS requirement was rechristened as Class II), defines eligibility as a renewable resource that began service, resumed operation or was substantially refurbished after September 2005. The initial Class I RPS requirement was set at 1% of load in 2008 and escalates annually at 1% per year until reaching 10% in 2017 and remaining at that level thereafter. (Maine Public Utilities Commission, 2007) (Maine Public Utilities Commission, 2014) While solar PV is eligible toward compliance for the Maine RPS Class I (Maine Public Utilities Commission, 2014), historically the RPS has not resulted in promoting investment in solar PV primarily

[46] Some states limit virtual net metering to sharing net metering credits to common ownership of meters or accounts, while others allow broader sharing with unrelated parties throughout the distribution company service territory. See Section 0 for more information.

due to inadequate price levels, and in the authors' analysis, this situation is not envisioned to change any time soon. Community-Based Renewable Energy Pilot Program

P.L. Ch. 329, enacted in 2009, directed the Commission to establish and administer a pilot program to support the development of community-based renewable projects, defined as locally-owned generating facilities with installed capacities of 10 MW or less. (Maine Public Utilities Commission, 2014) The Community-Based Renewable Energy Pilot Program is a feed-in-tariff program that provides incentives to community-based projects in the forms of (1) above-market priced long-term contracts (up to 20 years) with a price cap of 10¢/kWh or (2) a 150% renewable energy credit (REC) multiplier. Projects choosing the first option must enter into long-term contracts with the T&D utility in whose service territory the project is sited. (Maine Public Utilities Commission, 2014) So far, no projects have chosen to take advantage of the REC multiplier option. The program initially had a 25-MW utility-specific cap, which was removed pursuant to P.L. Ch. 434 in 2014. The 50-MW overall program was kept, although there is insufficient space under the 50-MW cap for additional projects.[47] To date, no solar projects have participated in the long-term contract aspect of the program. Pursuant to P.L. Ch. 329, the program is scheduled to expire on December 15, 2015.

Time-of-Use Rates

Maine's investor-owned transmission and distribution (T&D) utilities offer time-of-use transmission and distribution rates options to residential customers. (Emera Maine, 2014) (Central Maine Power Company, 2014).[48] In addition, CMP offers a time-of-use option on Standard Offer/Default generation service rates. The electricity prices for customers opting for these rate structures fluctuate based on the time of electricity use. Because Solar PV produces during peak periods, time-of-use rates may allow PV hosts to displace higher-than-average peak rates coincident with the time of peak production, yielding additional value for self-generating customers.

Interconnection Standards

The Commission adopted interconnection standards for small generators interconnecting to the grid in 2010. The standards were modeled after the 2006 Interstate Renewable Energy Council (IREC) guidelines. All T&D utilities are required to establish interconnection application and review procedures of customer-generator facilities in the following levels. Each level has different fees and technical screens.[49]

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[47] In a decision issued in April 2014, the Commission noted that there were 49.992 MW of projects certified for the Community-Based Renewable Energy Pilot Program to-date. (Maine Public Utilities Commission, 2014)

[48] The Commission staff report that these rates are not fully developed, with many issues to be resolved to better reflect cost and value.

[49] The 2014 Freeing the Grid Report gave the Maine interconnection standard a B grade, recommending that the state clarifies on the dispute resolution process. (Interstate Renewable Energy Council; Vote Solar, 2014)

Overview of Solar Implementation Approaches Used in Other States

This section focuses on solar implementation approaches adopted in the five other New England States (Connecticut, Massachusetts, New Hampshire, Rhode Island, and Vermont), New York, and four states (Delaware, Maryland, New Jersey, and Pennsylvania) within the PJM territory. These locations are selected for their electric market structure (same or similar regional system operator structure, deregulated markets) and economic opportunity (driven by insolation, similar geography and land use pattern, and demographics).

Table ES- 4. Summary of Solar Implementation Option: "Rules, Regulations and Rate Design"

Subcategory	Implementation Examples	Description
Removing Institutional Barriers	Interconnection Standards	Regulations standardizing the requirements of integrating solar PV to the grid
	Solar Access Laws	Rules protecting customers' access to sunlight and solar development rights
	Business Formation/Financing Laws	Policies authorizing certain types of business models or market structures designed to lower the entry barrier and expand access to the solar market
	Permitting Simplification, Other "Soft-Cost Reduction" Strategies	A suite of strategies designed to reduce the non-equipment costs associated with various stages of solar PV development
Building Codes	Solar-Ready Building Standards, Zero-Energy Capable Home Standards	Various building standards that (i) regulate orientation, shading, and other siting- and construction-related criteria; or (ii) support "plug-and-play" PV system configurations
Tax	Property Tax Exemption or Special Rate	Property tax relief to property owners installing solar PV
	Sales Tax Exemption	Tax relief exempting system owners from paying sales taxes for PV system equipment
	Property Tax/Payment in lieu of taxes (PILOT) Standardization or Simplification	State policies designed to limit community-by-community variations in property tax and PILOT rules; designed primarily to remove uncertainty

Grid Modernization	Policies Enabling Microgrids, Smart-Grid and Other DG-Friendly Grid Architecture	Policies designed to promote installations of DG-friendly technologies and grid architecture; aim to ease interconnection and advance implementation of solar PV
Rate Design	Time-Varying Rates, Rate Design, Fixed Charges and Minimum Bills	Cost-based utility rate design or rate structures designed to provide a correct or supportive price signal for the installation and operation of solar generation facilities

Table ES- 5. Summary of Solar Implementation Option: "Industry Support"

Implementation Examples	Description
Incentives for Companies, Technology Development, or Economic Development	Funding mechanisms designed to provide incentives for in-state solar businesses; allocated from the state budget, RPS alternative compliance payments, RGGI proceeds and/or public good funds
Local Content Bonus Or Mandate	Incentives or requirements that give preference to projects supporting in-state investment
Customer Acquisition Cost Reduction	Strategies leveraging scale economies or other measures to increase solar participation at a lower cost
Outreach/Education/Public Information/Voluntary Market Encouragement	Strategies designed to increase customer awareness of solar technology, voluntary and compliance solar markets, and solar funding and financing options
Public Sector Leadership and Demonstration	State or local initiatives, such as demo projects on public properties or statewide PV goals
Creation of Public Good Funds to Support Solar Programs/Policies	Policies establishing funds collected from ratepayers through utility bill surcharges; designed to provide long-term funding for solar incentive programs
Installer/Inspector Training and Certification	Training and certification programs designed to build a qualified local solar workforce

summarizes which of the identified implementation options has been adopted in each state. The rows describe the implementation approaches within each category, with a column for each state. An "X" indicates when a state has adopted a version of the associated implementation approach.

The remainder of this section qualitatively characterizes each implementation option. We selected a list of implementation approach characteristics guided by a literature review of solar implementation best

practices. This list was designed to provide a clear and transparent layout for identifying and contrasting the characteristics of each implementation option, as well as to present a comprehensive understanding of the interactions among different implementation options and constituent groups. Most options are characterized as follows:

- **Implementation Option Overview** – Provide general background of implementation approach, including typical objectives and target market, such as what types of solar projects (e.g. customer sectors, system sizes, technologies, etc.) the approach typically targets/supports.
- **Key (or interesting) Structural Variations**
- **Impacts on Different Stakeholder Groups**
- **Implementation Issues**
- **Interactions with Other Implementation Approaches** – Identify whether there are implementation options that are typically complimentary, commonly considered as alternative or mutually-exclusive or conflicting options.

Table 39 – Solar Implementation Options Adopted in Other States

Category	Subcategory	Implementation Examples	CT	MA	NH	RI	VT	NY	DE	MD	NJ	PA
Instruments Used to Incentivize Solar	Direct Financial, Up-front Incentives (nameplate capacity-based or denominated)	Grants, Rebates, or Buy-Downs	X	X	X	X	X	X	X	X	X	X
	Direct Financial, Performance-Based Incentives (PBIs) (energy-based or denominated)	Feed-In-Tariffs, Standard Offer PBI Contracts or Tariffs, or PBIs (RECs, Energy, or Capacity)	X			X	X	X	X			
		Competitive Long-Term PPAs	X			X	X	X	X		X	
		Long-Term Value of Solar Tariffs										
		Technology-Specific "Avoided Costs"					X					
	Production Tax Incentives	Production Tax Credits								X		
	Demand-Pull/Solar Minimum Purchase Mandates	Renewable Portfolio Standards (RPS)	X	X	X	X		X	X	X	X	X
		Solar Set-Asides in RPS (SREC markets)		X	X				X	X	X	X
	Net Metering	Net Metering Crediting Mechanism	X	X	X	X	X	X	X	X	X	X
		Virtual Net Metering Crediting Mechanism	X	X	X	X	X	X	X	X	X	X
		Community-Shared Solar		X	X		X		X			
Financing Enabling **Policies**		Solar Loan Programs (Non-Subsidized or Indirectly Subsidized)	X	X	X			X	X	X	X	
		PACE Financing	X	X	X	X	X	X		X	X	
		Green Bank – Institutions and Suite of Other programs	X					X				

Category	Subcategory	Implementation Examples	CT	MA	NH	RI	VT	NY	DE	MD	NJ	PA
		Utility Ownership	X	X			X					
		Solar Lease and/or Third-Party Ownership Enabling Policies or Eligibility in Other Policies	X	X	X	X	X	X	X	X	X	X
Rules, Regulations and Rate Design	Removing Institutional Barriers	Interconnection Standards	X	X	X	X	X	X	X	X	X	X
	Tax	Property Tax Exemption or Special Rate	X	X	X	X	X	X		X	X	
		Sales Tax Exemption	X	X		X	X	X		X	X	
Industry Support		Local Content Bonus Or Mandate	X	X								
		Customer Acquisition Cost Reduction	X	X		X		X				
		Public Good Funds to Support Solar Programs/Policies	X	X	X	X	X	X	X	X	X	X

Instruments Used to Incentivize Solar

Incentives commonly used as vehicles to incentivize distributed solar PV include a suite of implementation options aimed at changing market or economic decision making by (i) creating market demand, (ii) removing financing barriers, and/or (iii) lowering installation costs for solar PV. (Doris, 2012). These options include direct and indirect financial incentives targeted at capacity development (i.e. Capacity-Based Incentives) or electricity production (i.e. Performance-Based Incentives). Incentives can also be offered as tax benefits credited according to system costs (i.e. Expenditure-Based Tax Incentives) or generation (i.e. Production-Based Tax Incentives). Mandates creating a demand-pull (i.e. renewable portfolio standards/Solar Minimum Purchase Mandates) for solar PV are also a form of incentives.

Direct Financial, Up-Front (a.k.a Nameplate Capacity-Based or Denominated) Incentives

Grants, Rebates, or Buy-Downs

Direct, up-front incentives, including grants, rebates and buy-downs, compensate or incentivize generators in proportion to installed system capacities. The primary objective of these implementation approaches is to reduce the up-front cost of PV installations, hence, lowering the entry barrier to solar development. Sometimes called "investment incentives," these incentives differ from "performance incentives" because they are based on system initial size and investment, and are not contingent on performance. Typically, front-end payment policies are targeted to small- and medium-scale systems installed by residential and commercial and industrial (C&I) customers, where up-front cost is a great barrier. (Bird, Reger, & Heeter, 2012). Unlike tax-based incentives, cash incentives are available to entities with no tax appetite, such as municipalities and non-profit organizations. (DSIRE Solar Policy Guide: A Resource for State Policymakers, 2012).

Typically, up-front payment programs operate on a first-come, first-served basis for eligible installations until the allocated funding is fully subscribed. The incentive levels, nominally based on the installed (nameplate) capacity of the solar system (i.e. $/kW, usually measured at DC), are administratively-determined and known to eligible customers in advance. These programs can be funded with various mechanisms. Some common funding sources include state budgets (i.e. tax revenues), RPS Alternative Compliance Payment proceeds or public good funds (a.k.a. system benefit charge (SBC)-based funds). The latter two are funded by utility ratepayers.

There are several key design features to be considered when implementing an up-front incentive program:

- **Program Blocks –** One issue with incentive programs operating on a first-come, first-served basis with limited budgets is a lack of predictability of funding availability. It is often challenging for developers to predict when the funding will be fully subscribed, especially in situations

where applications for incentives outpace program budgets. Such an unstable start-stop cycle is especially challenging for large system owners, whose project development requires much longer planning time. (DSIRE Solar Policy Guide: A Resource for State Policymakers, 2012) This issue is especially prevalent where solicitation is infrequent. States can instead distribute program budget to multiple enrollment blocks and accept applications for block funding multiple times a year. This approach adds transparency and predictability to incentives over a longer period of time. Massachusetts' Commonwealth Solar II Rebate Program and New York's MW Block Program both operate under this model.

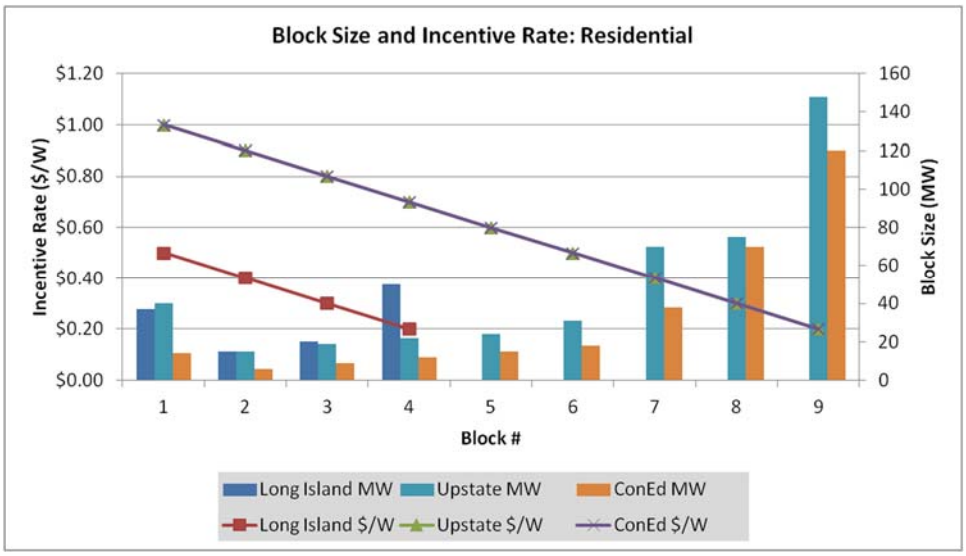
- **Performance Guarantees –** Front-end payments support the development of new capacity, but cannot guarantee actual energy production. It is a common concern that capacity-based incentives could not prevent poor system performance driven by improper installations or inadequate operation and maintenance (Bird, Reger, & Heeter, 2012), and in the absence of measures to encourage good performance, may actually incentivize poor performance. States can implement performance guarantees in their incentive programs, such as requiring equipment warrantees, establishing installer qualification requirements mandating inspections, etc. The New Hampshire Public Utilities Rebate program requires system owners to provide installer information, estimated optimal PV production, production loss from shading, and other system details. (New Hampshire Public Utilities Commission, n.d.). Some states have developed hybrid approached in which a portion of an incentive is distributed as a performance-based incentive (described below) during the first few years of operation. Some other states, such as California and New York, use a hybrid approach called an expected performance-based incentive, or EPBI, which is provided up-front like other incentives described in this subsection, but ultimately dependent on performance like PBIs described in the next subsection, with the potential for incentive 'claw-back' in the event of underperformance.

- **Geographic Balance –** Non-competitive standard incentives typically do not stimulate geographic diversity in project development. The New York MW Block Program addresses this issue by creating different incentive rates for different utility territories (e.g. higher incentive levels for New York City and upstate, lower incentive levels for Long Island). This mechanism allows more equitable allocation of incentive funding based on the difference in project development costs driven by geographic constraints (e.g. solar insolation, building structures, etc.). It also incentivizes solar development where distributed generation is needed most, such as areas with distribution constraints or high load density.

- **Incentives Adjustment –** It can be challenging to set upfront incentives correctly in a dynamic market. Good up-front payment programs should be responsive to changing market dynamics (e.g. demands, electricity prices, project economics, and market diversity, etc.). For example, the Massachusetts Clean Energy Center (MassCEC) can adjust the incentive level for each successive enrollment for the Commonwealth Solar II Rebate program to account for changing market interests, decline in solar technology costs and other market conditions. The MassCEC also incorporates incentive adders (e.g. Massachusetts Company Component adder, Natural Disaster Relief adder and Moderate Home Value and Moderate Home Income adder), which award

certain customer classes or project types with extra incentives. (Massachusetts Clean Energy Center, n.d.) Some states implemented capacity-based incentive programs with declining incentive schedules to reduce reliance on incentives, both following and encouraging reduced solar technology cost over time. The following graphs demonstrate the declining incentives under New York's MW Block Program:

Figure 33 – New York MW Block Program Declining Incentives (Residential)[50]



Compared to other incentives, capacity-based programs have a much more front-loaded budgetary demand. (Bird, Reger, & Heeter, 2012). Unlike tax incentives or performance-based incentives, which are typically funded by ratepayers, rebates, grants and buy-downs require an explicit funding mechanism, often appropriated from the state budget or established through a ratepayer SBC fund. This factor often makes up-front payment policies less appealing to policymakers, as demand can outstrip the funding source and bring a growing market to a halt. It also makes more rebates, grants and buy-downs programs more susceptible to raids when state budget is short, as evidenced in Connecticut and New Hampshire in recent years.[51] (DSIRE Solar Policy Guide: A Resource for State Policymakers, 2012)

[50] (The NY-Sun Initiative, 2014)

[51] In June 2013, the Connecticut legislature passed a budget bill that would transfer the $5 million in Regional Greenhouse Gas Initiative funding and $30.4 million in Clean Energy Finance and Investment Authority funding to the General Fund to help balance the budget for fiscal years 2014 and 2015.

Direct Financial, Performance-Based Incentives (PBIs)

PBI Feed-In-Tariffs, Standard Offer PBI Contracts or Tariffs

Standard offer performance-based incentives (PBI) reward generators for actual solar energy production (i.e. kWh) at a known rate over a fixed period of time. This approach provides generators with a predictable revenue stream, reducing financing risks. Typical standard offer PBI policies involve T&D utilities purchasing energy and/or RECs from generators through multi-year term contracts or tariffs at a predetermined $/kWh rate or rate schedule on a first-come-first-served basis. (New York State Energy Research and Development Authority, 2012). The contract/tariff rates are usually administratively-determined based on market research and economic analysis, although they can also be based on a competitively-derived price (as is the case for Connecticut's Small ZREC program, which sets prices at 110% of the weighted average of winning bids from Medium ZREC auctions). (Connecticut Light & Power Company; United Illuminating Company, 2011).They can be fixed over time, increased at a predetermined escalator, or indexed according to inflation, spot electricity prices and other factors. Utilities can use the purchased energy, capacity and/or RECs to meet their obligations or resell the attributes at spot market prices. In the latter option, utilities can recover the difference between the spot prices and the contract/tariff prices from ratepayers. Standard offer PBIs can be implemented with many different features, such as purchase and dispatch requirements and contract terms, designed to achieve different implementation objectives. (New York State Energy Research and Development Authority, 2012). A Feed-In-Tariff (FIT) is a globally popular form of a standard offer PBI policy that guarantees generators access to the electricity grid over a fixed term.[52]

Standard offer PBIs are available to most customer classes and system sizes, although some states have separate competitive procurement procedures for larger commercial-scale systems. Standard offer PBIs are especially attractive to small residential and C&I customers as they typically have low barriers to participate (New York State Energy Research and Development Authority, 2012) and have minimal transaction costs. To prevent large projects developed by more sophisticated players from crowding out smaller systems, most states allocate fixed budgets or capacities to different customer and or system size blocks to protect residential and small C&I customers and support market diversity.

Standard offer PBI programs can be implemented with different price setting and payment models, described as follows:

[52] For more information on FITs, see:

- Rickerson, Wilson H., Janet L. Sawin and Robert C. Grace, *If the Shoe FITs: Using Feed-in Tariffs to Meet U.S. Renewable Electricity Targets*, The Electricity Journal, Vol. 20 (4), May 2007; or
- Grace, Robert, Wilson Ricerson, Kevin Porter, Jennifer DeCesaro, Karin Corfee, Meredith Wingate and Jonathan Lesser, *Exploring Feed-in Tariffs for California: Feed-In Tariff Design and Implementation Issues and Options.* California Energy Commission. Publication number: CEC-300-2008-003-F, Sacramento, CA, November 2008.

- **Standard Offer PBI Price Setting –** Standard offer PBI prices can be determined in multiple ways. Levelized cost of solar generation (e.g. Rhode Island Renewable Energy Growth Program) and avoided costs (of solar e.g. Vermont Sustainably Priced Energy Enterprise Development Program) are two commonly used factors for calculating standard offer prices. Standard offer prices can also *value*-based, i.e. represented the value of solar generation to the society and/or utilities. A fourth option is a competitively-derived price approach, which uses the prices from a prior auction separate from the standard offer program to inform the standard offer incentive levels (e.g. Connecticut Small Zero Emissions Renewable Energy Credit Program[53] (Couture, Cory, Kreycik, & Williams, 2010)

- **Payment Structure –** Standard offer incentives can be credited with different payment structures. A typical approach is to issue the incentives as direct payments under multi-term contracts or tariffs. Another approach, typically targeted to residential and small C&I customers, is to pay the incentives as a bill credit to the generators. Rhode Island's Renewable Energy Growth program applies the PBIs first as bill credit on a residential customer's bill. The difference of the total PBI payment under the Renewable Energy Growth program and the value of the credit to the generating customer's bill is paid as a direct payment to the generator.

Standard offer PBIs provide generators with revenue predictability, reducing financing risks. While they do not spur competition among projects, they are generally understood to create market scale and stability which drives competition and innovation further up the value chain (i.e. shifting the basis of market competition from generation price to equipment price and installation labor cost). (KEMA, Inc. , 2009). Long-term standard offer contracts or tariffs which procure energy and RECs at a fixed price also help utilities hedge against fuel price volatility. The ratepayer impact of standard offer PBIs is mixed. While standard offer PBIs can reduce the cost of solar PV and increase electricity price certainty, if not set with certain well-understood cost-containment mechanisms limiting quantity or cost, there is a risk of oversubscription if the prices are set too high, potentially triggering undesirable rate increases.[54] (Kreycik, Couture, & Cory, 2011). Additionally, there are several implementation issues to be considered when implementing standard offer programs:

- **Price Setting –** PBI price must balance the drive for investment and ratepayer impacts. Incentive levels that are set too low may not support market growth. Incentive levels that are set too high could over-stimulate the market and lead to oversupply of solar PV and undesirable rate impacts. (Grace, et al., 2008)

- **Market Responsiveness –** Standard offer PBIs are generally considered to lack market responsiveness. These programs lock in electricity prices over multiple years, and in some cases, over a decade. As a result, they typically cannot react to market conditions and other external

[53] The Connecticut Small ZREC (systems up to 100 kW) tariff rate is derived using 110% of the weighted average bid price from the previous Medium ZREC (100 – 250 kW) solicitation.
[54] Spain's feed-in tariff is the classic example of this risk. (Kreycik, Couture, & Cory, 2011).

factors, such as policy changes. "Must-buy" provisions under long-term FITs can create additional inflexibility by prohibiting utilities from adjusting their purchases according to demands and electricity prices. (Couture, Cory, Kreycik, & Williams, 2010)

- **Drive for Project Cost Reduction –** By providing uniform incentives for all projects, standard offer PBI provides little drive for project competition, which push downward pressure on project pricing.

Standard offer PBIs for solar are sometimes paired with RPS policies (or operate within them), where utilities can use the purchased electricity and/or solar RECs toward RPS obligation compliance or resell the RECs to RPS obligated entities. FITs can sometimes serve as an alternative option to net metering. Instead of allowing solar customers to reduce retail load with onsite generation, utilities can purchase all electricity through FIT arrangements.

Competitively-Procured Long-Term Power Purchase Agreements (PPAs) or Tariffs

Six of the states studied here have implementation options that establish competitive solicitation process for long-term power purchase agreements or tariffs for solar PV and other distributed renewable generation. Typically, these options require a procurement entity, usually a T&D utility (but sometimes a separate central administrator), to purchase either RECs or a combination of RECs, solar energy and capacity through power purchase agreements or tariffs at fixed prices most often over a 10- to 25-year term. In most of the options discussed here, T&D utilities are the procurement entity and are responsible for the PPA or tariff payments. Competitive long-term power purchase agreements or tariffs are often paired with RPS to provide long-term added certainty to REC prices and supply availability, as well as to ensure that at least a portion of RPS supply is sourced locally (bringing local economic benefits). T&D utilities can use the purchased RECs toward their own RPS obligation or resell the RECs, energy, and/or capacity as applicable into the market at spot prices, passing the difference between the spot price and the PPA/tariff price through to distribution ratepayers. Competitive long-term PPA or tariff programs are usually targeted to larger distributed generation or utility-scale installations. Residential and small commercial and industrial (C&I) customers typically are targeted with non-competitive programs, which have less sophisticated procedures and lower transaction costs. To enable smaller customers to participate in competitive programs, some states allow installers to participate as aggregators on behalf of multiple small customers and bid in aggregations.

By providing long-term price certainty and revenue stability, long-term PPA or tariff policies lower the barrier of financing solar PV, which in turn enable solar projects to attract financing. Creditworthy PPAs or tariffs increase developers' ability to obtain low-cost financing and provides reasonable revenue stability. This reduces the required incentive for solar development in the long-run. Further, long-term PPA or tariffs which purchase energy allow T&D utilities to hedge against fuel volatility of their distribution customers. As a result, long-term PPAs or tariffs put downward pressure on solar subsidies, hence reducing ratepayer impacts in the long-run.

Competitive long-term PPA or tariff policies can be implemented with various design features:

- **Solicitation Classes -** To foster market diversity and equity, or to differentially incentive favored subsectors of the market, some long-term PPA or tariff programs are divided into multiple solicitation classes for different system sizes, ownership types and other project types. This approach has been taken in Connecticut, Rhode Island and Delaware, for example. The following table summarizes the solicitation classes available in each program:

Table 40 – Solicitation Classes in Connecticut, Rhode Island and Delaware's Long-Term PPA/Tariff Programs

State	Program	Solicitation Classes
Connecticut[55]	Zero Emission Renewable Energy Certificate Program	• Small ZREC (Systems up to 100 kW)[56] • Medium ZREC (Larger than 100 to Smaller than 250 kW) • Large ZREC (250 to 1,000 kW)
Rhode Island[57]	Renewable Energy Growth Program	• Small Solar I – Owner/Host Financed (1 to 10 kW) • Small Solar I – 3rd Party Financed (1 to 10 kW) • Small Solar II (11 to 25 kW) • Medium Solar (26 to 250 kW) • Commercial Solar (251 to 999 kW) • Large Solar (1 to 5 MW)
Delaware[58]	SREC Procurement Program	• N1 – New Projects (<30 kW) • N2 – New Projects (31 – 200 kW) • N3 – New Projects (201 – 2,000 kW) • E1 – Existing Projects (<30 kW) • E2 – Existing Projects (30 – 2,000 kW)

- **Price vs. Volume Limited –** Many programs establish volumetric targets, while some are budget-limited. For example, the program can be capped at a pre-determined capacity target (e.g. Rhode Island's Renewable Energy Growth program) or a percentage of the state utilities' peak retail loads. Alternatively, a program can operate subject to a pre-determined budget in each enrollment (e.g. Connecticut Low Emission Renewable Energy Certificates/Zero Emission Renewable Energy Certificates Programs and New Hampshire Commercial & Industrial RFP for Renewable Energy Projects). The volume procured therefore varies with price. One determinant of the approach is the source of funds: an SBC-fund or similar cash source of budget will often dictate a budget-limited

[55] (Connecticut Light & Power, n.d.)
[56] The Connecticut Small ZREC solicitation does not operate as a competitive program. However, the tariff rate is competitively-derived using the weighted average bid price from the previous Medium ZREC solicitation.
[57] (Rhode Island Distributed Generation Board, 2014)
[58] (Delaware Sustainable Energy Utility, 2014)

approach, while a program that results in regulator-approved pass-through of costs or benefits to ratepayers allows a fixed quantity target to be pursued without a specific budget cap.

- **Solar-Only vs. Multi-Technology Competition –** In most instances discussed herein, procurement pits solar PV installations against each other, often within subclasses as noted above. Competitive procurement of utility-scale solar head-to-head with other types of renewables has been common in California and the southwest for several years due to much higher capacity factors and scale economies than available in the Northeast. However, utility-scale solar could be nearing the point of being able to compete head-to-head with other renewables resources in all-renewables long-term contract procurements in the northeast, as evidenced by recent selection of a 20 MW utility-scaled project under Connecticut's Public Act 13-303 Section 6 RFP at the end of 2013 (it is too early to know whether the bid price is viable, as the project has until the end of 2016 to reach commercial operation).

There are several common implementation issues with long-term PPA or tariff procurement policies:

- **Potential Violation of Federal Power Act –** There have been several lawsuits in Maryland, New Jersey and Connecticut regarding the legality of state-administered long-term energy contract programs. (PPL Energyplus, LLC, et al. vs. Douglas R. M. Nazarian, 2013) (PPL Energyplus, LLC vs. Robert M. Hanna, 2013) (Allco Finance Limited vs. Robert Klee, 2014). Stakeholders argued that such programs overstep the Federal Energy Regulatory Commission's jurisdiction by establishing wholesale energy rates. Both Maryland and New Jersey's long-term contract programs were invalidated as a result of the legal actions. The Connecticut Section 6 procurement program was found not found by the courts to be preempted by the Federal Power Act, although that ruling is being appealed (Allco Finance Limited vs. Robert Klee, 2014).
- **Project Attrition –** Competitive procurements are commonly characterized by a modest to substantial rates of project attrition, driven by speculative bidding and sometimes excessive administrative burden and regulatory and utility delay, which can be exacerbated by inflexible completion milestones. These factors are exacerbated when solicitations are infrequent or there are low or no bid security requirements. When such conditions hold, sophisticated developers could submit an inventory of bids and then pick and choose which selected projects to develop.
- **Procurement Frequency** – In contrast to procurement mandates (like RPS tiers) or standard offers, which allow for a relatively steady stream of sales, design, financing and installation workflow that is conducive to establishing long-term jobs, episodic procurements represent bursts of activity that are difficult to staff for, often leading to short-term jobs and greater use of mobile labor. We have observed that infrequent procurement events tend to exacerbate speculative bidding, as the sparse market opportunities encourage bidders to offer immature projects with greater completion risk (rather than forego all opportunities until the next procurement events). Procurement frequency varies. For example, the Rhode Island DG Standard Contract program procured three times per year while the Connecticut ZREC solicitations are only offered once per year. Further, with competitive procurements for customer-sited generation, there can be significant frustration as hosts go through extensive internal decision-making efforts to decide to commit to a project, only to have their developer fail to win a bid, leaving them with no project (and if procurements are less frequent, a

long period before getting another shot at a bid, often requiring renegotiation of PPA or lease transaction to make a project viable). (Connecticut Conference of Municipalities, 2014)

- **Security Requirements** – To address high rates of project failure and speculative bidding, some states have considered implementation approaches that create higher barriers of entry (security requirements as well as project milestones) while allowing a degree of flexibility to address unforeseeable factors that may cause delays. (Belden, Michelman, Grace, & Wright, 2014). The downside of raising the bar to entry, however, is reduced participation and price competition.

Long-Term Value of Solar Tariffs[59]

A Value of Solar Tariff (VOST) is a net energy metering (NEM) tariff design that incorporates value of solar analysis in setting the credit value for customer generation from solar energy facilities. Under traditional net metering, the customer's retail rate is the rate applied to calculate the bill offset amount – an arbitrary proxy for the value of the generation. Under a VOST, the calculated value of solar is used to calculate the bill offset amount created by solar generation, a truer and more transparent incentive. As with net metering, many different modifications, adjustments, and options are also possible under a VOST—such as the credit rate for excess energy generation, the netting period for calculating offsets, the extent to which the credit can offset certain fixed charges, and the period over which the offset rate is stabilized. The VOST seeks to improve on traditional NEM by using an offset credit rate that is empirically derived through a full avoided cost methodology.

In the two places where the tariff has been implemented so far, the City of Austin (Texas) and the State of Minnesota, the tariff was expressly designed to be modeled on a basic net metering structure and to avoid a sale by providing only an offsetting credit for customer generation. In this regard, VOST and NEM structured in this way[60] differ from Feed-In Tariffs and so-called Buy-All-Sell-All rates. The VOST approach has been targeted at small customers, both residential and commercial, seeking to offset their electricity bill associated with consumption of energy.

[59] For more information on Value of Solar Tariff, see:

- The ICER Chronicle – A Focus on International Energy Policy "Chapter VIII – The Value of Solar Tariff: Net Metering 2.0:" http://www.rabagoenergy.com/files/icer-chronicle-rabago-vos-article-131220---extract.pdf.
- Minnesota Value of Solar: Methodology: http://mn.gov/commerce/energy/images/MN-VOS-Methodology-FINAL.pdf.

[60] Skadden, Arps, Slate, Meagher & Flom LLP prepared a legal memo for The Alliance for Solar Choice (TASC) regarding the tax implications of feed-in-tariffs and value of solar tariffs in August 2013. It argued that FIT and VOST frameworks require the sales of all customer generation, and hence, could jeopardize a customer's ability to receive certain tax credits that have on-site consumption threshold. (The Alliance for Solar Choice, 2013). TASC's argument presumes that VOST is set up as a "front of the meter" rate and system, while Austin and Minnesota both intended for the VOST to be a "behind-the-meter" netting system. Hence, it can be argued that VOST does not constitute a buy-all-sell-all arrangement. Rather, it is an offsetting credit for onsite generation.

The VOST as applied in these instances was designed to preserve the benefits of Federal residential solar tax credits and state-level property tax exemptions for solar equipment. A VOST is designed to fairly value customer generation (or, perhaps more accurately, to compensate generation based on an assessment on its administratively-determined value), and its advocates argue that it can nominally keep the utility whole for the cost of distribution and supplemental power services (we note that this could be the case so long as the portion of the VOST not readily avoided or monetized by the utility are recovered from ratepayers). The VOST approach serves as a model for valuing other distributed energy resources, such as energy storage, demand response, and ancillary services. The VOST requires a value of solar analysis, which in turn requires data and the development of a methodology. The VOST should be regularly updated to capture changes in avoided costs. Like traditional avoided cost proceedings, this process is best conducted with public participation and regulatory oversight. The VOST can be adopted as an optional alternative to traditional net metering, or as a substitute. In some cases, utilities may not collect the data or collect it in a form that allows full calculation of the value of solar. There may be ongoing disagreements about the best way to calculate some value components.

Technology-Specific "Avoided Costs"

Standard offers or feed-in tariffs have been challenged as violating the division of Federal versus state authority pursuant to the Federal Power Act (Hempling, Elefant, Cory, & Porter, 2010), but FERC has held that the Federal Public Utility Regulatory Policies Act (PURPA) allows purchase of electricity from a particular source of energy under a multi-tiered avoided-cost structure through a standard offer program at or below the specific technology's avoided-costs. (Cal. Pub. Util. Comm'n Et. al, (July 15, 2010)) (Cal. Pub. Util. Comm'n Et. al, (Oct. 21, 2010)) States or non-regulated utilities can establish their own methodology for determining the technology-specific avoided costs, provided that the method complies with the criteria in PURPA and is non-discriminatory to co-generators or small power producers. (Burns & Rose, 2014). It is important to recognize that technology-specific avoided costs are a federal rate concept. By definition, it does not account for non-jurisdictional avoided costs, such as RPS compliance costs.

Technology-specific avoided costs provide an improvement to the one-size-fits-all incentive rate setting method, allowing more accurate determination of the cost of each renewable technology. They have been applied as standard offer prices, or as ceiling prices under which competition can take place. Among the states considered in this section, Vermont is an example that explicitly uses technology-specific avoided costs, characterized as such, as an approach for setting standard-offer rates. The state's Sustainably Priced Energy Enterprise Development (SPEED) Standard-Offer program operates as a centrally-administered competitive procurement. The contract price for each technology block is capped at the avoided costs for that specific technology. For solar PV, the administratively-set avoided cost schedule is set at a fixed rate throughout the contract period. Bidders are required to propose a single price for the contract period that is no more than the administratively-set solar avoided cost. For other technologies, bidders can propose an escalating price schedule to reflect inflation. (VEPP Inc., 2014)

Indirect Financial Incentives

Emissions Markets

Emissions markets policies are market-based emission cap-and-trade programs usually implemented in a regional or broader scale. A typical emission markets program includes a declining emission target schedule for the power sector, with responsibility for meeting that cap apportioned to generators according to an administratively –determined process. Power plants from participating states can demonstrate compliance by purchasing emissions allowance from their states. The net effect is an increase in the price of electric energy resulting from generators including this variable cost in their wholesale energy market bids, indirectly increasing the value realized per MWh sold from non-emitting generation, like solar PV. It is important to note that emission allowance values represent the cost of program compliance, denominated in dollars per allowance or ton of carbon dioxide. This compliance cost may or may not be related to the value of avoided emissions in terms of avoided environmental damages. As such, the price of an emission credit should not be assumed to represent the "value" of non-emissions from non-emitting resources. Proceeds from the sales of emissions allowance are used to support state renewable energy and energy efficiency initiatives. The Regional Greenhouse Gas Initiative (RGGI) is an example of such approach. Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, New York, Delaware, and Maryland are all current members of RGGI.[61] (Regional Greenhouse Gas Initiative, n.d.)

Expenditure-Based Tax Incentives

Investment Tax Credits

Investment Tax Credits (ITC) are capacity denominated tax incentives. Typically, they are direct deductions in tax liability associated with the cost of purchasing and installing solar systems. To take advantage of an ITC, the owner must have a 'tax appetite' (and is thus not available to government and non-profit entities) and the investment must be 'at risk'. A 30% ITC for DG solar is currently offered at the federal level; after 2016, the 30% ITC expires, while a 10% commercial ITC (unavailable to residential-owned systems) will remain thereafter. (U.S. Department of Energy, 2014). Some states have implemented ITCs at the state level. For instance, Massachusetts has a residential solar ITC, which applies a 15% credit, up to $1,000, to a system owner's state income tax for the net expenditure of a solar PV facility installed on the system owner's primary residence.[62] Under the Massachusetts ITC program, excess tax credits can be applied to subsequent year for up to three years. (DSIRE, 2014).

[61] New Jersey was a RGGI member until 2011.
[62] The system owner can be a tenant of the property.

Production Tax Incentives

Production Tax Credits

Production Tax Credits (PTC) are tax incentives offered based on, and contingent on, electricity production (i.e. $/kWh), and as such, are akin to performance-based incentives (and could readily be categorized thereunder). Like an ITC, to take advantage of an ITC, the owner must have a 'tax appetite' (and is thus not available to government and non-profit entities) and the investment must be 'at risk'. It is not a common implementation approach at the state level. Maryland is the only state of those features here that offers Clean Energy PTC. The program has a credit floor, which sets a minimum amount of PTC payment a system needs to yield in order to be eligible for the program. The price floor indirectly eliminates any systems smaller than 20 kW to participate. (Administration, n.d.)

Demand-Pull/Solar Minimum Purchase Mandates

Renewable Portfolio Standards (RPS) and Solar RPS Tiers (Set-Asides)

All ten states discussed in this Section with the exception of Vermont[63] have active Renewable Portfolio Standards. RPS mandates typically require electric suppliers to meet a minimum percentage of their annual retail loads with renewable energy by purchasing and (for states considered here) retiring renewable energy certificates (RECs).[64] When the obligation is places on electricity suppliers, the cost of RPS compliance is embedded in the cost of electricity.[65] While solar PV is nominally eligible for all RPS, it is generally not competitive enough against other resources in technology-neutral RPS policies, especially in the northeast. As a result, some states have incorporated explicit tiers or set-asides (sometimes referred as carve-outs when they explicitly constitute a subset of another RPS tier) within the RPS for solar PV or distributed generation. Set-asides policies stimulate demand for, and thus investment in, specific technologies (in this case, solar PV) within the RPS that would otherwise not be supported due to cost and other development constraints. Solar set-asides require that a specified portion of the RPS be met with solar generation, typically (in the northeast competitive markets) through use of solar renewable energy certificates (SRECs) as a distinct tier of an overall RPS requirement, often carved-out of a larger tier designated for new resources. Solar carve-outs are a widely-adopted implementation approach, most common in states with deregulated markets. As shown in the following map, of the states studied for this report, Massachusetts, New Hampshire, Delaware, Maryland, New Jersey and Pennsylvania all incorporated solar set-aside policies.

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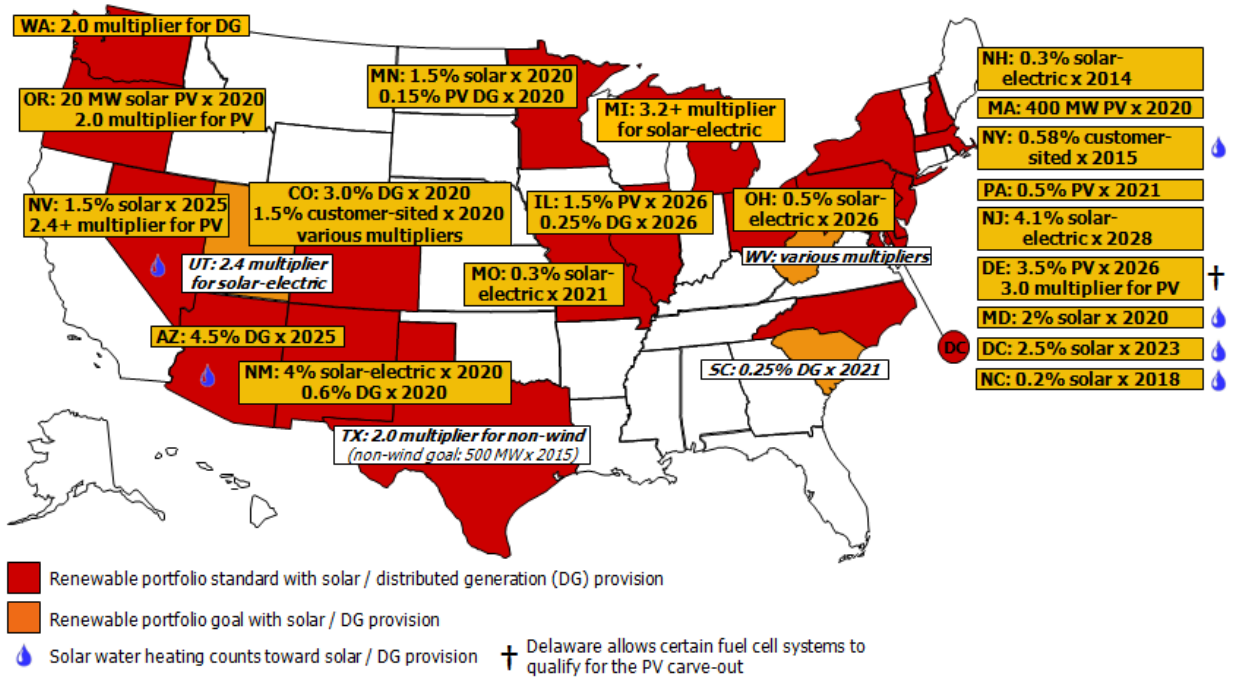
[63] Proposed RPS legislation, including a distributed generation tier, was filed in January of 2015, and appears to have significant potential for adoption.

[64] The exception is New York, where the RPS obligation is not placed on load-serving entities, but rather run by a centralized procurement entity, NYSERDA. Instead, generation attributes associated with production from systems driven by up-front incentives and competitively-procured long-term REC contracts are counted towards meeting state RPS targets.

[65] In the case of New York, or any state placing the obligation on the distribution company in an unbundled market, the costs are collected through a surcharge on distribution bills.

Figure 34 – States with Solar/DG Set-Asides Policies[66]



Solar set-aside policies are designed to provide additional incentive for solar development. The additional incentive is usually driven by higher price caps or Alternative Compliance Payment (ACP) levels relative to the Class I market. In order to track and encourage anticipated technology cost reduction, some states, such as Massachusetts and Maryland, have established declining ACP schedules that eventually merge with the "Class I" (undifferentiated) market. Alternatively, a credit multiplier approach, which increases the effective REC value ($/MWh) of solar generation relative to other Class I sources, is used. (DSIRE Solar Policy Guide: A Resource for State Policymakers, 2012). RPS and solar set-asides policies are sometimes paired with long-term contracts or tariffs to add price and supply certainty to the market. Under these embedded long-term procurements, T&D utilities may choose to solicit unbundled contracts for just the RECs (e.g. New Jersey and Connecticut) or bundled contracts for a combination of RECs, energy and capacity (e.g. Rhode Island). (Atlantic City Electric Co., Et. al, 2011) (SREC-Based Financing Program - Documents, 2011) . Attributes purchased through the long-term agreements can be used toward the utilities' obligations or resold to the spot market to be made available to RPS obligated entities.

Solar RPS set-aside policies support solar PV of all sizes and market sectors, although some states may choose to promote specific market sectors within the solar set-asides using additional eligibility requirements (e.g. system size caps, geographic location requirements, etc.) and differentiating

[66] (DSIRE Solar, 2014)

incentive mechanisms (e.g. Massachusetts' SREC factors). States can also adopt various design features to advance additional implementation objectives.

Key structural variations include:

- **Price Caps or ACP Levels –** Unlike the other states mentioned earlier, New Hampshire's solar carve-out (RPS Tier II) program has the same ACP level as its RPS Tier I. This design eliminates the main objective of set-asides policies, which is to stimulate solar investment by providing a higher level of incentives. The lack of additional incentives for solar compared to other technologies, coupled with the state's low ACP rates relative to the region provides little support for solar PV development in New Hampshire, and RECs from those PV installations are most often is sold into other New England markets with higher REC prices.[67]

- **Price-Support Mechanisms –** RPS target schedules are typically pre-determined by the legislature to achieve a specific overall quantity target over a period of time. In most cases, the targets can only be adjusted through legislation.[68] The lack of flexibility for solar set-asides to adjust with changing market conditions is a common concern. Several states, such as New Jersey, have observed drastic SREC price volatility over the years. (Belden, Michelman, Grace, & Wright, 2014). Both New Jersey (N.J. P.L. 2012, Chapter 24, 2012) and Maryland (Chapter 494, 2010) have accelerated their solar set-asides schedules through legislation in response to rapid market growth. With an eye towards mitigating SREC price volatility, and in particular prevent price crashes, in the absence of statutory authority to create a firm price floor the Massachusetts Department of Energy Resources implemented two strategies to add flexibility to its solar carve-out program. Massachusetts uses a unique supply-responsive demand formula that adjusts the demand targets at an annual basis according to the actual volume of past solar installations, ACP payments and market trends. The carve-out is further supported by a floor-price auction mechanism, which creates a soft price floor to limit SREC price variability. In years of market surplus, solar system owners can offer their unsold SRECs in a state-administered fixed-price auction at a pre-determined price of $285/MWh.[69] The auction is conducted in up to three rounds; if it does not clear in the first round, the life of SRECs purchases out of the auction are extended and the future demand is further ratcheted up to induce greater expected value for SRECs re-minted in the auction. This mechanism is a "soft" price floor because SRECs can be and sometimes are sold below the floor if buyers expect SREC prices to sink below the floor in the future, or if the floor price is expected to be realized from sale or re-minted SRECs in later years, discounted based on the time-value of money. (Massachusetts Department of Energy Resources, n.d.)

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[67] According the state's 2013 RPS Compliance Report, roughly 50% of the state's solar carve-out obligation is met by ACPs. (New Hampshire Public Utilities Commission, 2014) Most of New Hampshire's current solar development is facilitated by the state's solar rebate and competitive procurement programs, as well as Massachusetts' RPS Class I, which has a higher ACP level.

[68] In Rhode Island and New Hampshire, state regulators are authorized to adjust the RPS targets in the event of resource inadequacy.

[69] Buyers from the auction pay $300 per SREC, with the spread funding the cost of conducting the auction.

- **SREC Factor and Managed Growth Sector –** Massachusetts incorporated a SREC Factor mechanism under Phase II of its Solar Carve-out. This mechanism credits generation associated with specific market sub-sectors (defined by project types or sizes) at higher values (SREC/MWh), as shown in Table 41.

Table 41 – Massachusetts RPS Solar Carve-out Phase II Market Sectors and SREC Factor[70]

Market Sector	Generation Unit Type	SREC Factor
A	1. Generation Units with a capacity of <=25 kW DC 2. Solar Canopy Generation Units 3. Emergency Power Generation Units 4. Community Shared Solar Generation Units 5. Low or Moderate Income Housing Generation Units	1.0
B	1. Building Mounted Generation Units 2. Ground mounted Generation Units with a capacity > 25 kW DC with 67% or more of the electric output on an annual basis used by an on-site load	0.9
C	1. Generation Units sited on Eligible Landfills 2. Generation Units sited on Brownfields 3. Ground mounted Generation Units with a capacity of <= 650 kW with less than 67% of the electrical output on an annual basis used by an on-site load.	0.8
Managed Growth	Unit that does not meet the criteria of Market Sector A, B, or C.	0.7

- ***Limitations on Market Segments – Based on experiences with accelerated development of larger multi-MW scale systems triggering sudden surplus and volatility, desire for development diversity (i.e. maintaining opportunities for smaller, customer-sited installations) and the desire to steer development towards rooftops and locations with load and away from remote sites with other uses (such as agricultural land), states such as Massachusetts and New Jersey have acted to limit the aggregate capacity that can be developed in these segments.*** (Belden, Michelman, Grace, & Wright, 2014)***. For example, Massachusetts*** established a 'Managed Growth' sector (see Table 41), which includes ground-mounted utility-scale solar projects sited on greenfield sites. The aggregated target capacity is set, and capacity available to the Managed Growth sector is determined on an annual basis based on the volume of solar installations in other market sectors. This approach allows the state to control market growth and advance other implementation goals, such as promoting brownfield solar installation, residential and small-business solar installation and affordable housing solar projects. (MA 225 CMR 14.07, 2014)
- ***Who Bears the Obligation – Of the state's examined here, all but two place the RPS and SREC Set-aside obligation on load-serving entities. Exceptions include New York and Delaware. New York***

[70] (Massachusetts Department of Energy Resources, n.d.)

uses a 'central procurement' mechanism through which the New York State Energy Research and Development Authority (NYSERDA) runs solicitation programs funded by an SBC-like charge collected by the state's distribution utilities. Delaware places the RPS obligation on the state's distribution providers (Delmarva, DEC, and DEMEC). While we are not aware of an example, it is feasible that a distinct distributed solar PV tier obligation could be placed on distribution utilities while maintaining the RPS obligation on load-serving entities.

Our research and literature review have identified several concerns regarding the implementation of solar set-aside policies:

- **Potential Violation of Interstate Commerce Clause –** Most states have, in the process of developing their renewable energy implementation strategies, considered the local economic benefits an important driver. (Grace, Donovan, & Melnick, 2011) Some states have geographic requirement that limits their solar carve-out policies to in-state generation only. In several states, stakeholders have filed complaints or taken legal actions challenging the legality of "out-of-state exclusion" provisions in solar carve-out and other renewable policies on the ground of violation of the Constitution's Interstate Commerce Clause.[71] Thus far, there have been no successful legal challenges finding violation of the federal commerce clause. Nonetheless, states regularly take extreme care in crafting RPS mandates to avoid crossing this line, and crafting policies targeted at generation interconnected at the distribution level has been a commonly used approach. (Elefant & Holt, 2011)

- **Market Volatility –** Enhanced and expiring federal incentives, reduced solar installation costs and high SREC prices created a surplus of SRECs in New Jersey in late 2011 and early 2012. The rapid market growth was followed by a period of market stagnation as SREC prices plummeted in response to an oversupplied market. Volatility in the market creates revenue uncertainty and increases investment risks, raising the barrier for market-entry and undermining a stable environment for job growth. (Belden, Michelman, Grace, & Wright, 2014)

[71] In April 2010, TransCanada Power Marketing filed a civil lawsuit in Massachusetts District Court against the Department of Energy Resources and Department of Public Utilities, asserting, among other issues, that the Massachusetts Solar RPS carve-out, which requires load serving entities to meet solar specific RPS targets by purchasing SRECs from in-state generators is unconstitutional and in violation of the Interstate Commerce Clause. TransCanada ultimately reached a Partial Settlement Agreement with the Commonwealth of Massachusetts and the original suit was dismissed. (TransCanada Power Marketing LTD., 2010) (TransCanada Power Marketing LTD. v. Ian A. Bowles et. al., 2010). The New York State Energy Research and Development Authority also faced similar challenge regarding its geographic eligibility for the agency's long-term RPS procurement, which is limited to resources located within New York state or off-shore resources that are directly interconnected to the New York Grid. In an order issued in May 2013, the New York Public Service Commission asserted that the geographic eligibility limit does not violate the Interstate Commerce Clause due to the agency's role as a market participant (there is a "market participant exception" based on principles created by case law). (New York Public Service Commission, 2013)

Solar carve-out policies create predictable demands for solar PV generation and, if paired with long-term contract or tariff policies or other revenue-stabilizing tactics, can provide a degree of long-term revenue expectations sufficient to attract investment. However, compared to implementation approaches which provide stable revenue – standard offers and competitive long-term contracts – the revenue volatility in SREC markets is less attractive to investors. This leads to SREC markets having a higher cost of capital (New York State Energy Research and Development Authority, 2012) and often a difficultly in attracting debt financing, particularly early on in a policy's life. But our own market analysis reveals that experience in Massachusetts has shown that as market participants became more familiar with a policy and gain experience with its operation, many lenders have grown sufficiently comfortable with SREC risk to lend in this market environment. (Sustainable Energy Advantage, LLC; Meister Consultants Group, Inc.; LaCapra Associates; The Cadmus Group, Inc., 2013)

Further, compared to standard offer policies, RPS and solar set-asides encourage competition that, all else equal, favor least cost projects. On the other hand, fixed demand target schedules prevent set-asides programs from reacting to market conditions without legislative or regulatory changes. Constant policy changes can create uncertainty and affect generator revenues. (New York State Energy Research and Development Authority, 2012)

Net Metering

Net Metering Crediting Mechanism

Net metering is a well-understood and widely-adopted solar implementation approach that has been an important driver for customer-sited PV generation. Net metering rules require T&D utilities to credit their self-generating customers for the excess electricity produced from their PV systems. They are designed to provide solar system owners with a predictable revenue stream at a higher level than potentially available through sales of energy at wholesale, facilitate on-site solar generation by allowing a monetization of the value of PV production out of reach for unsophisticated retail electricity customers, and allow customers to realize utility bill savings by offsetting their own loads by displacing their own use independent of temporal production and usage. Typically, the excess generation over the course of a month is credited the net metering customer's utility bill in the following month as a reduction in energy usage. The credits can be carried over for a specific period of time, after which any unused credits will be eliminated. The costs of the program (i.e. lost utility revenues) are then passed through to ratepayers as net metering recovery charges on utility bills. For this reason, net metering is seen by utilities as a cross-subsidy between participants and non-participating customers. While historically the degree of cross-subsidy has been trivial, with the recent growth in solar penetration, electric utilities nationwide have recently turned to characterizing continued unmitigated net metering as an uncompensated use of their systems and an existential threat to ability to be paid for the services their systems render. (Kennerly, Wright, Laurent, Rickerson, & Proudlove, 2014)

Net metering rules normally include individual system size limits, sometimes differentiated by customers sectors (e.g. public versus private). Statutory changes over the past several years have increased typical system size caps to the 1 to 2 MW range in many states. Further, net metering programs are often

capped at a certain specified percentage of utilities' loads. Massachusetts has separate program caps for the public and private sectors. In Massachusetts, small renewable energy systems (less than 10 kW on a single-phase circuit or less than 25 kW on a three-phase circuit) are not subject to the aggregated caps altogether.

Virtual Net Metering Crediting Mechanism

Several states have expanded their net metering rules to provide customers with more flexibility. For example, virtual net metering rules allow a customer or multiple customers to aggregate their usage across multiple meter and net meter multiple units at separate facilities or on different properties. As a result, customers can offset electricity consumed from one site with electricity generation produced from a system at a remote site. (DSIRE Solar Policy Guide: A Resource for State Policymakers, 2012) The net metering credits can be allocated to the customer(s) in a pre-determined arrangement. In most states, virtual net metering is limited to municipalities, state and agriculture customers only. Virtual net metering also enables government entities to access solar tax incentives through a third-party ownership model. (Barnes, 2013) However, some states (such as Massachusetts) have instituted relatively liberal policies. The Massachusetts legislature established several means to virtually net meter, through mechanisms referred to as neighborhood, municipal and agricultural net metering. (Chapter 169 of the Acts of 2008, 2008) Under neighborhood net metering, for instance, a group of 10 or more residential customers within the same distribution company may own or contract with a net metering facility within their utility load zone and each get credit for the output. Depending on the net metering class, virtual net metering moderately to dramatically enhance the economics of distributed PV installations by crediting most avoided retail rate components regardless of the size of the host load. This has led to multi-MW installations at locations without prior load (where the PV facilities own usage, such a security lighting, can qualify as the retail customer) availing themselves of net metering through the sale of net metering credits to municipalities and other off-site parties at a discount. This has become a major pathway to monetizing compensation for what would otherwise be deemed wholesale electricity at a value reflecting the allowed components of retail rates which may be credited under three different classes of net metering facilities. It opened up the market to substantial growth under the state's SREC-I carve-out which has subsequently been pared back somewhat under the more restrictive SREC-II carve-out. And at present, it is also stimulating considerable activity in a specialized subsector, community-shared solar.

Community-Shared Solar[72]

An increasingly prevalent net metering arrangement is community shares solar (CSS), a form of community net metering which enables multiple customers (usually capped at a fixed number) to share ownership interest in a single remote net metered facility and allocate the credits based on pre-

[72] For more information, see IREC's Model Rules for Shared Renewable Energy Programs: http://www.irecusa.org/wp-content/uploads/2013/06/IREC-Model-Rules-for-Shared-Renewable-Energy-Programs-2013.pdf.

determined arrangements, such as proportional to ownership interest. CSS provides a platform for electricity customers in a community or condominium to jointly purchase a shared solar project. It provides solar access to customers who otherwise cannot host an onsite system, for instance because of building orientation, shading, building condition, multi-tenant buildings, etc. Further, by using a pooling approach, it supports participation in small increments, making solar more affordable, thus enabling low-income customers to participate. (Interstate Renewable Energy Council; Vote Solar, 2014). This community-shared ownership model has gained nation-wide popularity in recent years. Massachusetts, Rhode Island and Vermont have all authorized community net metering through legislation. New York is working on developing community net metering rules in 2014 and 2015 under the state's Reforming the Energy Vision initiative. (Durkay, 2014) Many advocates cite CSS as the democratization of solar, opening up participation of solar to all. Of course, CSS, which relies on net metering, triggers the same issues with cross-subsidization and use of utility facilities without paying for them as other virtual net metering installations.

Given the rapid growth in the grid-tied solar market, several states have approached their net metering caps. Increasing the net metering program caps typically require legislative authorization. Vermont[73], Massachusetts[74] and New York[75] , for example, all raised their program caps in 2014. However, as popularity for solar PV continues to grow and controversy regarding the cost impact of net metering deepens, many states have started exploring other implementation options. Vermont, Massachusetts and New York all recently initiated investigations to explore and develop longer-term and more sustainable alternatives to net metering.

State policy makers should also be aware that expanding access to net metering would accelerate the depletion of aggregated net metering capacity available in states with net metering caps. Utilities typically argue that high rates of rapid adoption could lead to greater risk of cost-shifting to non-participants.

[73] Act 99, enacted in 2014, increases the cumulative output capacity of net metering systems from 4% to 15% of the distribution company's peak demand during 1996 or the peak demand during the most recent full calendar year, whichever is greater. Further, it directs the Public Service Department to conduct a study on net metering in Vermont and identify best practices for net metering in other states. (An Act Relating to Self-Generation and Net Metering, 2014) (30 V.S.A. §219a Self-Generation and Net Metering, n.d.)

[74] The Massachusetts legislature enacted Chapter 251 in 2014 to increase the public and private net metering caps to 5% and 4% of peak loads (previously 3% for both sectors) respectively and ordered the creation of a Net Metering Task Force to evaluate the long-term viability of net metering in Massachusetts. (An Act Relative to Credit for Thermal Energy Generated with Renewable Fuels, 2014)

[75] The New York Public Service Commissioner, on December 15, 2014 issued a ruling in response to various solar stakeholders. The ruling increased the aggregate net metering cap for each utility to 6% of peak load. The ruling also directs its staff, in consultation with the New York State Energy Research and Development Authority, to identify a methodology to measure and properly value distributed generation resources. (New York Public Service Commission, 2014)

Finance Enabling Policies

Financing enabling policies enhance the accessibility of financing, lower financing transactions costs, open up access to lower-cost forms of financing, and otherwise lower the entry barrier to solar investment and enable a broader range of players to participate in the solar market.

Solar Loan Programs (Non-Subsidized or Indirectly Subsidized)

Solar loan programs can be implemented with different models and funding options. Non-subsidized or indirectly subsidized loan programs are supported by private sector financing options or utilities. PACE financing and on-bill financing, discussed further below, are specialized approached to non-subsidized loan programs. Generally, solar loans are targeted to residential customers who cannot afford the high upfront cost of solar and are not sophisticated enough to obtain private loans. These programs are also developed by states to create scale to the residential lending market, standardize transactions thus lowering transaction costs, familiarize and attract lenders to the market. Solar loans do not reduce the overall cost of solar PV installation, but lower the up-front cost by spreading the total cost over time, and in some instances may also lower interest costs. Connecticut's Green Bank recently established innovative programs, and in 2015 Massachusetts is rolling out a program driven by the Department of Energy Resources which will feature loan-loss reserves, interest rate buy-downs and advantageous terms for low-income homeowners. (Massachusetts Department of Energy Resources, 2015)

Recently, emerging solar loan products that incorporate innovative financing options or repayment models have provided system owners with more low-cost financing options for solar PV:

- In New Jersey, PSE&G's Solar Loan Program allows residential and commercial customers to repay their loan obligations with cash payment of SRECs. The program includes a floor price guarantee for SRECs generated by the systems. This design allows system owners to offset their loan obligations with SRECs generated by their systems, reducing actual out-of-pocket costs for the PV. (PSE&G, n.d.)

- The Connecticut Green Bank is working with multiple financing groups to create a crowd-sourced loan product for solar installations. The loan program uses projected energy savings as the basis for the loans and provides key protections, such as guarantees on system performance, for homeowners. The program will aggregate funding for the loans from American investment partners and repay investors through an online marketplace. (Clean Energy Finance and Investment Authority, 2014)

PACE Financing

Property-Accessed Clean Energy (PACE) financing is an implementation approach that allows municipalities to offer long-term, low-interest loans on customer-sited installations that are tied to the property where the project is hosted instead of the system owner. While used more broadly on energy efficiency investments, PACE programs are increasingly being targeted at solar PV installations Similar to most finance-enabling approaches, PACE financing lowers the entry barrier to solar PV installation by

spreading the project cost over a long period of time. Tying the loan obligations to the property instead of the system owner's credit standing also reduce the loan's risk profile. (New York State Energy Research and Development Authority, 2012). Under PACE financing, repayment obligations are made through a special assessment on property taxes. Unlike typical loan products, PACE financing allows loan obligations to be transferred along with the sales of the property. This design feature makes PACE financing very attractive to homeowners and business customers, and removes a barrier to solar adoption for those unsure whether they will be in their home long enough to recoup the investment. States that have adopted PACE programs often distinguish between commercial (C-PACE) and residential programs. C-PACE is more widespread than residential programs. The residential PACE program had significant momentum several years ago, but quickly ground to a halt after the Federal Housing Finance Agency issued a decision that made it impossible to implement a residential PACE program that assigns a senior lien to PACE financing. Several states have bypassed this rule by passing legislation that removes the senior lien provision in PACE programs and instead assigns PACE financing a subordinate lien. (DSIRE Solar Policy Guide: A Resource for State Policymakers, 2012).

On-Bill Financing

On-bill financing is a long-term, low-interest loan servicing tool that is typically used for financing energy efficiency retrofits. This model allows PV system owners to repay their loan obligations through their utility bills. Similar to PACE financing, on-bill financing allows the loans to be tied to the property instead of the system owner and can be transferred with the sales of the property. So, like PACE financing, on-bill financing can removes a barrier to solar adoption for those unsure whether they will be in their home long enough to recoup the investment. New York currently provides an on-bill recovery loan option for residential and small business/not-for profit solar installers. Under the state program, the monthly repayments cannot exceed the estimated cost offset by on-site generation from the solar project, therefore ensuring that project cost can be mostly recovered from energy savings. (Financing Options for NY-Sun Incentive Program, n.d.)

Green Banks and Their Programs

A Green Bank is a state-chartered institution that offers a suite of programs and financing products designed to provide affordable access to clean energy development to a wide range of audience. As an alternative to incentive approaches, states can establish Green Banks that leverage and recycle public funding to stimulate the growth of private financing markets for solar and other clean energy investments, while ensuring efficient use of public funds. (Brookings Metropolitan Policy Program; Clean Energy Finance and Investment Authority; Coalition for Green Capital, 2014) Green Banks can be established using multiple models (Coalition for Green Capital, n.d.):

- **Quasi-public corporation –** Leverages state public funds with private capital to create an institution that offers loans and financing products for solar and clean energy investment (e.g. Connecticut Green Bank)

- **Housing Green Bank in existing state agencies –** States can choose to offer financing tools utilizing the Green Bank model within state agencies (e.g. New York Green Bank housed within in NYSERDA)

Connecticut established the first state-based Green Bank program in the U.S. in 2011. It is the only operating Green Bank among the states considered here. The Connecticut Green Bank (originally known as Clean Energy Finance and Investment Authority) repurposed the state's public good funds and Regional Greenhouse Gas Initiative proceeds as seed capital to leverage private capital for a suite of products aimed at removing the upfront cost or minimizing the investment risk of solar PV. (Brookings Metropolitan Policy Program; Clean Energy Finance and Investment Authority; Coalition for Green Capital, 2014) These products include Commercial-PACE, solar insurance, loan loss reserves, and solar leases.

The nascent New York Green Bank is housed within and managed by the New York State Energy Research and Development Authority (NYSERDA), but has yet to launch its first formal programs, but in late 2014 announced its first series of investment commitments.[76] Similar to the Connecticut Green Bank, the New York Green Bank will be built on public funds from the state and play a major role in the state's Reforming the Energy Vision initiative.[77] The Bank will partner with private entities to fill gaps in the clean energy financing market and remove financing barriers to clean energy development. Specifically, it will focus on projects that are economically viable but not currently financeable.

By leveraging private investments, Green Banks replace or augment ratepayer/taxpayer-subsidized incentives, and hence, lower the public cost of solar development. Further, by creating long-term, low-cost financing support, Green Bank reduces system owners' reliance on expiring tax credits, public funds and subsidies. They can reduce the size of subsidy required to stimulate a PV installation and accelerate the timetable to the day when direct subsidies are no longer needed. The relatively low budgetary demand makes Green Bank a compelling implementation approach, especially during state budget shortages. (Berlin, Hundt, Muro, & Saha, 2012) As a result, Green Banks are less vulnerable to budget raids and political changes, adding stability and predictability to the solar investment market.

Utility Ownership

In decoupled electricity markets, T&D utilities are typically not permitted to have ownership interest in generation assets. Several states, including Connecticut, Massachusetts, Vermont and New Jersey, have authorized utility-owned solar generation subject to very restrictive conditions under state regulators' approval. RECs generated from the utility-owned systems can be used toward satisfying RPS (or solar set-aside) obligations. The utilities can choose to use the electricity generated to serve its retail loads or

[76] See: http://greenbank.ny.gov/initial-transactions
[77] The New York Green Bank was created using uncommitted proceeds from the state's Energy Efficiency Portfolio Standard and System Benefits Charge programs. (New York Public Service Commission, 2013)

resell it to the spot market. The net difference between cost and market value associated with the utility-owned generation is passed through to distribution ratepayers as recovery charges on utility bills.

Utility ownership adds another layer to market diversification strategies. Initially, utility ownership could access a lower cost of capital than available to independent power producers; with recent innovations and advancements in solar PV financing, this may no longer be the case. This ownership model can also lower the cost of solar PV generation by eliminating the costs involved in typical utility-generator transactions. Additionally, utility-ownership programs allow utilities to experiment with specific project types or advanced technologies and explore additional values of solar to the grid system and ratepayers. National Grid, for example, is developing 16 MW of solar projects in areas with high load density in Massachusetts to study the impact of solar generation equipped with advanced meters on system reliability, alternative orientations to maximize peak values, and quantify the potential system benefits from strategically-located PV. (National Grid, 2014)

Solar Lease and/or Third-Party Ownership Enabling Policies or Eligibility in Other Policies

Third-party ownership has emerged over the past few years as a solar development model common for residential and small business customers, as well as local governments, who often lack the upfront capital for the system equipment or do not want to install or maintain solar systems (due to lack of sophistication or risk aversion). The advent of this model has been highly correlated with significant expansion of state solar PV markets, unlocking participation by substantial segments of the market. (Solar Energy Industries Association, 2014) Sometimes municipalities and non-profit entities also utilize third-party ownership to indirectly access the benefits of tax incentives which they are unable to monetize directly. (DSIRE Solar Policy Guide: A Resource for State Policymakers, 2012).

Third-party ownership typically involves a private developer installing and owning a PV system hosted by a residential or commercial property owner, then selling the power generated from the system to the property owner at a pre-negotiated price over a period of term through power purchase agreement. Another model is a solar lease, which allows customers to lease PV panels, usually at a fixed cost over a long term from a supplier.

While third-party ownership is more of a financing approach than a policy itself, net metering or solar policies can either enable or preclude this model by virtue of eligibility restrictions. Policies crafted to allow, welcome or target third-party ownership remove barriers and create opportunities for these models. In order to enable third-party ownership, states need to create rules that prevent the seller end of a third-party power purchase agreement from being regulated as an electric utility or competitive supplier, a requirement which has proven too burdensome to make market entry attractive. States may also explicitly authorize third-party ownership models in their net metering regulations. New Jersey, for example, states a customer-generator is not required to own the net-metered solar PV system, provided the system is hosted on its property. (Kollins, Speer, & Cory, 2010) To increase market participation through third-party ownership, states can also make third-party owned systems eligible for other solar programs and incentives. Connecticut allows third-party owned behind-the-meter generation to

participate in the ZREC solicitation (Connecticut Light & Power Company, United Illuminating Company, 2014), and targets a PBI at 3rd-party owners under its Residential Solar Incentive program.[78]

[78] See: http://www.energizect.com/residents/programs/residential-solar-investment-program.

Rules, Regulations and Rate Design

Rules & regulations at all levels of government ensure legal access to the solar market and provide technical support to solar PV deployment. (Doris, 2012) Some rules and regulations are designed to remove institutional barriers. Building codes and standards prepare infrastructures for solar installation and familiarize installers and inspectors with the technology and its requirements for safe installation. Other rules and regulations may grant legal authorization to alternative solar installation models, such as Third-Party Ownership, that can ease access to the solar market. Some rules are created to regulate the economics of solar generation. For example, states can implement rules that compensate T&D utilities for the cost of integrating distributed solar into the grid systems from customers (which we discuss under the category of Rate Design), while providing a means of compensation for solar generation (which we discuss under the category of Indirect Financial Support). Another example is to internalize the public benefits of solar generation through the tax code. Finally, Grid Modernization rules and regulations are implemented to enforce investment in distributed-generation-friendly grid architecture.

Removing Institutional Barriers

Interconnection Standards

States are responsible for regulating distributed interconnection (whereas transmission interconnection is typically overseen by regional system operators). To standardize and add transparency to interconnection procedures, the ten states reviewed here have each implemented interconnection standards. Interconnection standards set forth the legal, technical and procedural requirements for customers who wish to connect the PV systems to the grid (DSIRE Solar Policy Guide: A Resource for State Policymakers, 2012). Interconnection standards are typically applied to distributed solar systems of all sizes. Most states have more relaxed interconnection rules and screening procedures for small, simple systems. The procedures become more stringent as the system size increases, and/or when multiple projects connect to a single feeder or the PV generation on a circuit approaches the scale of load on the circuit. Further, interconnection standards may include multiple tracks of interconnection procedures (e.g. simplified, expedited, etc.) that are designed for project of different system sizes that may require different levels of review.

Well-designed interconnection standards can increase investment appetite by lowering development uncertainty and reducing time, and hence, development costs, for solar PV. An interconnection regime with predictable costs and timelines facilities a robust investment environment, while unpredictable costs can result in much wasted development effort, and unpredictable interconnection timelines can result in completed projects sitting idle awaiting interconnection, which can materially undermine

expected financial performance of generators. The Interstate Renewable Energy Council (IREC) provides model guidelines for interconnection policies.[79]

Solar Access Laws

Solar access laws, such as solar easements or solar rights, protect solar system owners by securing their continued access to sunlight or remove zoning or building code barriers for solar development. These options can be implemented at the state and local level. (DSIRE Solar Policy Guide: A Resource for State Policymakers, 2012)

Business Formation/Financing Laws

State legislators can enact policies to authorize certain types of business models or market structures that aim to lower the entry barrier and expand access to the solar market. Crowd-funding, cooperatives and community solar are all innovative examples that have gained popularity nationwide in recent years. The objective would be to create paths to enable such business structures while balancing consumer (or investor) protections with onerous securities regulation.

Permitting Standardization, Simplification & Streamlining and Other "Soft-Cost Reduction" Strategies

Cumbersome and costly permitting and inspecting procedures could increase project cost and development time, hindering market growth. A recent report by the National Renewable Energy Laboratory and Rocky Mountain Institute identified four steps to reducing permitting and inspection related costs: (Ardani, et al., 2013) [80]

- Standardization of requirements across local jurisdictions;
- Transparency of requirements (e.g. creating publicly accessible database on requirements and provide real-time data on permitting/inspection status);
- Online permit application submittal; and
- Lowering market-wide average permitting fees.

It is estimated that permitting and inspections account for 6% of solar PV soft-costs. The remainder includes customer acquisition costs, installation labor costs and financing. States can implement a variety of soft-cost reduction strategies to reduce the capital cost of solar installations. In order to reduce customer acquisition costs, states can launch consumer awareness campaigns and support standardization of PV system designs. States can also implement building codes and standards, such as "solar-ready" standards and "plug-and-play" configurations to bring down installation labor costs. (Ardani, et al., 2013)

[79] International Renewable Energy Council. http://www.irecusa.org/regulatory-reform/interconnection/

[80] The report was developed as part of the U.S. Department of Energy's SunShot Initiative to identify soft-cost-reduction pathways in order to achieve the Department's PV price targets. For more information on the SunShot Initiative, see: http://energy.gov/eere/sunshot/sunshot-initiative.

Building Codes

Solar-Ready Building Standards or Zero Energy Capable Home Standards

States can implement building standards to ensure future solar installations or "zero-energy" upgrades would not be limited by the design or layout of a new infrastructure. Such standards may regulate orientation, shading, and other siting- and construction-related criteria, or may support acceptance of 'plug-and play' solar PV system configurations. (U.S. Department of Energy, 2012) California has recently started experimenting with solar-ready building codes for residences in special "Solar Zones." (California Energy Commission, 2014) There are currently no known examples in the Northeast.

Tax

Property Tax Exemption or Special Rate

Property taxation of distributed solar installations creates a dilemma for communities. Property tax revenue is entirely incremental, particularly for rooftop or brownfield installations, yet too high a rate will simply chase developers into other locations. Property tax rates and their application or appraisal can vary by location, municipality or appraiser.[81] Because property tax often constitutes a significant fraction of operating expenses, the difficulty in predicting property tax obligations can be problematic for developers or owners under some implementation regimes. This is particularly true if it is difficult to predict with precision how large an impact property tax obligations may have until after substantial investment in an installation has occurred, or a bid has been offered under an incentive solicitation.

Property tax relief policies are designed to remove or mitigate disincentives for solar development by protecting residential and business property owners installing solar systems from higher property taxes.[82] Property tax exemptions exempt the added value of solar development from being included in the assessment process for property tax purposes over an administratively-set period of time. Typically, the exemption can only be applied to generator-owned systems that are hosted onsite. In some states, the exemption is tied to equipment dedicated to the production of energy for use in or at the facility.[83] In some cases, the equipment must be owned by the building owner, creating potential problems for third-party leases, leased buildings or condominiums. However, Massachusetts recently found that certain virtually net-metered systems hosted on properties owned by the generator should also be

[81] Real estate appraisers are gaining familiarity with rooftop solar, but training and education in that sector would be valuable in improving community understanding of solar generation.
[82] One unintended side effect of property tax exemptions is that appraisers do not need to improve their solar system valuation skills.
[83] Such conditions can create complications for FIT other sale arrangement, if the property must be properly depreciated and income must be recognized.

eligible to receive property tax exemptions.[84] Special rates policies require properties hosting solar systems to be assessed at a discounted rate.

An alternative to property tax exemption policies is Payment-In-Lieu-Of-Tax (PILOT), which allows a system owner to make payments to the local government at a pre-negotiated rate over a period of time in lieu of property taxes. This approach is usually applied to larger, ground-mounted solar projects. While property taxes are usually collected at the local level, states may permit or require their municipal governments to implement property tax exemption or special rate policies for solar PV. Other states may allow communities to voluntarily offer such exemptions. This is the approach used by Rhode Island.

Tax exemption policies are very common, as they are generally much more politically viable than direct financial incentives as they are easy to administer and do not require an explicit funding mechanism. (DSIRE Solar Policy Guide: A Resource for State Policymakers, 2012). They also create beneficial local economic development multipliers and increase the overall value of the housing and building stock by encouraging local investment. (See recent Wiser study, showing that rooftop solar, in general, adds $4 per watt installed to home value.) Further, they are considered to be non-impactful as they do not increase the cost of solar installation for systems owners or reduce government tax revenues. Additionally, they can be implemented with a wide range of incentives, regulations and rules.

Sales Tax Exemption

Similar to property tax relief policies, sales tax exemptions lower the barrier to participate in the solar market. By exempting system owners from pay sales taxes for the PV system equipment, sales tax exemptions lower the cost of solar PV installation. Sales tax exemptions are usually offered to all system sizes and customer classes (e.g. Connecticut, Rhode Island, Vermont, New York, Maryland, and New Jersey). However, some states limit exemptions to certain customer sectors. Massachusetts, for example, only offers solar sales exemptions to residential customers. New Hampshire and Delaware do not have sales tax exemptions as they do not have a sales tax.

Property Tax/Payment-In-Lieu-Of-Tax (PILOT) Standardization or Simplification

Property tax application and assessment can vary dramatically from community to community, and often the amount of property tax to be due is difficult to predict, making it challenging for developers to project revenue requirements for viability before bidding for contracts or making investments. By standardizing and simplifying property tax and PILOT rules for solar PV development, states and municipalities can reduce the time installers spent examining property tax rules for each local jurisdiction, and remove an unnecessary uncertainty and risk. This approach can avoid local tax disputes

[84] The Massachusetts Appellate December 4, 2014 decision ruled narrowly that virtually net-metered systems sited on properties owned by the net metering customer should be permitted to receive property tax exemption for the solar facilities. However, the broader application of this decision, to both Community Shared Solar and transactions where an investor owns a system, and sellers of power or net-metering credits to a third-party property, is unclear. (Forrestall Enterprises Inc. v. Board of Assessors of the Town of Westborough, 2014)

that can disincentives solar development and create greater certainty for solar system owners. Further, it helps reduce the soft cost of solar PV, lower entry barrier to the market, and facilitate solar adoption.

Grid Modernization

Policies Enabling Micro-grids, Smart-Grid and Other DG-Friendly Grid Architecture

Distributed generation can play a significant role in enhancing grid resiliency when incorporated in micro-grid and other smart-grid systems. Distributed-generation friendly technologies and grid architecture can ease the interconnection of distributed generation and advance the implementation of such systems. States can adopt policies that promote installation of such technologies or require more comprehensive grid modernization planning. Several states studied here have adopted grid modernization policies to various degrees:

- **Massachusetts –** The Massachusetts Department of Public Utilities initiated a regulatory proceeding directing the state's distribution utilities to conduct comprehensive grid modernization planning with the intent to integrate distributed resources, reduce the effects of outages, and optimize demand, which includes reducing system and customer costs. Utilities are required to provide ten-year grid modernization plans and business cases outlining how the companies plan to implement measure grid modernization effort. (Massachusetts Department of Public Utilities, 2014)

- **Connecticut –** The Connecticut legislature implemented a micro-grid grant and loan pilot program to promote local distributed generation for critical facilities. The program operates under a competitive solicitation process. In the past two solicitations, the state awarded grants to a mix of solar PV, fuel cell, cogeneration and combined heat and power projects. (Connecticut Department of Energy and Environmental Protection, n.d.)

- **Maryland –** Maryland has been working with its distribution utilities to roll out a smart-grid program. The first phase of the program, implemented in 2011, was the installation of smart meters, which among a series of benefits, would enhance solar PV compatibility with the grid system and provide more effective communications between solar customers and utilities, which may result in solar generator friendly rate designs or other incentives. (Maryland Energy Administration, n.d.)

Rate Design

It is the job of utilities regulators to apply a series of traditional ratemaking principles to balance sometimes conflicting objectives. Among these, cost-based rate design or rate structure for the purchase of electricity supply and transmission and distribution services will serve to provide customers

a correct price signal for the installation and operation of solar generation facilities.[85] Rate structures which vary by time to reflect the temporal variation in cost causation are one such tool receiving significant attention industry-wide.[86] For the most-part, such cost-based rate designs involves time-varying rates or time-of-use (TOU) rates which charge and compensate customers for consumption and generation at different energy prices during on-peak and off-peak hours. If solar production is high or consumption is reduced during high-value, on-peak hours, TOU rates can improve the economics of solar generation (although solar is limited in its ability to respond to price signals, coincidence of production and high-prices hours would properly increase compensation to solar customers relative to average rates). A more technically complex related option is "dynamic pricing," which adjusts energy prices based on changing market demand and supply conditions. (Linvill, Shenot, & Lazar, 2013). Dynamic pricing that adjusts electricity supply prices by hour reflect daily and seasonal differences in electricity supply costs. TOU rates can reflect, to the extent they exist, daily and seasonal differences in electricity delivery costs.

Fixed or customer charges in electricity bills tend to reduce the economic payback value of customer solar installations. However, it should be recognized that a certain portion of a utility's costs are fixed and are not lowered by reduced consumptions. Therefore, some type of fixed charge, such as a customer charge or minimum bill, is often part of an appropriate rate design process. The "minimum bill" model allows customers to reduce their bill with efficiency or self-generation, but only to a certain minimum level.

Such a minimum bill, influenced by a cost of service study, seeks to address the traditional ratemaking principles of utility cost recovery for use of their facilities and setting utility rates based on costs, and could, when applied equitably to all customers, be designed to avoid unduly penalizing low-usage customers, energy conservation and distributed generation. Within limits, this approach can mitigate disproportionate impacts on customers with behind the meter distributed generation often raised

Industry Support

Industry support approaches are often paired with incentives, rules & regulations and rate design strategies to accelerate solar deployment. By incentivizing in-state solar investment, many industry support approaches are also designed to simulate local job creation and foster state economic growth.

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[85] Other principles include cost-causation, gradualism, fairness, equity concerns, adequate customer segmentation, and encouragement of efficiency.

[86] There is significant interest in this topic, with advocacy enumerating benefits that such price signals can enable in combating peak system demands and incentivizing efficient use of resources. There is however ongoing debate as to whether residential customers can or will effectively respond in a meaningful fashion to such price signals, and enabling such responses can involve costs (in sophisticated metering and other technology) which some have debated may outweigh the benefits. This debate has so far served as a damper on universal adoption of mandatory time-varying rates. Such factors are mentioned here for completeness but beyond the scope of this study.

Incentives for Companies, Technology Development Funds or Economic Development Funds

To promote local economic development, states can leverage technology development funds, economic developments funds and other funding mechanisms to provide incentives for in-state solar businesses, such as solar equipment suppliers, contractors, etc. These funds can be allocated from the state budget, ACP payments, RGGI proceedings, and public good funds.

Local Content Bonuses or Mandates

Local content bonuses or mandates support investment in local solar industries by supporting the employment of local labor force or use of technologies manufactured in-state. These policies usually exist in other programs as eligibility requirements, evaluation criteria, or incentive adders. For example, the Connecticut legislature allows the state Public Utilities Regulatory Authority to give preference to contracts that use technologies manufactured, researched or developed in the state.[87] The Massachusetts Commonwealth Solar Rebate II program provides an incentive adder to solar projects that use modules, inverters or other significant electricity production components manufactured by a company with a significant Massachusetts presence.[88] Under some circumstances such incentives may be subject to challenge under the Interstate Commerce Clause of the US Constitution, or under trade agreements, so care should be taken before pursuing such avenues.

Customer Acquisition Cost Reduction (e.g. Solarize Initiative)

A 2010 survey estimated that the average customer acquisition costs for residential PV systems was $0.67/W. (Ardani, et al., 2013) States can leverage the economy of scale to increase solar participation at a lower cost. "Solarize" is a cost reduction strategy mainly targeted to residential and small business customers. Through this community-oriented approach residents and small business owners from participating communities will receive pre-negotiated solar installation discounts through bulk purchases resulting from state-run solicitations for vendors. These discounts are often structured as tiered-pricing, where the pricing lowers with increased participation. (Condee, 2014). Table 42 is an example of Solarize Massachusetts' tiered pricing.

Table 43 – Solarize Massachusetts Example Tiered Pricing

	Tier 1	**Tier 2**	**Tier 3**	**Tier 4**
Contracted Capacity	1 – 100kW	>100 – 200kW	>200 – 300kW	>300kW
Installed Price ($/W)	5.08	5.03	4.98	4.93

[87] http://www.cga.ct.gov/current/pub/chap_283.htm#sec_16-244r
[88] http://images.masscec.com/uploads/programdocs/CSII_Program%20Manual_V20_Final.pdf

3rd Party Pre-Paid ($/W)	2.88	2.86	2.81	2.78
Leased Price ($/kWh)	0.108	0.104	0.10	0.096

States will also provide small subsides for coordinated community-based education, marketing, and outreach efforts. Massachusetts and Connecticut are two early adopters of this approach. Both Rhode Island [89]and New York[90] have announced their own versions of Solarize incentives in late 2014.

Outreach, Education, Public Information or Voluntary Market Encouragement

Lack of costumer awareness can impede solar adoption, especially in the residential and small C&I sector. States can educate residents and businesses on how the voluntary and compliance solar markets work, as well as inform customers of solar funding and financing options through outreach and education programs. Example initiatives include consumer workshops and development of a central information web portal that provides a one-stop-shop to information on solar technologies, funding and financing opportunities, qualified solar installers and vendors. States can also consider more innovative models capitalizing emerging resources for public engagement and social media.

Public Sector Leadership and Demonstration (e.g. Solar on Schools)

States can implement lead-by-example strategies to increase awareness and create education and outreach opportunities for solar PV development. Strong local and statewide solar programs can also add important sales and business volume to the sector, facilitating more full-time employment and reducing “boom and bust” cycles in markets. Typical lead-by-example strategies include installing demonstration projects on public properties and establishing statewide solar generation goals.

Example of lead-by-example initiatives:

- **Massachusetts –** In 2014, Massachusetts provided capacity-based incentives to state agencies and state universities for solar PV canopy projects through its Leading by Example initiative, which involves a range of clean energy targets for state-owned facilities regarding renewable energy, greenhouse gas emissions and other energy and environmental goals. The state also awarded multiple grants to municipalities for an inventory of clean energy resiliency projects,

[89] In summer of 2014, the Rhode Island Office of Energy Resources and Rhode Island Commerce Corporation announced that they will jointly administer Rhode Island’s version of the “Solarize” program. Phase I of the program will be launched in fall 2014 in North Smithfield. Phase II of the program, which will begin in early 2015, will focus on the Towns of Little Compton and Tiverton. OER and Commerce RI will consider how the program will expand after the first two phases are complete, sometime in summer 2015.

[90] New York State initiated Community Solar NY under the NY-Sun initiative to make solar more easily accessible and affordable through community-driven strategies. The state will be launching Solarize campaigns in participating communities in spring 2015.

among which include several solar PV systems for emergency generation during outage. (Massachsuetts Executive Office of Energy and Environmental Affairs, 2014)

- **Rhode Island –** Rhode Island offers a competitive grant using its RGGI auction proceeds for renewable energy projects at K-12 schools throughout the state. The program requires applications to contain and education element as part of the project. (Rhode Island Office of Energy Resources, 2014)

Creation of Public Good Funds to Support Solar Programs and Policies

States can create public good funds to provide long-term funding for solar incentive programs. Public good funds are typically collected from ratepayers as a surcharge on electricity customers' utility bills. The surcharge could be a fixed monthly rate (e.g. $/month) or based on electricity consumptions (e.g. $/kWh). Public good funds can also be established through utility merger settlement proceedings. The Pennsylvania Sustainably Energy Funds are supported by utilities in lump-sum payments. Merger settlements between Allegheny Power and First Energy, PECO and Unicom, and GPU Energy and First Energy have resulted in additional payments to the Funds. {Need to find original dockets} (DSIRE Solar Policy Guide: A Resource for State Policymakers, 2012)

Public good funds, in conjunction with ACP and RGGI proceeds, can be allocated to a variety of solar programs and other clean energy initiatives such as those detailed in this report. Direct up-front incentives like rebates and grants are often supported by public good funds. It should be noted that in years of budget shortage, public good funds have been raided in many states to fill state budget gaps, reducing available funding for renewable initiatives. Some states have hired independent administrators to manage public good funds and prevent them from being used for general budgetary purposes. However, this is not a fool-proof method, as evidenced by the Connecticut Clean Energy Fund raid in 2013.

Installer and Inspector Training and Certification

States may create training and certification procedures for solar installers and contractors to help build a qualified local workforce which might otherwise serve as a constraint to growth. Alternatively, states may adopt installer requirements or pre-approval procedures in their incentive programs to encourage participation while ensuring safe practices and system performance. For example, new installers participating in the Massachusetts Residential Solar Loan Program are subject to state inspection of their first two projects. If the inspection is successful, the installer will be expedited moving forward. (Massachusetts Department of Energy Resources, 2015).

Some states implement installer licensing requirements or training and certification programs to protect customers from unsafe practices, ensure system performance, and maintain industry reputation. (DSIRE Solar Policy Guide: A Resource for State Policymakers, 2012). For example, Connecticut has a solar contractor licensing program administered by the state's Department of Consumer Protection. Contractors must obtain a license in order to perform solar energy work within the state. (Regulations of State Agencies Title 20, 2008).

In addition to providing proper training to solar installers, states may wish to educate building inspectors on the structure review and approval for solar PV systems. The Massachusetts Department of Energy Resources, for example, has created multiple guidelines on the topic and hold regular training sessions to help solar installers and inspectors understand the permitting and review process. (Massachusetts Department of Energy Resources, 2014).

Implementation Option Evaluation and Analysis

Introduction

Maine's Solar Implementation Status

Compared to neighboring states, Maine has a relatively small solar market. As of the end of 2014, Maine has installed 11.7 MW in nameplate capacity of solar PV. This represents 0.59% of the state's 3-year average peak load (between 2011 and 2013) of 1990 MW. As compiled by ISO-New England's Distributed Generation Forecast Working Group[91] (ISO-New England Distributed Generation Forecast Working Group, 2014), this penetration level at year-end 2014 is compared to:

- 120 MW (1.7%) in Connecticut[92];
- 530.1 MW (4.1%) in Massachusetts[93];
- 10.7 MW (0.4%) in New Hampshire[94];
- 18.2 MW (0.9%) in Rhode Island[95]; and
- 56.2 MW (5.6%) in Vermont[96].

Connecticut, Massachusetts, Rhode Island and Vermont have all established aggressive policies, programs and other implementation options to grow these figures several fold by a factor of two to six times over the next five years. In addition, New Hampshire has implemented options (grants and rebates under its Renewable Energy Fund, expanded virtual net metering, etc.) to grow these figures materially (New Hampshire Public Utilities Commission Sustainable Energy Division, 2014).

Maine's relatively lower solar PV penetration to date correlates to a degree with a more limited set of implementation options in place to date than these other states, as discussed in Section 0.

Evaluation and Analysis Approach

In this section, we attempt to identify a suite of implementation strategies that might be considered appropriate within Maine's context. The authors first identified a list of priorities and common objectives appropriate for Maine's consideration. Next, based on the literature review on solar PV implementation, the authors discussed various findings common to experiences of other states. Finally,

[91] More information on each of these state's suite of implementation options can be found in presentations posted at http://www.iso-ne.com/committees/planning/distributed-generation.
[92] http://www.iso-ne.com/static-assets/documents/nwsiss/grid_mkts/key_facts/final_ct_profile_2013_14.pdf
[93] http://www.iso-ne.com/static-assets/documents/nwsiss/grid_mkts/key_facts/final_ma_profile_2013_14.pdf
[94] http://www.iso-ne.com/nwsiss/grid_mkts/key_facts/final_nh_profile_2014.pdf
[95] http://www.iso-ne.com/nwsiss/grid_mkts/key_facts/final_ri_profile_2014.pdf
[96] http://www.iso-ne.com/nwsiss/grid_mkts/key_facts/final_vt_profile_2014.pdf

we identified additional considerations the legislature may wish to account for when examining the various implementation options and approaches.

Evaluation of Implementation Options

To guide the Legislature's analysis effort, the authors identified a set of priorities and common objectives through literature review, research on other states' solar implementation experiences and what we understand of Maine's context. This exercise helped establish a list of illustrative evaluation criteria for assessing the effectiveness of the policy options at meeting different policy priorities. Further, it provided a meaningful framework for comparing and balancing the policy options and objectives in order to identify an appropriate pathway that leads to the most desired outcomes. The legislature should in no way feel bound by such objectives, but may find them a useful starting point.

Table 44 – Policy Priorities and Objectives for Solar PV in Maine

Implementation Priorities	Implementation Objectives
Market Growth	• Stimulate a self-sustaining solar market • Supports increased investment in distributed solar • Supports increased deployment in distributed solar
Equity	• Provide fair cost recovery to T&D utilities • Provide just and reasonable compensation to solar customers • Allocates costs equitably among ratepayers
Feasibility	• Establish a policy that is administratively simple, transparent and verifiable • Establish a policy that is viable within the existing political and legal framework
Compatibility with Maine's Energy Market Goals	• Create a market that is compatible with competition in wholesale and retail energy markets in Maine • Diversify Maine's energy portfolio, while ensuring protection of system reliability
Economic	• Facilitate investment and development in in-state solar generation, manufacturing, installation, and R&D industries
Environment	• Advance Maine's environmental goals and improve the state's environment through reducing GHG emissions and other adverse impacts of existing electricity generation

Lessons Learned from Other State's Experiences with Implementing Solar PV

To identify the most effective approach to implementing solar PV, we identified four key themes or lessons learned based on our literature review and research on solar implementation in other states:

- A comprehensive strategy to support solar PV is effective at increasing solar PV penetration.
- Low- or no-cost implementation options - options to enhance distributed solar adoption with minimal financial outlay relative to direct incentive programs - are available, and may be considered either alongside direct incentives, prior to adoption of incentives, or when there is limited appetite for costlier measures.
- Sequencing implementation option in a particular order enhances the cost-effectiveness of solar deployment.
- Adopting synergetic implementation options can advance support for increased solar penetration, while over-stimulation and conflicting implementation objectives may impede or disrupt healthy market growth.

Comprehensive Strategy

One key finding is that a comprehensive approach to support solar PV is effective at increasing solar PV penetration. (Steward, Doris, Krasko, & Hillman, 2014). In all ten states studied here, state policymakers implemented a combination of implementation options simultaneously to maximize the support available for, and reduce barriers to, diverse solar deployment. The Legislature may wish to consider combining various policies, programs rules, regulations rate designs, incentives and industry support strategies to achieve multiple implementation objectives (e.g. develop scale economies, reduce costs, reduce risk and create an attractive investment climate, etc.) and maximize the benefits realized.

Low- and No-Cost Implementation Options

When considering the variety of implementation options, the Legislature should be aware that there are a number of alternatives with either no or modest cost, particularly relative to broad-based incentive programs with multi-million dollar ratepayer costs implemented with many of the states studied. Table 45 provides a summary of low- and no-cost implementation options in different categories. These options may be implemented in various market stages described further below in Subsection 0. For example, some are commonly deployed early in a market preparation phase. The Legislature may choose to implement some of the options early on to create leverage for solar PV support at a relatively low cost. Several options are more suitable for later stages when the solar market has reached a certain level of penetration, and can be deployed to drive down costs in concert with phase-down of direct incentives. It should be noted that, while most of these options require little funding compared to direct incentives, some – such as 'green bank' programs - may require an initial injection or allocation of funds that can be re-circulated in later stages.

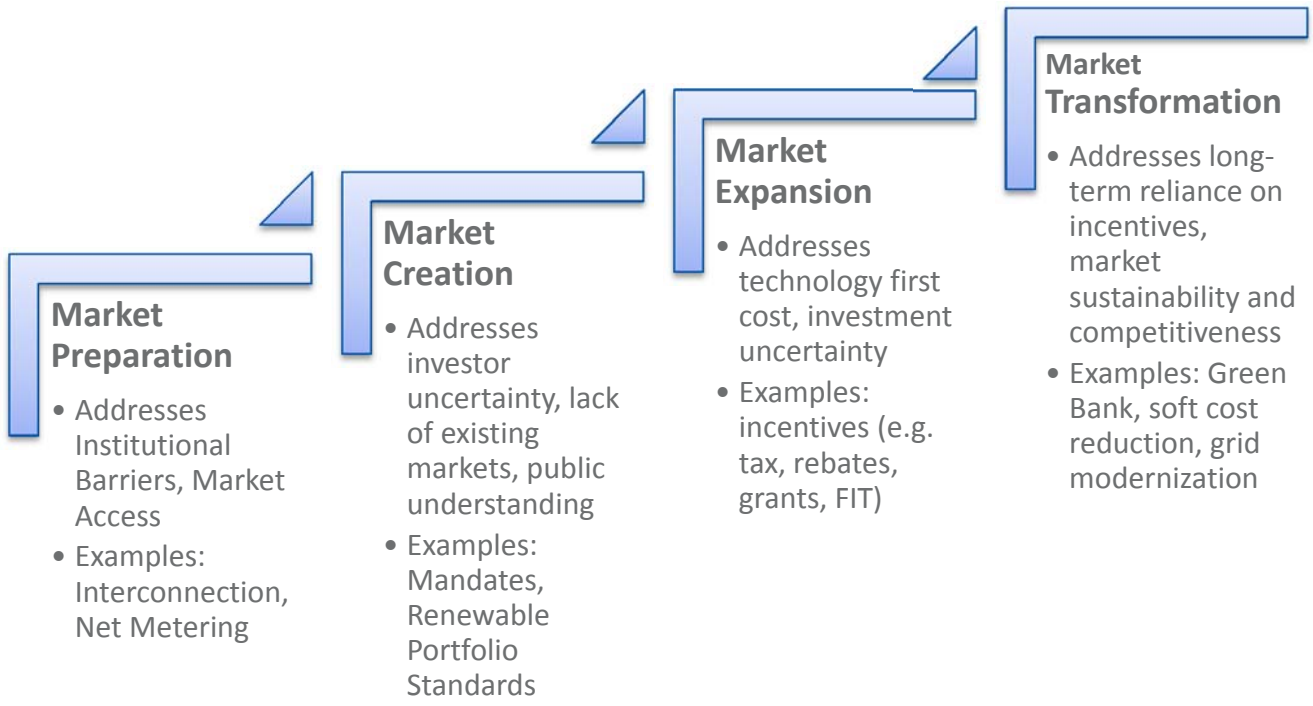
Table 45 – Low- and No-Cost Implementation Options

Category	Subcategory	Implementation Examples
Finance Enabling Policies		Non-Subsidized Solar Loan Programs
		On-Bill Financing
		PACE Financing
		Utility Ownership
		Solar Lease and/or Third-Party Ownership Enabling Policies or Eligibility in Other Policies
Rules & Regulations	Removing Institutional Barriers	Interconnection Standards
		Solar Access Laws
		Business Formation/Financing Laws (e.g. Securities Registration, Innovative Market Structures, such as Crowd-Funding, Cooperatives, Community Solar, etc.)
		Permitting Standardization, Simplification, and Streamlining, and Other "Soft-Cost Reduction" Strategies
	Building Codes	Solar-Ready Building Standards, Zero-Energy Capable Home Standards
	Tax	Property Tax Exemption or Special Rate
		Sales Tax Exemption
		Property Tax/PILOT Standardization or Simplification
Rate Design	Other Rate Design	
Industry Support		Customer Acquisition Cost Reduction (e.g. Solarize Initiative)
		Outreach/Education/Public Information/Voluntary Market Encouragement
		Public Sector Leadership and Demonstration (e.g. Solar on Schools)
		Installer Training and/or Certification

Implementation Sequencing

Another observation is that, based on analysis of state experiences, staging implementation in a particular order can enhance the effectiveness and the cost-effectiveness of solar deployment. The following implementation framework is the authors' adaptation of National Renewable Energy Laboratory's "Framework of Policy Stacking." It illustrates a path of policy ordering commonly adopted by states. (Krasko & Doris, 2012).

Figure 35 – Sequencing Solar Implementation[97]



Market Preparation

The first stage of the framework begins with **"Market Preparation"** strategies. These include a variety of implementation strategies that fall under our broad categories of finance enabling policies, rules and regulations for removing institutional barriers, rate design and industry support strategies. Market preparation strategies are not designed *explicitly* to stimulate growth towards any particular goal or target. Instead, they focus on standardizing market access and removing institutional barriers of entry to the market (Krasko & Doris, 2012). As such, market preparation strategies are typically low-cost and can be executed without significant programmatic changes.

[97] Adapted from (Krasko & Doris, 2012). The authors added the Market Transformation stage.

Market preparation strategies perform several key functions in enabling access to the solar market:

- **Removing technical and legal barriers to solar PV implementation.** Interconnection standards establish the technical and legal procedures for solar PV to integrate to the electric grid. It is an important enabling policy that allows solar PV to participate in the electricity market. Besides interconnection standards, states can adopt permitting rules and regulations that protect solar system owners by (i) ensuring customer's right to solar installations and (ii) reducing the risks, time and cost associated with solar development. Examples include solar access laws and permitting simplification, standardization and streamlining. Additionally, a state may implement installer training or certification programs to standardize and regulate solar installation procedures, or building inspector training to ready local governments for increasing prevalence of initially unfamiliar, but well-understood, installations.
- **Creating a reasonable mechanism for compensating distributed solar generation.** Net metering policies establish the crediting systems for the excess generation being sold back to the grid. As discussed in earlier Sections, net metering is a critical funding source for residential and small business customers and is a key engine for solar development in many states.
- **Lowering the cost of market entry.** To enable affordable access to the solar market, and hence, broaden the scale of market participation, the Legislature may wish to consider market preparation strategies designed reduce the upfront cost of solar installations. Potential implementation options include finance enabling policies (e.g. non-subsidized or indirectly subsidized solar loans, PACE financing and on-bill financing) and tax exemption policies (e.g. property tax exemptions, special property tax rates and sales tax exemptions). It should be noted that while most of these options have minimal budgetary demand, some indirectly subsidized loans may require initial injections or allocations from the state. Alternatively, the state may consider enabling other market/finance approaches such as solar leases, third-party sales agreements, community-solar, and crowd-funding by adopting enabling policies or implementing eligibility requirements in other policies that are already in place.

Market Creation

"Market Creation" strategies demonstrate the state's long-term commitment to support solar PV, and hence, strengthen confidence for widespread private investment. (Krasko & Doris, 2012). Market creation strategies serve three main purposes:

- **Creating stable and predictable long-term demand for solar PV.** RPS is a typical approach to stimulate confidence in the renewable energy market. By mandating a certain portion of retail electricity sales to be met by renewables, RPS creates a predictable long-term demand and revenues for such resources. As discussed in previous Sections, to date solar PV is seldom active in traditional technology-neutral RPS markets outside the sunbelt. A more effective mechanism for stimulating solar investment is to implement an explicit solar tier or solar set-asides, as evidenced in Massachusetts, Delaware, Maryland and New Jersey. In order to successfully drive solar development, incentive levels (i.e. ACP schedules) would need to allow for price levels

sufficient to support solar economics. The Legislature may also wish to consider price supporting mechanisms and market segment limitations to direct supply and control price volatility.

- **Creating long-term funding mechanism to support solar PV initiatives.** In order to show long-term commitment and prepare for the next market phase, states may decide to establish a long-term mechanism dedicated to generating funding for solar PV initiatives. An example is to create a public good fund dedicated to supporting solar PV efforts. More commonly, states choose to mandate a certain percentage of an existing or new renewable energy fund or Regional Greenhouse Gas Initiative (RGGI) proceeds be allocated to funding solar initiatives through legislation. Once a funding mechanism is in place, the Legislature may also wish to create a mandate or adopt other strategies to protect the funding from budget raids.

Market Expansion

"Market Expansion" strategies are designed to scale-up market deployment by increasing market access and expanding market coverage. Solar PV cost is not static or independent from the market. There are substantial economies of scale impacting solar PV cost other than module prices. Most states that have sought to implement support for PV have undertaken some level of programmatic or policy initiatives to get market to scale, which have included targeted incentives. Such initiatives are implemented with the intent to achieve a scale to the state's PV industry that accelerates market transformation along a trajectory towards post-incentive sustainability. Performance-based incentives, such as FITs, Standard Offer PBIs and long-term competitive PPAs can also be deployed to create sufficient revenue predictability to attract low-cost financing or reduce the cost of financing. Further, some market expansion strategies are targeted to certain market sectors of public interest (e.g. low-income housing sector, municipal sector, brown fields, capped landfills, etc.).

Market expansion strategies can require substantial funding support from ratepayers, taxpayers or other sources. In order to implement solar PV cost-effectively, the Legislature may wish to utilize the Value of Solar study to help develop an incentive level that increases solar penetration and promotes implementation objectives, at a compensation level in line with the value of distributed solar energy. Further, the Legislature may consider applying a combination of incentives that target various stages of project development and market sectors. Table 46 summarizes the typical roles of various incentive options in the solar PV market. The "Development Stage" column illustrates whether an incentive is designed to provide upfront, short-term or long-term incentives. The "Market Sector" column identifies which sector the incentive typically supports.

Table 46 – Summary of Typical Roles of Incentive Options in the Solar PV Market

		Development Stage	Market Sector
Direct Financial, Up-front (a.k.a. Nameplate Capacity-Based/Denominated) Incentives	Grants, Rebates, or Buy-Downs	Upfront	Residential and small C&I sectors
Direct Financial, Performance-Based Incentives	Feed-In-Tariffs, Standard Offer Contracts or Tariffs, or PBIs (RECs, Energy, or Capacity)	Depends on how program is designed; could be short-term or long-term	All; but typically available to residential and small C&I sectors
	Competitive Long-Term PPAs	Long-term	Large- and utility-scale sectors
	Long-Term Value of Solar Tariffs	Long-term	Typically residential and small C&I sectors
	Technology-Specific "Avoided Costs"	Depends on how program is designed; could be short-term or long-term	Depends on how program is designed; could be available to all sectors
Expenditure-Based Tax Incentives	Investment Tax Credits	Upfront	All
Production Tax Incentives	Production Tax Credits	Long-term	All

In additional to incentives, the legislature may wish to implement strategies that expand solar PV implementation and fulfill other important state objectives. Virtual net metering and community-shared solar/net metering can accelerate solar PV penetration by opening up the market for substantial investment to include participations by ratepayers whose specific situation is not conducive to investing in on-site solar (reasons might include renting, orientation, shading, etc.). Outreach, education and public sector leadership campaigns may also increase awareness of solar PV, opening the market to further opportunities. States may also wish to consider strategies that ensure the economic benefits of increased solar investment are captured within the state. Examples of such implementation options include local content bonus or mandates and direct incentives for in-state solar businesses.

Market Transformation

As the market approaches to a scale, states may wish to implement options that drive down installed cost as incentives are being scaled down. The goal of **"Market Transformation"** strategies is to attract sufficient private investment to achieve a certain market scale that can operate healthily without substantial ratepayer or taxpayer subsidies (or while allowing a step-down of direct support over time). Market transformation strategies include a variety of innovative options, many of which have relatively low-cost or require only initial capital injections that can be re-circulated. Market transformation strategies have several common purposes:

- **Driving down solar PV cost such that it can become competitive with other technologies.** As market penetration increases and incentives are phase down, the Legislature may wish to consider implementation options that focus on driving down the cost of solar PV but which are best deployed within markets with sufficient scale, to help solar compete more effectively with other renewable technologies in the absence of additional incentives. There is a broad spectrum of implementation options targeted to bring down various cost components of solar PV (e.g. module prices, soft costs, operation & maintenance costs, etc.). Recent literature has illuminated implementation options states can execute to reduce soft costs associated with customer acquisition, permitting and inspection, and installation labor. Examples include Solarize Initiatives, bulk-purchasing, education/outreach campaigns, online permit application procedures, and solar-ready building codes.
- **Phasing down market reliance on incentives by leveraging private investment.** An example of an implementation option designed to such objective is establishing a Green Bank and deploying an associated suite of programs. A Green Bank typically uses public funds to attract and leverage for increased private investment, allowing the program to ultimately operate as a self-sustaining institution without public subsidies. By implementing a Green Bank states can also choose to offer a variety of financing tools and products targeted to address different barriers in the market, and thereby fill gaps in the financing market.
- **Enhancing the physical infrastructure for solar PV implementation to prepare for widespread adoption.** As solar penetration increases and broadens, states may wish to consider enhancing existing grid architecture to advance solar PV implementation. Such initiatives could be a combination of rules, regulations and incentives that support micro-grids, smart-grid and other DG-friendly infrastructures.

Interactions

While most of the implementation options identified in this study could be executed concurrently - and in the laboratory of the states, nearly all options have been tried in combination somewhere- the Legislature may wish to consider distributed solar implementation options that are synergistic. This includes executing a combination of implementation options that address various market barriers and provide sufficient incentives that attract solar investment. Meanwhile, the Legislature should be mindful of selecting a cost-effective and administratively effective suite of implementation options that avoids

needless duplication and aims for simplicity, transparency, clarity, and consistency with underlying policy objectives.

Other Considerations

In addition to the various issues discussed in the sections above, we have identified a list of considerations that should be taken into account when developing a comprehensive implementation approach:

- Implementation options selected (if any) should align as best possible with the legislature's definition of objectives. For example, if the state's policy objective is to increase installed solar PV capacity, the legislature needs to consider whether selected implementation options support actual installations (i.e. does the strategy yield a high project success rate). If the objective is to support in-state economic development and job growth, then the implementation option might target support for local manufacturers and contractors, and also encourage installations by local developers instead of favoring national players. Because policy objectives like those delineated in Table 44 can conflict - specific implementation options can maximize one objective while working counter to another - it is important that the legislature understand the tradeoffs among these options. (Grace, Donovan, & Melnick, 2011) (New York State Energy Research and Development Authority, 2012).
- The Legislature may wish to create leverage with polices and initiatives already in place in other states and the region to support solar investment and deployment in Maine. For example, in the absence of a local RPS market, Vermont solar system owners are able to finance their projects through a combination of revenues from the state's net metering program and the sales of RECs to Class I markets in other New England states (e.g. Massachusetts and Connecticut). The Maine legislature may choose to adopt implementation options that synergize with the regional solar market infrastructure.
- Implementation objectives and options are subject to constraints. For example, Federal preemption via the supremacy clause of the US constitution[98] may impact the legislature's choice when considering implementation options with in-state geographic eligibility requirements.[99] Other constraints, such as siting feasibility and grid interconnection constraints, may affect how the market responds to the implementation option.

98 Federal law may limit some approaches to standard offer PBIs, relating to PURPA and the Federal Power Act (Hempling, Elefant, Cory, & Porter, 2010).

99 The commerce clause may impact the ability of a policy to limit eligibility to in-state generation (Elefant & Holt, 2011).

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