SOLAR COST REDUCTION PROGRAM

Final Initiative-Level Logic Model Report

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Energy Research and Development Authority

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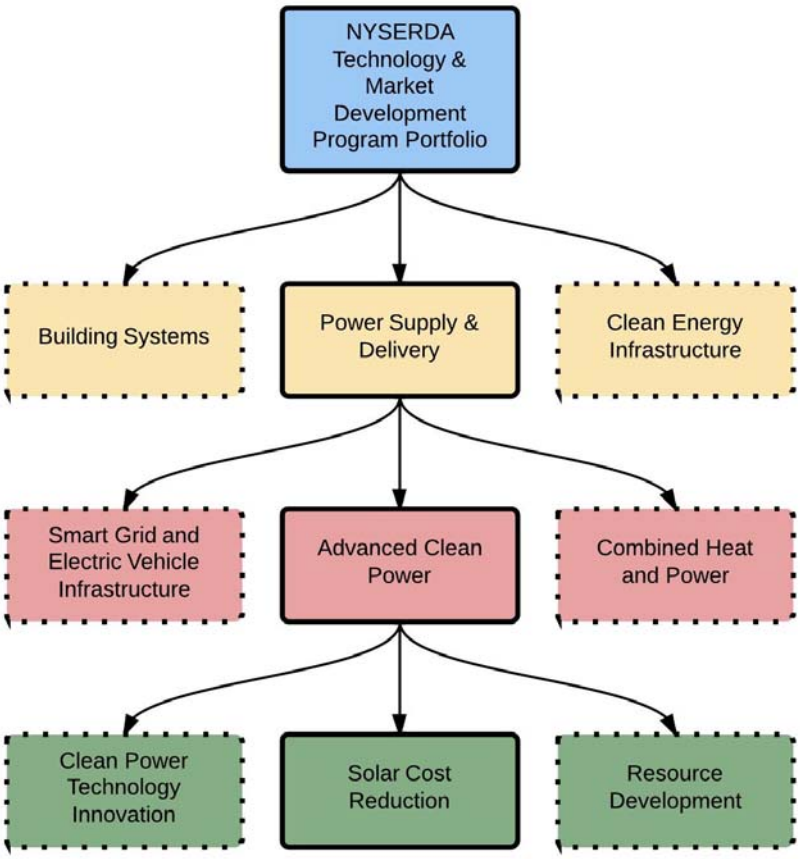
1 Initiative Context, Stakeholders, Intent, and Design

NYSERDA's Solar Cost Reduction (SCR) program, established in 2012, aims to reduce balance-of-system (BOS) costs of solar photovoltaic (PV) installations. BOS costs include everything involved in a PV system except the module, such as, the costs of non-module hardware, design, installation, permitting, interconnection, inspection, financing, and customer acquisition.

The SCR program is a component of NYSERDA's Advanced Clean Power (ACP) initiative. Advanced Clean Power falls under the Power Supply & Delivery program of NYSERDA's Technology and Market Development (T&MD) portfolio (see **Figure 1**). Advanced Clean Power seeks to facilitate meeting New York State's renewable power standard (RPS) goals and increase the availability of other clean power technologies. The ACP initiative aims to enable performance improvements and cost reductions through investment in technology innovation and market acceptance.

Figure 1-1: Solar Cost Reduction Program's Position Within the Overall Structure of the Technology & Market Development Portfolio



The SCR program is also a part of Governor Cuomo's NY-Sun initiative, which seeks to significantly expand customer-sited PV capacity across the state, advance PV technologies, and reduce the cost of PV systems (see text box).

The SCR program stems from NYSERDA's earlier Power Systems Technology Development program (Power Systems). Power Systems invested in 60 product development efforts in to the renewable energy industry in New York State. Thirteen of these product development efforts related directly to solar PV.[1] The SCR program extends these earlier efforts, but with an explicit focus on non-module PV product development and an added an emphasis on reducing 'soft costs,' through efforts to address customer acquisition costs, business and financing models, information access, and regulatory processes. Clean Power Technology Innovation, another component of Advanced Clean Power, continues the other renewable energy technology development efforts from the prior Power Systems program. Other related NYSERDA programs include Cleaner Greener Communities, which seeks to address permitting issues; Workforce Development, which focuses on workforce training; Community Solar NY, which will address accessibility issues related to solar PV; and Economic Development and Growth Extension (EDGE), which provides outreach services for the entire T&MD portfolio.

The NY-Sun initiative was announced in Governor Cuomo's 2012 State of the State address and was subsequently extended through 2023. The initiative sets aggressive targets for solar PV deployment in New York State and also seeks to reduce the cost of installed PV systems, including reductions in BOS costs. The initiative provides long-term funding certainty through a nearly $1 billion commitment over 10 years to support PV projects across New York State. The initiative also draws on programs across multiple agencies to achieve its goals, leveraging existing resources and staff expertise to develop holistic solutions. Programs falling under the purview of NY-Sun include NYSERDA and Long Island Power Authority (LIPA) deployment programs; SCR; Cleaner Greener Communities; and training for students, practitioners, and municipalities; among others.[a]

[a]Sarah J. Osgood, Program Manager, Policy & Program Development, NYSERDA, The NY-Sun Initiative, presentation given at Advanced Energy 2012, October 31, 2012, and Governor's Press Office, "Governor Cuomo Announces $60 Million in NY-Sun Funding Available," May 13, 2014, accessed May 15, 2014, http://www.governor.ny.gov/press/51314-ny-sun.

Targeted Problem

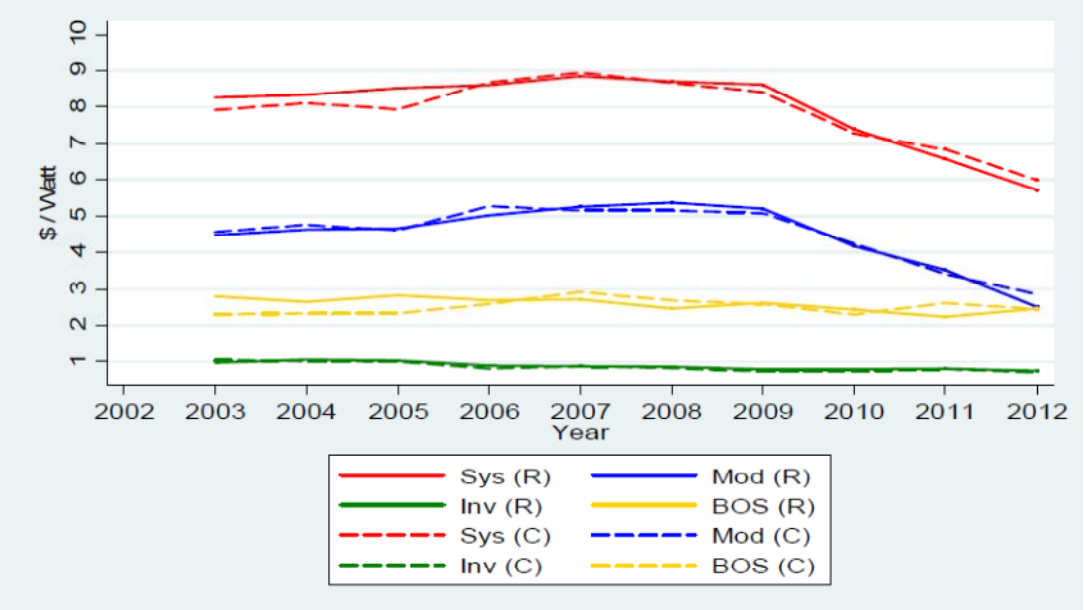
The overall cost of solar PV installations has fallen considerably in recent years.[2] This trend has been driven largely by reductions in the average cost of PV modules; other cost components of PV systems, known collectively as BOS

1 NYSERDA, Operating Plan for Technology and Market Development Programs (2012-2016), Second Revision, "Chapter 9.1.2: Advanced Clean Power," February 15, 2013.

2 Alan Goodrich, Ted James, and Michael Woodhouse, "Residential, Commercial, and Utility-Scale Photovoltaic (PV) System Prices in the United States: Current Drivers and Cost-Reduction Opportunities," National Renewable Energy Laboratory, February 2012, page 2. The SCR program seeks to reduce both the initial cost of PV installations and their lifetime operations and maintenance costs.

costs, have remained comparatively stable (see **Figure 1-2**).[3] BOS costs currently constitute more than 50 percent of the cost of installed residential and commercial PV systems in New York.

Figure 1-2: Median System and Component Prices for Residential and Commercial PV Systems Installed in New York State, 2003-2012



Source: State University of New York – Albany, College of Nanoscale Science & Engineering, "Analyzing Solar PV Installation Data in NY," page 6. Figure 1-2 shows price per watt for residential ("R") and commercial ("C") PV systems ("sys"), which are composed of PV modules ("mod"), inverters ("inv"), and balance of systems ("BOS").

BOS costs can vary considerably by location. A 2012 report by Lawrence Berkeley National Laboratory (LBNL) found that differences in BOS costs were a primary driver of differences in the average total cost of customer-owned residential PV systems in the U.S. versus Germany. Average BOS costs in Germany were only $1.18 per Watt, compared with $4.36 per Watt in the U.S.[4] Price variation within the U.S. is also significant. Data compiled by

3 State University of New York – Albany, College of Nanoscale Science & Engineering, "Analyzing Solar PV Installation Data in NY," page 6.

4 Joachim Seel, Galen Barbose, and Ryan Wiser, "Why are Residential PV Prices in Germany So Much Lower Than in the United States?" Lawrence Berkeley National Laboratory, September 2012, pages 24 and 35. The authors attributed this overall price difference to differences in inverter costs ($0.22/Watt difference); other hardware costs ($0.24/Watt); installation labor costs ($0.55/Watt); customer acquisition and system design costs ($0.62/Watt); permitting, inspection, and interconnection costs ($0.12/Watt); permitting fees ($0.09/Watt); sales tax ($0.21/Watt); and profit overhead, and other residual costs ($1.13/Watt). Note, however, that the authors do not take into account voltage differences between Germany and the United States, which also affect other hardware costs and installation labor costs.

LBNL in 2012 indicate that the installed price of PV systems smaller than 10 kW was higher in New York than in many neighboring states.[5]

BOS costs must drop for solar-generated electricity to achieve price parity with conventional sources of electricity without government subsidies. The SCR program therefore seeks to reduce barriers to BOS cost reduction in five principal categories:

- Non-module hardware;
- Business costs, including customer acquisition;
- Development costs, including contracting and financing;
- PV system design, installation, and operation; and
- Permitting, zoning, interconnection, and inspection.

Table 1-1 shows the current barriers to BOS cost reduction in New York State.

Table 1-1: Barriers to BOS Cost Reduction in New York State

Problem Area and Barrier Details	Stakeholders Impacted and/or Involved
1. Barriers related to non-module hardware	
• BOS hardware components are not designed to minimize installation labor requirements and other costs. There are underused opportunities for prefabrication, module-integrated power electronics, or integrated mounting and racking, among others. [a] • New residential and commercial buildings are not typically designed to be "solar ready," leading to later inefficiencies when PV systems are installed as retrofits. [b] • "Smart" hardware components such as inverters and network protectors are often needed to ensure compatibility between PV systems and the electric grid. [c] • Many BOS hardware components are not engineered to use minimal materials or enhance electricity production on site, thereby raising overall costs. [d] • Lower voltage requirements across the U.S. electricity grid necessitate PV systems with more wiring and larger pieces of equipment, further adding to costs; changing voltage requirements would require an extensive consultation process followed by highly coordinated efforts. [e]	• BOS hardware manufacturers • BOS hardware supply chain managers • Architects, real estate and construction companies • Zoning and planning officials • PV component and system engineers • Local utilities and the New York State Public Service Commission

5 Galen Barbose, Naïm Darghouth, Samatha Weaver, and Ryan Wiser, "Tracking the Sun VI: An Historical Summary of the Installed Price of Photovoltaics in the United States from 1998 to 2012," Report Summary, Lawrence Berkeley National Laboratory, July 2013, page 21.

Problem Area and Barrier Details	Stakeholders Impacted and/or Involved
2. Barriers related to business costs, including customer acquisition	
• Existing strategies for targeting potential customers are inefficient, with limited use of marketing partnerships, referral programs, and online outreach materials. [f] • Existing processes for bid preparation and contract negotiation are labor-intensive and costly. [g] • Customer awareness of relative prices and qualities of installed PV systems is often low, preventing efficient comparison-shopping across developers or installers and lengthening the customer acquisition process. [h]	• Developers/installers • Retail, construction, and real estate companies who could serve as partners in identifying customers • State and local governments who could provide customer education, refer or aggregate customers, or otherwise facilitate lead generation • Current and potential customers • Academic institutions and businesses that develop tools, provide customer education, and otherwise facilitate customer acquisition
3. Barriers related to development costs, including contracting and financing	
• Third-party tax equity financing, which dominates the distributed PV market, has a high cost of capital and fails to serve small-scale commercial and institutional installations. [i] • Public capital vehicles are largely unavailable for financing PV systems in the U.S.; securities, debt products, Master Limited Partnerships (MLPs) and YieldCos could all unlock new sources of financing and lower the cost of capital for PV installations. [j] • Other financing mechanisms that have been employed elsewhere in the U.S. remain underused in New York, including property assessed clean energy (PACE) financing, competitive loans, and interest rate buy-downs. [k] • Group purchasing ("solarizing") is underused in New York compared to other East Coast states, preventing the industry from realizing economies of scale and raising the cost of capital for PV installations. [l] • Contracts for PV installations are not standardized, necessitating more time-consuming and expensive due diligence processes. [m] • Federal and state tax incentives for PV installations are unpredictable over the long term, increasing project risk and potentially destabilizing the market. [n] • There is a paucity of publicly available data on the risks of financing solar PV installations, including historical information about payment defaults and the technical performance of installed systems. [o]	• Federal government regulators, including the Internal Revenue Service (IRS) • State and local government regulators • Providers of private capital • Providers of public capital • Community investors • Existing PV customers who could benefit from lower cost of capital • Underserved PV customers such as non-profit institutions • New York State Green Bank

Problem Area and Barrier Details	Stakeholders Impacted and/or Involved
4. Barriers related to PV system design, installation, and operation	
• Contractor services required for PV installations are immature compared to those in comparable industries (e.g., air conditioning installation), leading to higher profit margins and higher overhead costs. [p] • System design and installation methods are not standardized, resulting in additional installation labor requirements. [q] • Software tools and databases need improvement before most PV system design can occur remotely, so in-person visits are currently required to optimize system efficiency based on site characteristics. [r] • Workforce development and training programs are needed to streamline installation methods. [s]	• Developers/installers • Contractor services • IT service providers and software developers
5. Barriers related to permitting, zoning, interconnection, and inspection	
• Permitting processes are often cumbersome, requiring extensive paperwork and rarely allowing online application. [t] • Permitting processes are not uniform across New York's 1,550 municipalities, raising the cost of compliance for developers operating in multiple jurisdictions. [u] • Specific permitting requirements are often opaque, and accessing information about regulations can be difficult for both developers and customers. [v] • Permitting fees are often higher than are necessary to recover local government costs. [w] • Grid interconnection requirements vary by location, and information on specific sites is often not available before beginning project development. [x] • Multiple inspections from local governments and utilities increase project cost and time. [y] • Zoning regulations in New York can restrict PV installations, with significant variation in zoning ordinances in different local areas. [z] • Solar-friendly ordinances are rarely incorporated into comprehensive plans in local areas where such plans exist. [aa]	• Permitting officials • Building code officials • Planning and zoning boards • Other state and local government regulators • Local utilities and the New York State Public Service Commission • Developers/installers working with regulators

a. Ardani et al, "Non-Hardware ('Soft') Cost-Reduction Roadmap for Residential and Small Commercial Solar Photovoltaics, 2013-2020," National Renewable Energy Laboratory and Rocky Mountain Institute, page 65, and "SunShot Vision Study," U.S. Department of Energy, February 2012, page 183.
b. "Non-Hardware ('Soft') Cost-Reduction Roadmap," page 65, and "SunShot Vision Study," page 86.
c. Meeting minutes, NYPA and New York utilities, November 28, 2012.
d. "SunShot Vision Study," page 86.
e. Bony et al, "Achieving Low-Cost Solar PV: Industry Workshop Recommendations for Near-Term Balance of System Cost Reductions," Rocky Mountain Institute, September 2010, page 7.
f. "Non-Hardware ('Soft') Cost-Reduction Roadmap," page 6, and "Why are Residential PV Prices in Germany So Much Lower Than in the United States?", page 27.
g. Ibid, page 9.
h. Ibid, pages 21-22.
i. Michael Mendelsohn and David Feldman, "Financing U.S. Renewable Energy Projects Through Public Capital Vehicles: Qualitative and Quantitative Benefits," National Renewable Energy Laboratory, April 2013.
j. Mendelsohn and Feldman, "Financing U.S. Renewable Energy Projects Through Public Capital Vehicles."
k. City University of New York, NYSERDA, and NYPA, "NYSolar Smart Survey Final Report," January 2014,

Problem Area and Barrier Details	Stakeholders Impacted and/or Involved
pages 33-34. l. "NYSolar Smart Survey Final Report," pages 33-34. m. "Financing U.S. Renewable Energy Projects Through Public Capital Vehicles: Qualitative and Quantitative Benefits," page 5. n. NYSERDA, "New York Solar Study: An Analysis of the Benefits and Costs of Increasing Generation from Photovoltaic Devices in New York," January 2012; see, for example, pages 9-13. o. "Financing U.S. Renewable Energy Projects Through Public Capital Vehicles: Qualitative and Quantitative Benefits," page 5. p. Goodrich, James, and Woodhouse, "Residential, Commercial, and Utility-Scale Photovoltaic (PV) System Prices in the United States," page 26. q. "Residential, Commercial, and Utility-Scale Photovoltaic (PV) System Prices in the United States," page 6. r. "Non-Hardware ('Soft') Cost-Reduction Roadmap," page 9, and "SunShot Vision Study," page 86. s. Ibid. t. "NYSolar Smart Survey Final Report," pages 9-22. u. Ibid. v. Ibid. w. Ibid. x. Ibid, pages 35-36. y. Ibid, page 28. z. Ibid, pages 23-27. aa. Ibid.	

Program Design

Based on consultations with stakeholders, SCR program staff have elected to adopt a broad-based approach to BOS cost reduction. Stakeholder discussions suggested that NYSERDA's involvement could best address BOS costs by targeting several of the barriers described in Table 1-1. These discussions also suggested that there is no single solution to reducing BOS costs, and that efforts are required on multiple fronts to realize substantial cost reductions.[6]

SCR's efforts to reduce BOS costs are undertaken primarily by providing funding to projects implemented by third parties. SCR's primary role is to evaluate and prioritize proposed projects, award funding, and provide ongoing coordination and support to funding recipients.

Program staff instruct funding applicants to consider BOS cost reduction "in a holistic manner to ensure that cost reductions in one area don't cause unintended cost increases in another area that negate overall savings."[7] Section 4 of this report provides additional detail on the types of projects funded by the program.

6 Personal communication with Jen Harvey, Jennifer Phelps, and Jonathon Steiner, NYSERDA, April 15, 2014.

7 NYPA and NYSERDA, Photovoltaic Balance-of-System Cost Reduction, Program Opportunity Notice (PON) 2672, page 1.

2 Program Objectives (High-Level)

Through reviewing NYSERDA's *Operating Plan for Technology and Market Development Programs (2012-2016)* and other materials, IEc has identified the following objectives for the Solar Cost Reduction program:

Short term/Intermediate-term (1-4 years):

- Facilitate the development of next-generation technologies that reduce BOS costs;
- Accelerate market readiness of new products that reduce BOS costs;
- Empower customers and promote healthy competition in the solar PV industry;
- Improve the efficiency of PV system design and installation;
- Unlock new sources of financing and reduce financing costs for solar PV installations;
- Encourage more widespread use of best practices in permitting, interconnection, and inspection (PII) and zoning processes; and
- Improve program staff's understanding of what works in reducing BOS costs in New York State.[8]

Long-term (5+ years):

- Realize and sustain cost savings associated with purchasing, installing, owning, and operating a solar PV system in New York State;
- Reduce uncertainties associated with purchasing, installing, owning, and operating a solar PV system in New York State;
- Increase market acceptance of solar power generation in New York State;
- Catalyze self-sustaining commercial activities in New York State;
- Leverage other sources of public and private investment into New York State; and
- Reduce greenhouse gas emissions and reduce dependence on fossil fuels in New York State.[9]

8 PON 2672 and Operating Plan for Technology and Market Development Programs (2012-2016), "Advanced Clean Power."

9 PON 2672 and Operating Plan for Technology and Market Development Programs (2012-2016), "Advanced Clean Power."

3 Resources

The SCR program has received a total of $12 million for 2012-2016 from NYSERDA and NYPA. NYSERDA funding comes from the continuation of New York's System Benefits Charge (SBC), which the New York State Public Service Commission (PSC) approved in fall 2011 to support NYSERDA's T&MD portfolio. $6 million of this comes from NYSERDA. An additional $4 million in NYSERDA funds that had originally been allocated to SCR has been redirected to solar-specific workforce training and development programs managed under a separate NYSERDA program (Workforce Development). SCR also received $6 million in funding from the New York Power Authority (NYPA), with another $4 million in NYPA funds being diverted to NYSERDA's Community Solar program. NYSERDA and NYPA contribute in equal parts to the total funding awarded to each successful project.

Table 3-1: Solar Cost Reduction Budget

Budget (Funds Committed to PON)					
	Average Annual ($ million)	2012-2013 ($)	2014-2015 ($)	2016 ($)	Total ($)
T&MD Funding	1.2	0	2,750,978	3,249,042	6,000,000
NYPA Funding	1.2	0	2,750,977	3,249,043	6,000,000
Total: Solar Cost Reduction	**2.4**	**0**	**5,501,955**	**6,498,045**	**12,000,000**

Source: Personal communication with Jen Harvey, NYSERDA, June 17, 2014, and Operating Plan for Technology and Market Development Programs (2012-2016), "Advanced Clean Power."

The NYSERDA staff that manage and oversee the SCR program have been developing and managing renewable energy research projects for over 20 years. Their focus areas include technology/product development, market stimulation programs, establishing PV test centers, and supporting manufacturing facility development. SCR staff have also collaborated closely with other NYSERDA staff involved in PV incentive programs, training, and policy as needed. The staff brings this background of program management experience, market knowledge, and experience to the development and management of the SCR program.

Table 3-2 shows the financial, staff, intangible, and external resources available to the program.

Table 3-2: Program Resources

T&MD Funding
• $6 Million to fund contracted activities (plus $4 million reallocated to Workforce Development)
• **NYPA Funding**
• $6 Million to fund contracted activities (plus $4 million reallocated to Community Solar)
• **NYSERDA Staff Resources**
• 0.5 direct FTE • Support from other NYSERDA staff
• **Intangible Resources**
• NYSERDA staff knowledge and time • Expertise of Technical Evaluation Panel • Experience and technical capabilities of funding recipients • NYSERDA's relationships with key actors and stakeholders
• **External Resources**
• Other efforts to reduce BOS costs, including the U.S. Department of Energy (DOE)'s SunShot Initiative • Other efforts to increase deployment of solar PV systems in New York State, including the RPS program, the NY-Sun initiative, and others • Leveraged funds and cost-sharing by funding recipients

Source: Personal communication with Jen Harvey, Jennifer Phelps, and Jonathon Steiner, NYSERDA, April 15, 2014, and Operating Plan for Technology and Market Development Programs (2012-2016), "Advanced Clean Power."

4 Program Activities

This section provides a description of NYSERDA's activities under the Solar Cost Reduction program. These activities fall into four major categories:[10]

- ***Stakeholder Engagement:*** As an initial step, NYSERDA program staff reviewed relevant research and held discussions with utilities, installers, finance professionals, permitting authorities, and other stakeholders through workshops and third-party meetings. NYSERDA program staff held an independent workshop in May 2012 and participated in the Northeast PV Roundtable in April 2012, the New York City Solar Summit in February 2013, the NY-Sun Stakeholder Meeting in February 2013, and the SunShot prize workshop at SUNY College of Nanoscience and Engineering in June 2013. Through these engagements, program staff sought to develop a thorough understanding of the PV project development process and the elements that constitute BOS cost components. In particular, they asked for stakeholder input about how NYSERDA could achieve the greatest impact in reducing BOS costs. The lessons learned from these discussions informed the program's solicitation of project proposals.
- ***Solicitation and Selection of Proposals:*** The SCR program uses a competitive solicitation process to identify and award funding to promising projects that seek to reduce BOS costs in New York. Projects are funded through Program Opportunity Notice (PON) 2672. The first round of funding applications was due on July 30, 2013; winning proposals were selected on November 17, 2013. The second round was due on January 30, 2014, with winning proposals selected on June 3, 2014.

  In these two rounds of the PON, the SCR program sought to fund projects that targeted either BOS soft costs or non-module hardware costs. Soft costs could include developer or installer business costs; development costs; system design and engineering; permitting, interconnection, and inspection; installation labor; and operation and maintenance. Non-module hardware could include electrical or non-electrical components.

  PON 2672 asked applicants to demonstrate their knowledge of existing efforts to reduce BOS costs and to describe how their proposals would complement, supplement, or leverage these efforts. The program specifications explicitly instructed applicants not to duplicate previous or ongoing efforts, but did allow applicants to apply existing cost reduction solutions to the particular context of New York State.

  A Technical Evaluation Panel (TEP) evaluated project proposals and identified proposals to recommend to NYSERDA management for funding. The TEP consisted of representatives from industry, state government, U.S. DOE, and others involved in the development and deployment of PV systems. Evaluation criteria included the problem and proposed solution; technology transferability, replicability, and commercialization potential; the New York impact and project benefits; the statement of work and

10 Personal communication with Jen Harvey, Jennifer Phelps, and Jonathon Steiner, NYSERDA, April 15, 2014.

schedule; the proposer qualifications; project cost and value; and other considerations such as geographic diversity, portfolio balance, risk-reward relationship, and minimizing duplication of efforts.

- ***Project Funding:*** The program awards funding to a wide range of projects, based on the recommendations of the TEP. Projects seek to develop innovative products and processes or to diffuse known best practices within the industry, or to achieve some combination thereof. Funded projects fall into five principal categories, three of which received funding in the first round and two of which program staff hope to fund during the second round of the PON:[11]
  - *Categories that received funding in the first round of funding:*
    - Facilitate new business and financing models: The SCR program endeavors to apply underused business and financing models to a New York State-specific context, as well as to pilot new business and financing models in the market. Underused approaches include group purchasing, reverse auctions, and community power purchase agreements (CPPAs). The program is also developing social enterprise and community business models that make PV installations affordable and accessible to low-income homeowners and non-profit organizations in New York State.

      Improve access to information for market actors: Limited access to information is a challenge facing several types of actors in the solar PV industry, given the diversity of site characteristics and regulatory and technical requirements affecting the development of PV installations. SCR program activities include funding a "solar mapping" exercise to provide developers with information about technical issues related to grid connectivity, which can then inform decisions about project location and cost. The program also seeks to fund projects that provide local and community investors with information about potential PV projects, along with standardized legal documents to facilitate the information gathering requirements of the due diligence process. Finally, the program endeavors fund projects that to provide customers with price transparency and New York State-specific educational content about PV installations. The SCR program intends for improved access to information to reduce transaction costs and lower barriers to entering the marketplace.

    Facilitate adoption of streamlined permitting, zoning, and interconnection processes: Due to New York State's home rule authority, state officials cannot impose streamlined permitting or zoning processes on individual cities or counties. As a consequence, these processes are often fragmented, resulting in inefficiencies for developers working across multiple jurisdictions. The SCR program therefore funds projects that assist and encourage jurisdictions to adopt regional and state-wide best practices in solar-friendly zoning and planning, interconnection,

11 Untitled list of projects funded under Round 1 of PON 2672. Provided via personal communication with Jennifer Phelps, April 8, 2014.

inspection, and other regulatory processes, with input from stakeholders. Jurisdictions which adopt these best practices as part of SCR-funded projects should then serve as a model to others in New York.

- *Categories that program staff hope to fund during the second round of funding:*

  Hold demonstration projects for commercial-ready BOS hardware products: The SCR program seeks to fund demonstration projects for commercial-ready or commercially-available products which can reduce BOS costs directly or indirectly. The program intends that these demonstration projects will catalyze more widespread use of these solutions to near-term BOS cost reduction in New York State.

  Develop emergent BOS technologies: The SCR program's technology development efforts support product design, prototyping, lab testing, or field testing for emerging technological solutions to reducing BOS costs. Supported technologies could include non-module individual hardware components, standardized hardware platforms, or new software tools that reduce PV system costs directly or indirectly by lowering soft costs. The program seeks to fund projects that will eventually result in the successful commercialization of products manufactured in New York State and that will reduce BOS costs in the near term.

- ***Support and Coordination of Funded Projects:*** NYSERDA program staff actively engage with funded projects throughout project implementation. Before project commencement, NYSERDA program staff assist with refining statements of work and work plans based on recommendations received from the TEP during the review process. As projects are underway, program staff provide troubleshooting support as needed and coordinate the efforts of similar programs, so as to avoid duplication of efforts and facilitate sharing of best practices and lessons learned. Program staff also help to coordinate between funded projects and other relevant NYSERDA programs.

5 Program Outputs

This section describes the anticipated short-term results (i.e., outputs) associated with Solar Cost Reduction activities. Outputs are the direct and measurable results of specific program activities. Outputs tend to be easily identified and quantified, often by reviewing program records.

Table 5-1: Outputs, Indicators, and Potential Data Sources for Solar Cost Reduction Activities

Outputs	Leading Indicators	Data Sources and Potential Collection Approaches
Outputs from Stakeholder Engagement		
Meetings with stakeholders held to identify key barriers to BOS cost reduction	Record of meetings held	Collect meeting minutes/ summaries from NYSERDA staff
Outputs from Solicitation and Selection of Proposals		
Program Opportunity Notice written and issued	Program Opportunity Notice published	Verified through Program Opportunity Notice (publicly available)
Project proposals prioritized and selected for funding	Selection of successful projects by Technical Evaluation Panel (TEP)	Collect project selection documentation from NYSERDA staff
Outside funds leveraged	Cost sharing in projects awarded funding through the SCR program	Verify cost sharing through financial documentation from funding recipients
Contracts issued	Funding awarded to successful applicants	Collect contract documentation from NYSERDA staff
Outputs from Project Funding		
Demonstration projects held for commercial-ready BOS hardware products	Number of demonstration projects held	Collect project documentation from NYSERDA
Projects implemented to support emergent BOS technologies in testing, product design, and prototyping	Number of new technologies receiving support	Collect project documentation from NYSERDA
New and underused financing models applied to local context	Number of new and underused financing models supported	Collect project documentation from NYSERDA
New and underused business models applied to local context	Number of new and underused business models supported	Collect project documentation from NYSERDA
Demonstration projects held for BOS soft cost reduction strategies	Number of demonstration projects held	Collect project documentation from NYSERDA
New means of accessing information created	Number of new platforms launched (e.g., new websites)	Collect project documentation from NYSERDA

Outputs	Leading Indicators	Data Sources and Potential Collection Approaches
Strategies to reduce barriers to streamlined permitting, zoning, and interconnection promoted	Number of engagements with local government officials, utility representatives, and other key actors	Collect project documentation from NYSERDA
Outputs from Project Coordination and Contract Management		
Individual projects coordinated	Number of coordinating engagements with funding recipients during program duration	Conduct interviews with NYSERDA staff
Program participants assisted in troubleshooting	Number of troubleshooting engagements with funding recipients during program duration	Conduct interviews with NYSERDA staff

6 Program Outcomes and Logic Diagram

This section contains the anticipated short-, mid-, and long-term outcomes of the SCR program. Outcomes are the expected effects of a program, which are often closely related to the program's goals and objectives. These outcomes include changes in awareness, behavior, or conditions. Compared to outputs, they are less certain to occur and should be prioritized as potential areas for investigation as part of a formal program evaluation.

Table 6-1 details expected outcomes of the Solar Cost Reduction program, as well as the observable indicators that would signify the presence of these outcomes. Table 6-1 also shows data sources and potential data collection approaches that an evaluation effort might undertake to evaluate the achievement of the expected outcomes. Additional detail on the specific data sources anticipated for use in the planned process and impact evaluations will be provided in the forthcoming Evaluation Readiness Report for the Solar Cost Reduction program.

Given the relatively modest scope of the SCR program in terms of the number and size of funded projects, IEc has elected not to conduct a market-level analysis of these outcomes. Instead, IEc will evaluate these outcomes on the program level. The narrow focus of SCR-funded projects means that it should be straightforward to distinguish between the parts of the New York State solar PV market which the program has influenced and those which it has not. Furthermore, the relatively small degree of expected overlap with other NYSERDA programs means that IEc should be able to account for these other programs' influence when attributing impacts to the Solar Cost Reduction program specifically. A program-level approach is also desirable in that it enables NYSERDA to identify implementation strategies, which in turn will facilitate better decision-making regarding program design and funding priorities.

Table 6-1: Outcomes, Indicators, and Potential Data Sources for Solar Cost Reduction Activities

Outcomes	Indicators	Data Sources and Potential Collection Approaches
Short-Term Outcomes from Stakeholder Engagement		
Improved understanding of barriers to BOS cost reduction	Program structured and PON designed to address effectively barriers to BOS cost reduction	Interviews with program staff and participants; interviews with representatives from key stakeholder groups, including manufacturers, developers, contractors, consumers, and permitting authorities ("stakeholder interviews")

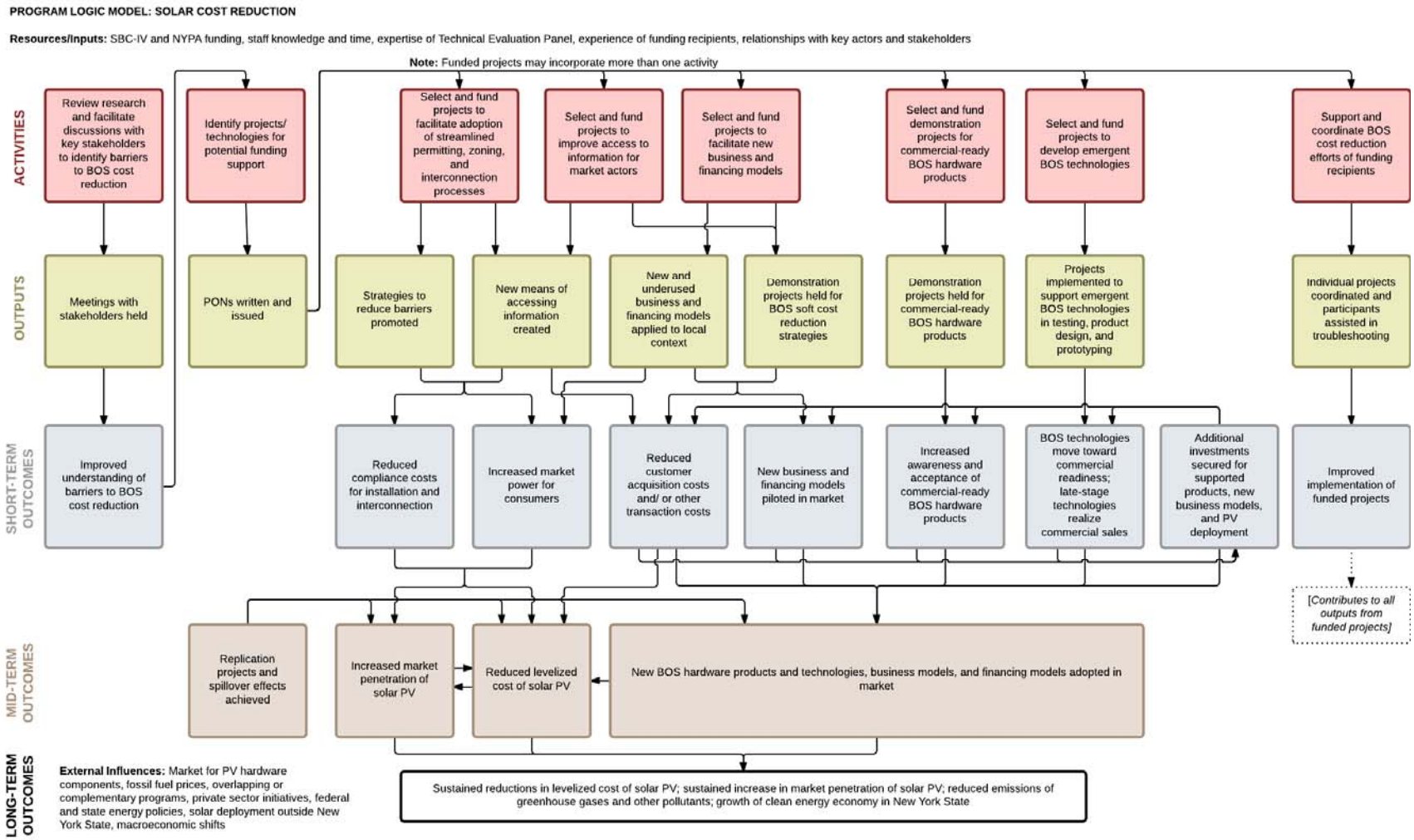
Outcomes	Indicators	Data Sources and Potential Collection Approaches
Short-Term Outcomes from Project Solicitation and Selection		
Project proposals with highest likelihood of helping to achieve program goals are identified and funded	Effective project solicitation and selection processes; application process does not hinder potential applicants from applying for program funding	Review of project selection documentation; interviews with program staff and participants; interviews with other key stakeholders in the PV market to address questions regarding the effectiveness of the solicitation and funding process and barriers to increased participation
Short-Term Outcomes from Project Funding		
Increased awareness and acceptance of commercial-ready BOS hardware products	Changes in stakeholder awareness, attitudes and behavior towards supported BOS hardware products	Stakeholder interviews
BOS technologies move toward commercial readiness	Supported technologies advance to later phases in technology development process	Stakeholder interviews; bibliometric/citation analysis; review of manufacturers' technical documentation
Late-stage BOS technologies realize commercial sales	Dollar value of commercial sales of supported BOS hardware products	Stakeholder interviews; telephone questionnaire of owners and/or installers of recently installed solar PV systems ("customer and/or installer survey"); RPS Customer-Sited Tier program database (PowerClerk); review of manufacturers' financial documentation; other sources; NYSERDA R&D Metrics Database
New financing models piloted in market	Number of pilot projects held for new and underused financing models	Program documentation from NYSERDA; interviews with funding recipients
New business models piloted in market	Number of pilot projects held for new and underused business models	Program documentation from NYSERDA; interviews with funding recipients
Additional investments secured for supported products, new business models, and PV deployment	Dollar value of additional investments secured for supported products and new business models; incremental investments in PV deployment as a result of cost reductions and streamlined processes	Stakeholder interviews; review of financial documentation from program participants; NYSERDA R&D Metrics Database
Reduced customer acquisition costs and/or other transaction costs	Change in average costs to supplier of identifying and converting new customers, and change in average costs to customers of identifying and selecting suppliers	Stakeholder interviews; review of financial documentation from program participants
Increased market power for consumers	Healthy competition levels in local PV markets	Stakeholder interviews; economic analysis of industry competition levels, possibly using reverse auction data

Outcomes	Indicators	Data Sources and Potential Collection Approaches
Reduced compliance costs for installation and interconnection	Change in average costs of complying with installation and/or interconnection requirements	Stakeholder interviews; review of recent changes to various jurisdictions' zoning codes, permitting requirements, etc.; review of financial documentation from program participants
Short-Term Outcomes from Project Coordination and Contract Management		
Improved implementation of funded projects	Funded projects successfully implemented; funding recipients accessed help as needed; duplication of effort avoided	Stakeholder interviews
Mid-Term Outcomes from Project Funding		
New BOS hardware products and technologies, business models, and financing models adopted in market	Dollar value of commercial sales of supported BOS products and technologies; valuation of companies or company divisions using those business models	Stakeholder interviews; customer and/or installer survey; RPS Customer-Sited Tier program database (PowerClerk); other sources
Replication projects and spillover effects achieved	Market penetration of supported BOS technologies and practices, beyond projects directly funded by program	Stakeholder interviews; customer survey and/or installer survey
Reduced cost of solar PV	Cost of solar PV in New York State for projects using SCR-supported technologies and approaches versus projects not using these technologies and approaches	Customer and/or installer survey; possibly a bottom-up analysis of PV system prices; baseline system price data from National Renewable Energy Laboratory (NREL) and New York-specific price data from PowerClerk
Increased market penetration of solar PV	Incremental number of PV systems purchased as a result of price reductions brought about by the SCR program	Economic analysis based on estimates of PV system cost reductions (see above) and responsiveness of PV adoption rates to changes in cost; New York-specific data from the U.S. Energy Information Administration (EIA) and other sources
Long-Term Outcomes		
Sustained reductions in overall cost of solar PV	Dollar value of reductions in average cost of solar PV in New York State	Customer and/or installer survey; possibly a bottom-up analysis of PV system prices; baseline system price data from National Renewable Energy Laboratory (NREL) and New York-specific system price data from PowerClerk
Sustained increase in market penetration of solar PV	Incremental number of PV systems purchased as a result of price reductions brought about by the SCR program	Economic analysis based on estimates of PV system cost reductions (see above) and responsiveness of PV adoption rates to changes in cost; New York-specific data from the U.S. Energy Information Administration (EIA) and other sources

Outcomes	Indicators	Data Sources and Potential Collection Approaches
Reduced emissions of greenhouse gases and other pollutants	Avoided emissions of carbon dioxide and other pollutants	Estimation of energy generated from incremental number of PV systems; standard emissions reduction factors from avoided fossil fuel energy generation
Growth of clean energy economy in New York State	Number of jobs and size of solar PV industry in New York State	Economic analysis estimating industry size and using input-output models such as REMI or NREL's JEDI to estimate local economic impacts of solar installations

Figure 6-1 presents a logic model diagram for the Solar Cost Reduction program. The diagram shows causal linkages between activities; outputs; and anticipated short-, mid-, and long-term outcomes; as well as program resources and potential external influences.

Figure 6-1: Solar Cost Reduction Program Logic Model



7 Assumptions About Strategies

This section describes testable assumptions about the SCR program that may be explored in later evaluations. Paired with each testable assumption are several key questions, which examine how program activities and outputs lead to the anticipated short-, mid-, and long-term outcomes. These testable assumptions will form the basis of later program evaluations. IEc intends to address these assumptions during the planned process and market evaluations, but limited data availability may impede our ability to develop robust analyses in all of the areas listed below.

In addition to the assumptions listed here, two broader assumptions underlie the SCR program's strategies: first, that a broad-based approach at the state level will reduce BOS costs more effectively than would a narrower approach; and second, that reducing BOS costs will lead to increased market penetration of solar PV, with its attendant environmental and economic benefits. Comparative analyses across programs may be useful in assessing these more general assumptions.

Testable Assumptions

1. Project solicitation and selection processes were effective in identifying projects with a high likelihood of contributing to the program's goals.
    a. Were potential funding applicants aware of the relevant PON?
    b. Were potential funding applicants unduly hindered from applying for program funding?
    c. Did the selection process choose strong project proposals to receive NYSERDA funding?
    d. Did the selection process avoid duplication of efforts across funded proposals?

2. If NYSERDA facilitates and encourages the adoption of streamlined permitting, zoning, and interconnection processes for solar PV systems, relevant market actors will voluntarily adopt these processes.
    a. Did NYSERDA identify best practices for permitting, zoning, and interconnection processes?
    b. Did NYSERDA facilitate and encourage the adoption of streamlined permitting, zoning, and interconnection processes?
    c. Did market actors become aware of streamlined permitting, zoning, and interconnection processes as a result of NYSERDA activities?
    d. Did market actors adopt streamlined permitting, zoning, and interconnection processes as a result of NYSERDA activities?
    e. Did compliance costs for solar PV installation and interconnection fall in areas where streamlined processes have been adopted?

3. If NYSERDA improves access to information on solar PV systems, consumer market power will increase.
    a. Were new means of accessing information created?
    b. How many market actors made use of these tools?
    c. Did customers using these tools find it easier to access information about relative prices and quality of PV systems, installation options, and other decision points?
    d. Did consumers using these tools gain additional market power in the solar PV industry, as evidenced by increased competition in local markets?
    e. Did reductions in BOS costs translate into reduced PV system prices for consumers?

4. If NYSERDA improves access to information on solar PV systems, transactions will become more efficient.
    a. Were new means of accessing information created?
    b. How many market actors made use of these tools?
    c. Did solar PV developers and installers using these tools find it easier to identify and target potential customers?
    d. Were there reductions in customer acquisition costs in the New York State solar PV industry?

5. If NYSERDA supports the development and demonstration of new and underused business models, additional market actors will adopt these models in New York State.
    a. How many demonstration projects were held for new and underused business models?
    b. Did local market actors gain increased awareness of those business models as a result of NYSERDA activities?
    c. Were those business models adopted by other market actors in New York State?
        i. What was the total valuation of companies or company divisions using those business models?
    d. Did those business models offer customers PV systems at a lower overall cost?

6. If NYSERDA supports the development and demonstration of new and underused financing models, local market actors will voluntarily adopt these models.
    a. How many demonstration projects were held for new and underused financing models?
    b. Did local market actors gain increased awareness of those financing models as a result of NYSERDA activities?
    c. Were those financing models adopted by other market actors in New York State?
    d. Did those financing models unlock new sources of capital for solar PV installations?
        i. What was the total amount of additional investment secured through those financing models?
    e. Did those financing models result in lower financing costs for solar PV installations?

7. If NYSERDA supports demonstrations of commercial-ready BOS hardware products, local market actors will become aware of and increasingly accept these products.
    a. How many demonstration projects were held for commercial-ready BOS hardware products?
    b. Did local market actors gain increased awareness of the supported BOS hardware products as a result of the demonstration projects?
    c. Did local market actors increasingly accept these new BOS hardware products as superior alternatives to existing BOS hardware products?
    d. Did the supported BOS hardware products realize commercial sales?
        i. What was the total value of commercial sales of supported BOS hardware products?
    e. Were additional investments secured for the companies producing the supported BOS hardware products?
        i. What was the total value of the additional investments in companies producing the supported BOS hardware products?
    f. Did the supported BOS hardware products reduce the overall cost of PV systems?

8. If NYSERDA provides supplemental funding for BOS technology development, those technologies will move toward commercial readiness, and some will realize commercial sales.
    a. How many emergent BOS technologies received support through the SCR program?
    b. Did supported BOS technologies advance to later phases in the technology development process as a result of NYSERDA support?
    c. Did supported BOS technologies realize commercial sales?
        i. What was the total value of commercial sales of supported BOS technologies?
    d. Were useful lessons learned from supported BOS technologies that did not realize commercial sales?
    e. Were additional investments secured for the companies using the successful BOS technologies?
    f. Did the successful BOS technologies reduce the overall cost of PV systems?

9. Additional support and coordination from NYSERDA program staff will improve the implementation of funded projects.
    a. Did funded projects receive troubleshooting and other forms of support from NYSERDA program staff?
    b. How useful did funding recipients find this support from NYSERDA?
    c. Was the SCR program able to avoid duplication of effort among funding recipients?
    d. Did the troubleshooting and other forms of support from NYSERDA program staff result in identifiable improvements in project implementation?

10. Funded projects will catalyze changes in the market for solar PV systems which are sustained beyond the duration of the SCR program.
    a. Did reductions in various BOS cost components (e.g., financing costs; customer acquisition costs and other transaction costs; permitting, installation, and inspection costs) extend beyond individual funded projects to the larger New York State market?
    b. Did reductions in various BOS cost components endure after the end of the SCR program?

8 External Influences on Program Outcomes

This section describes the factors external to the Solar Cost Reduction program that NYSERDA has no direct influence over that may affect program outcomes.

Market for PV hardware components: The global market for module and non-module PV hardware components has had a considerable influence on overall PV system prices in recent years. The emergence of additional hardware suppliers, such as the dramatic expansion of Chinese module manufacturers between 2006 and 2012, could reduce the price of PV systems. Conversely, shortages of key commodities, like the shortage of polysilicon between 2004 and 2008, could raise the price of PV systems.[12]

Fossil fuel prices: The attractiveness of solar PV systems depends in large part on the cost of electricity from other sources, such as natural gas and coal. Because natural gas currently provides almost half of New York's electricity, its price will be especially relevant in determining the state's overall electricity generation profile over the long run.[13]

Overlapping or complementary programs: Other national and state-level programs seek to reduce BOS costs or pursue other goals with potential implications for BOS costs. The U.S. Department of Energy's SunShot Initiative seeks to reduce the cost of solar PV systems by 75 percent between 2010 and 2020. This will require reducing BOS costs by 72 percent for residential systems, 74 percent for commercial systems, and 80 percent for utility systems.[14] Within New York, NYSERDA's solar deployment programs, workforce training and development, permitting initiatives, and outreach activities have direct implications for BOS costs and the market penetration of solar PV. Workforce development initiatives affiliated with NY-Sun, for example, include technical and more general training for local officials involved in permitting and inspection processes for PV systems. Nonetheless, IEc anticipates that the overlap between SCR and other New York-specific solar programs will be limited in scope. As a result, IEc believes that evaluation of the SCR program will be able to account for the influence of these other programs when attributing impacts to SCR.

12 Alan Goodrich, Ted James, and Michael Woodhouse, "Solar PV Manufacturing Cost Analysis: U.S. Competitiveness in a Global Industry," National Renewable Energy Laboratory, October 10, 2011, and Ucilia Wang, "Polysilicon Prices Head for a Steep Fall," Greentech Media, November 13, 2008, accessed May 15, 2014, http://www.greentechmedia.com/articles/read/polysilicon-prices-head-for-a-steep-fall-5174.

13 U.S. Energy Information Administration, "State Electricity Profiles: New York Electricity Profile 2012," released May 1, 2014, http://www.eia.gov/electricity/state/newyork/index.cfm.

14 "SunShot Vision Study," page 86.

Private sector initiatives: Private sector efforts to establish competitive advantage in the PV industry may result in reduced BOS costs. Google, for example, has offered a $1 million prize for the development of a smaller and lower cost inverter.[15] Other companies such as Mosaic and Clean Energy Collective have sought to develop new business and financing models that reduce customer acquisition and contracting costs for widespread PV deployment.[16]

Federal and state energy policies: Residential and commercial PV systems receive federal government support through the Investment Tax Credit (ITC). Commercial PV systems can also benefit from the IRS's Modified Accelerated Cost Recovery System (MACRS). Within New York, solar installations receive further support through state tax credits; sales and property tax exemptions; loan programs; and net metering, among other initiatives. The expiration of any of these policies, several of which are slated to occur in the near term, could stunt the development of the solar PV industry. Even further, additional uncertainties surrounding the duration of these policies would create a higher-risk climate for financiers and developers, who would not be able to engage in adequate long-term planning.

Solar deployment outside New York State: Increased deployment of solar PV outside New York has the potential to affect the market within New York, as lessons learned, best practices identified, and new products developed elsewhere could be later applied to a New York-specific context.

Macroeconomic shifts: Both short-run and long-run economic trends may affect the development of the solar PV industry in New York State, influencing rates of capital investment, interest, employment, and overall economic growth, as well as levels of government resources.

15 Tim Worstall, "Google's Little Box Challenge; A $1 Million Prize for Creating a Better, Smaller, Solar Power Inverter," Forbes, May 10, 2014, accessed May 16, 2014, http://www.forbes.com/sites/timworstall/2014/05/10/googles-little-box-challenge-a-1-million-prize-for-creating-a-better-smaller-solar-power-inverter.

16 Peter Kelly-Detwiler, "Clean Energy Collective's Goal: Bring Mass Financing to Solar, One Panel at a Time," Forbes, May 15, 2014, accessed May 16, 2014, http://www.forbes.com/sites/peterdetwiler/2014/05/15/clean-energy-collectives-goal-bring-mass-financing-to-solar-one-panel-at-a-time.

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