

New York State Energy Research and Development Authority

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# NYSERDA

## Renewable Portfolio Standard Main Tier 2013 Program Review

Volume 1 — Program Review Introduction

Final Report

September 5, 2013



# NYSERDA's Promise to New Yorkers:

NYSERDA provides resources, expertise and objective information so New Yorkers can make confident, informed energy decisions.

**Our Mission:** Advance innovative energy solutions in ways that improve New York's economy and environment.

**Our Vision:** Serve as a catalyst—advancing energy innovation and technology, transforming New York's economy, empowering people to choose clean and efficient energy as part of their everyday lives.

**Our Core Values:** Objectivity, integrity, public service, partnership and innovation.

## Our Portfolios

NYSERDA programs are organized into five portfolios, each representing a complementary group of offerings with common areas of energy-related focus and objectives.

### Energy Efficiency and Renewable Energy Deployment

Helping New York to achieve its aggressive energy efficiency and renewable energy goals – including programs to motivate increased efficiency in energy consumption by consumers (residential, commercial, municipal, institutional, industrial, and transportation), to increase production by renewable power suppliers, to support market transformation and to provide financing.

### Energy Technology Innovation and Business Development

Helping to stimulate a vibrant innovation ecosystem and a clean-energy economy in New York – including programs to support product research, development, and demonstrations; clean-energy business development; and the knowledge-based community at the Saratoga Technology + Energy Park®.

### Energy Education and Workforce Development

Helping to build a generation of New Yorkers ready to lead and work in a clean energy economy – including consumer behavior, youth education, workforce development and training programs for existing and emerging technologies.

### Energy and the Environment

Helping to assess and mitigate the environmental impacts of energy production and use – including environmental research and development, regional initiatives to improve environmental sustainability and West Valley Site Management.

### Energy Data, Planning and Policy

Helping to ensure that policy-makers and consumers have objective and reliable information to make informed energy decisions – including State Energy Planning; policy analysis to support the Regional Greenhouse Gas Initiative, and other energy initiatives; emergency preparedness; and a range of energy data reporting, including *Patterns and Trends*.

**NYSERDA**  
**Renewable Portfolio Standard**  
**Main Tier 2013 Program Review**

**Volume 1**  
**Program Review Introduction**

*Final Report*

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**New York State Energy Research and Development Authority**  
Albany, NY

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# Table of Contents

**Executive Summary ..... ES-1**

**1 Introduction ..... 1**

1.1 Establishment of the New York State’s RPS ..... 1

1.2 Tiered Approach to Implementing the RPS ..... 2

1.3 Treatment of Existing Renewable Resources ..... 3

1.4 2009 RPS Review ..... 3

**2 Intervening Orders and Activities..... 5**

**3 Main Tier Program Review Approach ..... 9**

3.1 RPS Program Objectives ..... 9

3.2 Scope of Program Evaluation ..... 9

3.3 Market and Policy Context ..... 11

3.3.1 Market Impacts..... 11

3.3.2 Policy Context ..... 11

**4 Progress and Results ..... 12**

4.1 NYSERDA Progress ..... 12

4.2 Main Tier Progress..... 12

4.3 Wind Power Capacity Additions to New York State..... 14

4.4 Weighted Average Award Price Trends ..... 15

4.5 Performance-Related Contract Adjustments ..... 16

4.6 RPS Program Funding ..... 17

**5 Methodology ..... 20**

5.1 Introduction..... 20

5.2 Direct Investment in New York..... 21

5.3 Electricity System Impacts ..... 23

5.4 Key Assumptions for RPS Modeling Cases..... 25

5.5 Environmental Impacts..... 25

5.5.1 Air Emissions Impacts ..... 25

5.5.2 Fossil Fuel Use Impacts..... 27

5.6 Benefit-Cost Analysis ..... 27

5.6.1 Required Premium ..... 30

5.6.2 Net Electricity Ratepayer Impact..... 30

5.6.3 Statewide Benefit-Cost..... 31

5.6.4	Study Period and Calculation of Net Present Value .....	32
5.7	Macroeconomic Analysis .....	32
5.7.1	Overview of REMI PI+ Model.....	32
5.7.2	Impact Analysis Model .....	33
5.7.3	General Assumptions Used for the REMI Analysis.....	34
5.8	Main Tier Cost Study.....	36
5.8.1	Supply Curve.....	36
5.8.2	Commodity Price Forecast Assumptions .....	38
5.8.3	Federal Production Tax Credit .....	39
5.8.4	Decreased Wind Levelized Costs due to Technology Improvement .....	42
5.8.5	Combined Wind and PTC Cases .....	42
5.8.6	Cumulative Onshore Wind Resources.....	42
<b>Appendix A. Active Main Tier Facilities as of December 31, 2012.....</b>		<b>A-1</b>

## List of Figures

---

Figure 1. Main Tier and Maintenance Resources, December 31, 2012 .....	14
Figure 2. Wind Power Capacity Additions to New York by Year .....	15
Figure 3. Average Main Tier Weighted Bid Price Trends .....	16
Figure 4.. RPS Program Budget through 2024 (in millions) as of December 31, 2012.....	18
Figure 5. RPS Program Expenses through December 31, 2012 (in millions) .....	19
Figure 6. Key Inputs and Outputs of IPM <sup>®</sup> .....	23
Figure 7. Identifying Annual Economic Impacts with a REMI Model (Source: Regional Economic Modeling, Inc.).....	33
Figure 8. New York Grouped Zones .....	39

## List of Tables

---

Table 1. NYSERDA 2015 RPS Energy Targets (MWh).....	4
Table 2. Intervening Orders and Activities .....	6
Table 3. NYSERDA 2015 RPS Procurements and Energy Targets (in MWh) and Progress as of December 31, 2012.....	12
Table 4. Project Development Status for Contracted Main Tier Projects as of December 31, 2012.....	13
Table 5. Benefit and Cost Perspectives .....	28
Table 6. PTC Cases (Percent of Current Level) .....	40
Table 7. Base Case Financing Assumptions .....	41
Table 8. PTC Phase-out Financing Assumptions .....	41

# Executive Summary

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The Renewable Portfolio Standard (RPS), established by the New York State Public Service Commission (Commission or PSC) and administered by the New York State Energy Research and Development Authority (NYSERDA), has been the State's primary policy initiative to promote the development of new renewable energy resources since it was established in 2004.<sup>1</sup> In accordance with Commission directives with respect to a 2013 review and in cooperation with staff of the Department of Public Service, NYSEDA has developed a series of reports to assist the Commission in assessing the RPS program in its entirety.<sup>2</sup>

## Focus and Approach

Many areas of the program were extensively considered in the 2009 Program Evaluation Report<sup>3</sup> and addressed through subsequent Commission Orders. As noted in Section 2, these activities have subsequently impacted the scope and emphasis of the review for 2013. Therefore, the 2013 Main Tier Program Review report focuses on:

- Main Tier status;
- Main Tier direct economic impacts;
- Main Tier benefit/cost analyses;
- Main Tier macroeconomic effects; and
- Future Main Tier resource availability and costs.

The filing of this report as well as potential future reports will comply with the given directives to help the Commission assess the Program's contributions, and to shed light on how best to continue the State's public investment in the achievement of the RPS Program goals.

## Program Progress

NYSERDA has conducted seven competitive Main Tier solicitations and is in the process of conducting an eighth Main Tier solicitation in pursuit of the Main Tier target. Renewable energy production under executed or pending Main Tier contracts is expected to be 4.49 million MWh in 2015, corresponding to 47% of the Main Tier target.<sup>4</sup>

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<sup>1</sup> *Proceeding on Motion of the Commission Regarding a Retail Renewable Portfolio Standard*, "Order Regarding Retail Renewable Portfolio Standard;" issued and effective September 24, 2004.

<sup>2</sup> *Proceeding on Motion of the Commission Regarding a Retail Renewable Portfolio Standard*, "Order Establishing New RPS Goal and Resolving Main Tier Issues;" issued and effective January 8, 2010.

<sup>3</sup> NYSEDA, *New York State Renewable Portfolio Standard Evaluation Report: 2009 Review* (Evaluation Report). The Evaluation Report relied on the reports of two NYSEDA contractors: KEMA, *New York Main Tier RPS: Impact and Process Evaluation* (March 2009) and Summit Blue Consulting, *New York State Renewable Portfolio Standard: Market Conditions Assessment—Final Report* (February 19, 2009).

<sup>4</sup> NYSEDA counts toward the MWh program targets only the portion of a project's output or potential output that is under contract. Contract quantities are as of December 31, 2012 including any prior adjustments to contract quantities from those facilities that have underperformed.

Approximately \$876.6 million, or roughly 38% of the total approved RPS Main Tier funding has been expended or committed to achieving the 2015 Main Tier target.

## Current Portfolio Analysis

The Current Portfolio<sup>5</sup> analysis evaluates the impact of the renewable energy generation sources that have been successful in bidding into NYSERDA's Main Tier RFPs through December 31, 2012. This analysis accounts for the associated cost of Main Tier procurements to ratepayers, assesses the associated direct investments made in New York State, and models the impact of Main Tier renewable energy generation resources on the New York wholesale electric system. This analysis also includes an assessment of the environmental benefits resulting from the displacement of conventional generation, including avoided fossil fuel use and reduced emissions. Together, this information provides an assessment of the direct benefits and costs of the Main Tier program. However, changes in costs and spending as a result of the program will impact New York State's economy beyond these direct effects. Therefore, this Evaluation of the Main Tier also includes an analysis of the statewide macroeconomic impacts on New York, including changes in employment.

The retrospective analysis of the Current Portfolio of NYSERDA Main Tier contracts consists of the following analytical components:

- **Direct Cost:** Actual Main Tier expenditures to date associated with the Current Portfolio and two Maintenance Resource projects, and an extrapolation of expected expenditures through the end of those contract's durations.
- **Direct Investment:** The reported and verified direct expenditures in New York by renewable electricity generators under contract to NYSERDA, the projection of these expenditures for the full output and expected life of each project, and the extrapolation of expenditures to the remaining projects with Main Tier contracts.
- **Electric System Impacts and Environmental Impacts:** Past electric system impacts attributable to the supported renewable electricity generators as modeled relative to a base case with no RPS policy investment, and projected impacts resulting from continued operation of these generators.
- **Benefits and Costs:** The various costs and benefits estimated in the components above are compiled into a summation of direct costs and direct benefits, leading to the calculation of a benefit cost ratio.
- **Macroeconomic Analysis:** Impacts and changes to jobs in New York – positive and negative – resulting from the costs and benefits as estimated using a macroeconomic model representation of the New York economy.

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<sup>5</sup> "Current Portfolio" refers to projects with Main Tier RPS contracts as of December 31, 2012 and also includes four projects with Main Tier contracts which expired prior to December 31, 2012.

## Future Main Tier Resource Availability And Costs

The cost study work uses a model of the New York State renewable electricity generation supply curve, electric energy and capacity price forecasts derived in the State Energy Plan (“Plan”), and the projected Main Tier RPS procurement budget for a given scenario to estimate the least-cost mix of renewable resources procured and corresponding renewable premiums for each year in the study period. The supply curve model was developed by Sustainable Energy Advantage, LLC and La Capra Associates for New York renewable energy policy cost study analysis,<sup>6</sup> and is maintained and updated by La Capra Associates. The model has been used in previous analyses of RPS program compliance costs, but key modeling assumptions have been updated for this effort.

The cost study model compares the annual incremental budget with the incremental available undeveloped supply, sorted from least to highest renewable generation cost. The intersection of incremental supply and incremental demand (i.e. annual RPS procurement and budget) establishes the choice of resource and associated market clearing price. This market clearing price, in dollars per megawatt-hour, represents the projected cost of all renewable attributes<sup>7</sup> to be procured. Although to date the RPS Main Tier RPS solicitations have been applied on an as-bid rather than clearing price auction, the approach used assumed that over time, bid prices will tend to converge towards the clearing price with increased market experience, liquidity and transparency.

## Structure Of The Report

Volume 1 is a companion piece to Volume 2 and Volume 3 of the overall RPS Main Tier Program Review.<sup>8</sup> This volume provides an overview of the RPS Policy and Orders, a summary of the Program Review approach, a status update on what has been accomplished as of December 31, 2012, and a review of the methods that were used to perform the analysis presented in subsequent volumes.

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<sup>6</sup> Grace, Robert C. K. Cory and D. Smith, *Cost Estimate of N.Y. Executive Order 111 Renewable Energy Purchase Provisions*, for New York State Energy Research & Development Authority, October 2001.

<sup>7</sup> The terms renewable attributes, RPS Attributes (the term used in the RPS Main Tier solicitations), and renewable energy certificates or credits (RECs) are used interchangeably throughout this report.

<sup>8</sup> Volume 2 presents an evaluation of all RPS Main Tier projects under contract or with closed contracts as of December 31, 2012. Volume 3 presents an analysis of new renewable resources that could be procured under future Main Tier solicitations by expending the remaining authorized but uncommitted funds.



# 1 Introduction

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## 1.1 Establishment of the New York State's RPS

Recognizing the need for a proactive approach to the State's energy and environmental challenges, in February 2003, the Public Service Commission initiated a proceeding to explore the development of a Renewable Portfolio Standard (RPS). On September 24, 2004, following an extensive stakeholder process, the Commission issued an Order adopting an RPS as the primary policy to move the State toward a newly-established goal of increasing the proportion of renewable energy used by New York State consumers from the then-current 19.3% (baseline resources) to at least 25% by the end of 2013.<sup>9</sup>

As part of the September 24, 2004 Order, the Commission designated NYSERDA as the central procurement administrator for the RPS Program. In doing so, the Commission noted an expectation that voluntary renewable purchases by retail customers (the "Voluntary Market") would contribute at least 1% toward the 25% goal, thus leaving baseline resources, State Agencies' purchases under Executive Order 111 (EO 111), and NYSERDA RPS procurements to realize the remaining 24%. In the same Order, the Commission directed the major investor-owned utilities to collect funds from ratepayers to be administered by NYSERDA for the purpose of supporting NYSERDA's implementation responsibilities.

In most other states with RPS programs, the renewable energy percentage target is implemented by requiring the load serving entities to supply their customers with a certain percentage of electricity from eligible renewable sources. However, New York's RPS uses a central procurement model, with NYSERDA as the central procurement administrator. NYSERDA does not procure renewable electricity directly; rather, NYSERDA pays a production incentive to renewable electricity generators selected through competitive solicitations for a percentage of the generator's electricity which is delivered for end use in New York State. In exchange for receiving the production incentive, the renewable generator transfers to NYSERDA all rights and/or claims to the RPS Attributes<sup>10</sup> associated with the contracted percentage of the megawatt-hour (MWh) of renewable electricity generated, and guarantees delivery of the associated electricity to New York State ratepayers. For all RPS Main Tier Facilities, the electricity associated with the RPS Attributes must meet one of the three following conditions:

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<sup>9</sup> *Proceeding on Motion of the Commission Regarding a Retail Renewable Portfolio Standard*, "Order Regarding Retail Renewable Portfolio Standard," issued and effective September 24, 2004.

<sup>10</sup> "RPS Attributes" include any and all reductions in harmful pollutants and emissions, such as carbon dioxide and oxides of sulfur and nitrogen. RPS Attributes are similar to Renewable Energy Certificates that are commonly used in other RPS programs to catalog and recognize environmental attributes of generation.

1. Delivered into a market administered by the NYISO for end-use in New York State.
2. Delivered through a wholesale meter under the control of a utility, public authority or municipal electric company such that it can be measured, and such that consumption within New York State can be tracked and verified by such entity or by the NYISO.
3. Delivered through a dedicated generation meter, which shall be approved by and subject to independent verification by NYSERDA, to a customer in New York State (excluding customers in the service territory of the Long Island Power Authority) whose electricity was obtained through the NYISO/utility system as of January 20, 2011.

By acquiring the RPS Attributes, rather than the associated electricity, the program ensures that increasing amounts of renewable electricity will be injected into the State's power system, while minimizing interference with the State's competitive wholesale power markets.

## 1.2 Tiered Approach to Implementing the RPS

The Commission established two tiers of resource types under the RPS. The Main Tier consists primarily of medium to large-scale electric generation facilities that deliver their electrical output into the wholesale power market administered by the NYISO. Noting the importance of accelerating the development of emerging technologies, because of their environmental benefits, potential for increased future contribution to the resource mix, and ability to be sited in urban, heavily-loaded areas, the Commission also established a separate tier called the Customer-Sited Tier (CST). The CST consists of smaller, "behind-the-meter" resources, such as photovoltaic (PV) systems, fuels cells, wind facilities, anaerobic digester gas, and similar technologies that for the most part produce electricity for use on site. The CST also includes a competitive program (Competitive PV) for larger solar PV installations from 200 kW to 2 MW.

Only renewable energy systems installed on or after January 1, 2003, or previously installed facilities that make improvements to their renewable energy generation that is incremental to historical production levels are eligible to participate in the RPS. The Main Tier and Competitive PV programs operate through the issuance of periodic competitive solicitations; all other CST resources are supported through first-come/first-served open enrollment programs that provide a combination of standard offer incentives for the "buy-down" of capital costs and/or energy production.

Eligible resources and technologies for both the Main Tier and CST are as specified by the Commission.<sup>11</sup> The RPS also includes a process for the evaluation of new resources and technologies for eligibility in the program as it progresses.

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<sup>11</sup> *Proceeding on Motion of the Commission Regarding a Retail Renewable Portfolio Standard*, "Order Approving Implementation Plan, Adopting Clarifications, and Modifying Environmental Disclosure Program," Appendix B, issued and effective April 14, 2005 and; "Order Authorizing Customer-Sited Tier Program Through 2015 and Resolving Geographic Balance and Other Issues Pertaining to the RPS Program," issued and effective April 2, 2010.

### 1.3 Treatment of Existing Renewable Resources

In creating the Program, the Commission recognized that 19.3% of the energy sold at retail in New York State was being generated by renewable resources that existed prior to the RPS being adopted in 2004 (baseline resources). For the purpose of ensuring the continuing operation of these valuable existing resources, the Commission's September 24, 2004 Order established an additional Maintenance Resource program.<sup>12</sup> To be eligible to receive RPS program funding as a Maintenance Resource, a baseline resource is required to demonstrate financial hardship through a formal request to the Commission. The Commission then determines the existence and degree of hardship and makes a determination as to the eligibility of the facility for Maintenance Resource treatment. The Commission may or may not grant Maintenance Resource status. If this status is granted, the Commission determines the form and magnitude of financial support to be offered.

### 1.4 2009 RPS Review

The 2005 Implementation Order<sup>13</sup> required NYSERDA to conduct an evaluation reviews of the RPS program; one mid-course review in 2009 and one at the then-conclusion of the program in 2013.

In anticipation of the 2009 review, NYSERDA prepared and submitted an Evaluation Report.<sup>14</sup> DPS Staff also issued its own report to the Commission for reconsideration of the RPS Program.<sup>15</sup> Two technical conferences were held by the Commission to explore issues raised by DPS Staff.

In concluding the mid-course review of the RPS program, in early 2010, the Commission issued a series of Orders.<sup>16</sup> Therein, the Commission:

- Expanded the RPS goal to increase the proportion of renewable electricity consumed by New York customers from 25 to 30%.
- Extended the terminal year of the program from 2013 to 2015, established new CST program targets.
- Authorized new CST programs.
- Established the scope and cost of the administration of the RPS program.
- Reaffirmed NYSERDA's role as central procurement authority.

<sup>12</sup> *Proceeding on Motion of the Commission Regarding a Retail Renewable Portfolio Standard*, "Order Regarding Retail Renewable Portfolio Standard;" issued and effective September 24, 2004.

<sup>13</sup> *Proceeding on Motion of the Commission Regarding a Retail Renewable Portfolio Standard*, "Order Approving Implementation Plan, Adopting Clarifications, and Modifying Environmental Disclosure Program;" issued and effective April 14, 2005.

<sup>14</sup> NYSERDA. February 19, 2009. *New York State Renewable Portfolio Standard Evaluation Report: 2009 Review* (Evaluation Report). The Evaluation Report relied on the reports of two NYSERDA contractors: KEMA, *New York Main Tier RPS: Impact and Process Evaluation* (March 2009) and Summit Blue Consulting, *New York State Renewable Portfolio Standard: Market Conditions Assessment—Final Report*.

<sup>15</sup> New York State Department of Public Service. October 26, 2009. *The Renewable Portfolio Standard: Mid Course Report*.

<sup>16</sup> *Proceeding on Motion of the Commission Regarding a Retail Renewable Portfolio Standard* "Order Establishing New RPS Goal and Resolving Main Tier Issues;" issued and effective January 8, 2010, "Order Authorizing Customer-Sited Tier Program Through 2015 and Resolving Geographic Balance and Other Issues Pertaining to the RPS, issued and effective April 2, 2010;" and "Order Resolving Main Tier Issues;" issued and effective April 2, 2010.

- Provided for augmented and extended collection of funds from electric delivery customers to fully achieve New York’s 2015 targets Renewable Energy Targets.
- Required an evaluation of the Main Tier to be conducted in 2013.

In establishing MWh for the year 2015 renewable energy targets, the Commission assumed:

- A reduction in electricity consumption due to energy efficiency efforts, including those supported by the Commission-established Energy Efficiency Portfolio Standard program, by 15% over a business-as-usual growth forecast for the year 2015.
- Past and anticipated renewable electricity purchases made through a variety of initiatives. Executive Order 111, Voluntary Market activity, and Long Island Power Authority contributions
- Continued generation of energy from baseline generation sources.

The current NYSERDA RPS program annual, established by the Commission’s April 2, 2010 Order, for the combined Main Tier and Customer-Sited Tier, is approximately 10.4 million MWh in year 2015.<sup>17</sup> In response to an April 24, 2012 Commission Order, NYSERDA published the 2012 -2015 Customer-Sited Tier Program Operating Plan (Plan) on June 29, 2012, which revised the Customer-Sited Tier targets based on increased funding allocations for some programs.<sup>18</sup> The Plan set forth the program goals and implementation strategies for the Customer-Sited Tier program for 2012 through 2015. Including these changes, the combined NYSERDA RPS target consists of approximately 9.5 million MWh from the Main Tier and 0.9 million MWh from the Customer-Sited Tier. These targets are depicted in Table 1. NYSERDA 2015 RPS Energy Targets (MWh).

**Table 1. NYSERDA 2015 RPS Energy Targets (MWh)**

<b>Program</b>	<b>Target</b>
Customer-Sited Tier	878,089
Main Tier	9,519,765
<b>Total</b>	<b>10,397,854</b>

<sup>17</sup> *Proceeding on Motion of the Commission Regarding a Retail Renewable Portfolio Standard*, “Order Authorizing Customer-Sited Tier Program through 2015 and Resolving Geographic Balance and Other Issues Pertaining the RPS Program;” issued and effective April 2, 2010.

<sup>18</sup> *Proceeding on Motion of the Commission Regarding a Retail Renewable Portfolio Standard*, Renewable Portfolio Standard Customer-Sited Tier Program Operating Plan (2012-2015), filed June 29, 2012.  
<http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={A6A2772B-310C-47A2-B5F9-25FFBCAC6660}>

## 2 Intervening Orders and Activities

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Some issues specified in the 2005 RPS Implementation Order for analysis, evaluation and review in 2013 were subsequently addressed or superseded, fully or partially, in a series of Commission Orders and other activities between 2005 and 2012, or were resolved through the 2009 Program Evaluation. Collectively, these Orders and activities modified the scope and emphasis of the 2013 evaluation review. This section is intended to provide context on the Orders, reports and other activities that affected the scope or direction of the 2013 evaluation review. A list of Orders and activities following the 2009 Program Evaluation is provided in Table 2.

**Table 2. Intervening Orders and Activities**

Orders and Activities	Date	Description
PSC 2009 Mid-Course Report	September 2009	This report provided a review of the current status of the program, including a review of the NYSERDA Evaluation Report, and presented the Staff's proposals for the RPS Program going forward.
PSC Order Authorizing an Additional Main Tier Solicitation and Setting Solicitation Guidelines	August 2009	This order allowed an additional solicitation to enable generation facility developers to leverage funds temporarily available in federal grants under the American Recovery and Reinvestment Act of 2009 (ARRA).
PSC Order Establishing New RPS Goal and Resolving Main Tier Issues (Order also specifies 2013 Program Review Requirements)	January 2010	This order adopted a goal of 30% renewable energy by 2015 and set MWh program targets. It also authorized an additional Main Tier solicitation of \$200 million, consistent with the results of a previous solicitation and the MWh trajectory needed to meet the revised goal.
PSC Order Addressing the Scope and Cost of Administration of the RPS program, and the Collection of Costs from Utility Customers.	April 2010	The order modified collections for 2010-2013 to meet the expectations of the revised RPS program following the program review. This order stated that the PSC estimated that the schedule of collections approved was sufficient to support through 2024 current Main Tier contract and maintenance contract costs, future Main Tier contract costs, current and future Customer-Sited Tier costs including the Geographic Balance component, and the costs of administration and program evaluation by NYSERDA for the Main Tier and Customer-Sited Tier, including the payment by NYSERDA of the New York State Cost Recovery Fee.

PSC Order Clarifying NYSDERDA Main Tier RPS Target and Resolving Main Tier Eligibility Issues	April 2010	This order addressed a number of issues regarding the Main Tier arising out of the 2009 Review of the RPS program. It dictated which technologies were eligible, reserved the right to revise the vintage date, clarified that projects can only be in contract for a total of 10 years, and denies some suggestions that arose as part of the program review, such as a proposal to include waste-to-energy.
NYSDERDA Files 2010 CST Operating Plan Setting Forth Revised Program Specification Budgets and Targets	June 2010	Revised the CST budgets and targets.
PSC Order Regarding Acceptance of Permanent Tariff Levels for RPS Collections	October 2010	In response to April 2010 order authorizing the CST through 2015 and resolving other RPS issues, the Commission directed the Utilities to file tariff amendments and/or statements incorporating the revisions and increasing collections of RPS costs described in the April 2010 Order, to become effective on a temporary basis on July 1, 2010. This order allows the tariff amendments to become effective on a permanent basis.
PSC Order Allowing Main Tier "Behind The Meter" Contracts and Wholesale Delivery to Utility/Municipal Utility/Public Authority Entities, Applicable to Future Solicitations Only	November 2010	The Commission modified the Main Tier eligibility rules to allow certain "behind-the-meter" bilateral energy contracts or installations to qualify for RPS incentives, and to allow the energy in previously allowed bilateral contracts to be delivered through a wholesale meter under the control of a utility, public authority or municipal electric company such that it can be measured, and such that consumption within New York State can be tracked and verified by one of those entities instead of the New York Independent System Operator (NYISO), or along with the NYISO.

<p>PSC Order Authorizing Additional Main Tier Solicitation and Setting Future Guidelines for NYSERDA to conduct Solicitations at least annually</p>	<p>December 2010</p>	<p>The PSC authorized an additional Main Tier solicitation and provided guidance in issuing future Main Tier solicitations. Guidance included that NYSERDA was authorized to conduct future Main Tier solicitations, without Commission approval, for RPS Main Tier resources, after consultation with Staff and approval by the OEEE Director prior to each solicitation. Future contract awards were directed to be for a 10-year term. The contracts with fuel-based renewable energy generators were directed to have an escape clause actionable every two and one-half years so that the generator is able to drop out of the program if unable to secure a continuous fuel supply at a price that supports its contract with NYSERDA. Additionally, winning bid criteria was maintained as a weighted combined score with price comprising 70% and economic benefits at 30%. As before, only renewable generation facilities that commence commercial operation on or after January 1, 2003 are eligible to bid.</p>
<p>NYSERDA issues Biomass Power Guide</p>	<p>May 2011</p>	<p>This document was prepared to offer guidance to prospective biomass power project developers on requirements for the eligibility of biomass-based projects to participate in the RPS Program.</p>



## 3 Main Tier Program Review Approach

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### 3.1 RPS Program Objectives

A September 2004 Commission Order<sup>19</sup> specified RPS Program Objectives that were used to guide the development of the RPS Program. The Program Objectives are listed in priority order below as they appear in the 2004 Order:

1. **Renewable Resources:** institute an RPS to increase New York State's supply of renewable resources with the ultimate aim of establishing a viable, self-sustaining competitive renewable generation market.
2. **Generation Diversity for Security and Independence:** diversify the generation resource mix of energy retailed in New York State to improve energy security and independence, while ensuring protection of system reliability.
3. **Economic Benefits:** develop renewable resources and advance renewable resource technologies in, and attract renewable resource generators, manufacturers, and installers to New York State.
4. **New York's Environment:** improve New York's environment by reducing air emissions, including greenhouse gas emissions, and other adverse environmental impacts on State, including upon underserved communities, of electricity generation.
5. **Equity and Economic Efficiency:** develop an economically efficient RPS requirement that minimizes adverse impacts on energy costs, allocates costs equitably among ratepayers, and affords opportunities for recovery of utility investment.
6. **Administrative Fairness and Efficiency:** develop an RPS that is administratively transparent, efficient, and verifiable; and
7. **Competitive Neutrality:** develop an RPS compatible with competition in energy markets in New York State.

### 3.2 Scope of Program Evaluation

The Commission's January 8, 2010 Order<sup>20</sup> revising the RPS goals and targets further instructed that the RPS program be reviewed in 2013. In accordance with Commission directives with respect to a 2013 review and in cooperation with staff of the Department of Public Service, NYSERDA has developed a series of reports to assist the Commission in assessing the RPS program in its entirety.<sup>21</sup> This evaluation report is intended to assist the

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<sup>19</sup> *Proceeding on Motion of the Commission Regarding a Retail Renewable Portfolio Standard*, "Order Regarding Retail Renewable Portfolio Standard;" issued and effective September 24, 2004.

<sup>20</sup> *Proceeding on Motion of the Commission Regarding a Retail Renewable Portfolio Standard*, "Order Establishing New RPS Goal and Resolving Main Tier Issues;" issued and effective January 8, 2010.

<sup>21</sup> *Proceeding on Motion of the Commission Regarding a Retail Renewable Portfolio Standard*, "Order Establishing New RPS Goal and Resolving Main Tier Issues;" issued and effective January 8, 2010.

Commission in assessing the Main Tier RPS Program's progress toward meeting its goals and objectives, provide information to assess the various impacts of the program, and to provide input on how to best continue the State's investment in clean energy.

Many areas of the program were extensively considered in the 2009 Program Evaluation Report<sup>22</sup> and addressed through subsequent Commission Orders. As noted in Section 2, these activities have subsequently impacted the scope and emphasis of the evaluation review for 2013. Therefore, the 2013 Main Tier Evaluation focuses on:

- Main Tier status.
- Main Tier direct investment impacts in New York State.
- Main Tier benefit/cost analyses.
- Main Tier macroeconomic effects.
- Future Main Tier resource availability and costs.

Subsequent volumes of the Main Tier Program Review Reports will assess the impacts of the Current Portfolio of Main Tier projects previously awarded funding through the New York State RPS Program as well as project program achievement associated with the use of currently uncommitted Main Tier funds. This report as well as potential future reports will comply with the given directives to help the Commission assess the Program's contributions, and to shed light on how best to continue the State's public investment in the achievement of the RPS Program goals.

In compliance with the referenced Commission Orders, this report was prepared by NYSERDA and a team of contractors in cooperation with Department of Public Service Staff. In December 2010, through Request for Proposals (RFP) 2087, NYSERDA competitively procured the services of consulting firms in eight different support areas including those with expertise in the evaluation of renewable energy programs to provide technical and analytical support for documenting the results and impacts of the RPS Program and future resource costs and availability. Through this process Sustainable Energy Advantage, LLC and its subcontractors, La Capra Associates and Economic Development Research Group, as well as ICF International, were selected to conduct program analyses including macroeconomic benefits and benefit/cost analyses.

This report presents key findings provided by NYSERDA and contractors ICF International, Sustainable Energy Advantage, LLC, and its subcontractors La Capra Associates and Economic Development Research Group. The findings are intended to provide input to the Commission on the RPS Program's progress and future opportunities to help inform program and policy decision making.

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<sup>22</sup> NYSERDA, *New York State Renewable Portfolio Standard Evaluation Report: 2009 Review* (Evaluation Report). The Evaluation Report relied on the reports of two NYSERDA contractors: KEMA, *New York Main Tier RPS: Impact and Process Evaluation* (March 2009) and Summit Blue Consulting, *New York State Renewable Portfolio Standard: Market Conditions Assessment—Final Report* (February 19, 2009).

## **3.3 Market and Policy Context**

### **3.3.1 Market Impacts**

Market conditions in 2013 continue to evolve from those present in 2004 when the RPS Program was designed and in 2009 during the mid-course review. Passage of the Article X Siting Law is expected to provide more surety to developers with respect to public participation and permitting process, but permitting wind facilities in New York State will remain challenging as projects continue to enter service.

The decline in the price of natural gas during the reporting period and the current market outlook for forward natural gas prices has the effect of reducing future expectations for power prices in the competitive wholesale power market. This development was likely a dominant factor in the recent increase in the price of RPS Attributes, and is expected to reduce the quantity of RPS Attributes that can be purchased with the available Main Tier budget.

From a technology perspective, considerable learning and development has occurred in the renewable industry in recent years. Specific to wind energy, the industry's development and adoption of taller towers that reach stronger wind resources, longer blades that capture more energy, and other technological improvements designed to increase production in lower wind speed regimes, translate into lower overall cost of wind-generated electricity. This trend is expected to increase wind project revenues from the competitive markets and thereby lower RPS program costs, which will counter the recent upward cost pressures brought about by lower natural gas costs, as well as the potential loss of federal incentives.

### **3.3.2 Policy Context**

The continued lack of stable, long term federal policy continues to affect the development of renewable projects in New York State and across the United States. In the fourth quarter of 2012, the Production Tax Credit (PTC) and Investment Tax Credit (ITC) in lieu of PTC were extended and modified to allow projects to qualify for the credit by commencing construction, rather than commercial operations, by the end of 2013. Although this extension provides short term opportunities in the marketplace, a continued lack of long-term policy incentives remains an impediment to sustained market growth.

## 4 Progress and Results

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### 4.1 NYSERDA Progress

Production of 4.77 million RPS Attributes<sup>23</sup> is expected to result in 2015 from commitments made through December 31, 2012, under both the Main Tier and the Customer-Sited Tier programs. This represents progress of about 46% toward the NYSERDA portion of the RPS target. Current Customer-Sited Tier contracts and accepted applications are anticipated to support the installation of systems capable of producing 287,972 MWh by 2015, representing 33% of the total Customer-Sited Tier portion of the NYSERDA RPS target.<sup>24</sup> Renewable energy production under active Main Tier contracts is expected to be 4.49 million MWh in 2015, corresponding to 47% of the Main Tier target.<sup>25</sup>

**Table 3. NYSERDA 2015 RPS Procurements and Energy Targets (in MWh) and Progress as of December 31, 2012**

Program	Target	Progress <sup>a</sup>	Progress as % of Target
Customer-Sited Tier	878,089	287,972	33%
Main Tier	9,519,765	4,486,656	47%
<b>Total</b>	<b>10,397,854</b>	<b>4,774,628</b>	<b>46%</b>

<sup>a</sup> The achievement of the targets set forth in Table 3 will be measured on the basis of energy production associated with funding that is “encumbered/contracted” or “pending contracting” as of the end of program year 2015.

### 4.2 Main Tier Progress

NYSERDA has conducted seven competitive Main Tier solicitations and is in the process of conducting an eighth Main Tier solicitation in pursuit of the Main Tier target. As of December 31, 2012, through these seven completed solicitations, NYSERDA has entered into existing contracts to procure RPS Attributes from 54 large-scale electricity generation projects, facility upgrades or facility repowering (Current Portfolio). Contracts with four generators ended prior to the end of 2012.<sup>26</sup>

<sup>23</sup> One RPS Attribute is generated by the production of one megawatt-hour (MWh) of energy production from an eligible renewable generator.

<sup>24</sup> The Customer-Sited tier target was increased by more than 40% in 2012 from 625,390 MWh in 2011 to 878,089 MWh, largely as a result of the NY-Sun Initiative.

<sup>25</sup> NYSERDA counts toward the MWh program targets only the portion of a project’s output or potential output that is under contract. Contract quantities are as of December 31, 2012 including any prior adjustments to contract quantities from those facilities that have underperformed.

<sup>26</sup> RFP 916 permitted contract delivery terms of less than 10 years.

When all of the contracted projects reach commercial operation, approximately 1,834 MW of new renewable capacity<sup>27</sup> will be added, of which 1,787 MW will be located in New York State. Wind power is the predominant generating technology in the Main Tier, representing 1,653 MW of new renewable capacity under contract, of which 1,561 MW was in operation at the end of 2012. The balance of new capacity is comprised of hydroelectric upgrades, landfill gas to electricity, and biomass (direct and co-fired) facilities. As of December 31, 2012, 50 projects representing approximately 1,695 MW were operating, with the remaining four projects representing approximately 139 MW expected to be in operation by September 30, 2013. Further details on the status of Main Tier projects are shown in Table 4.

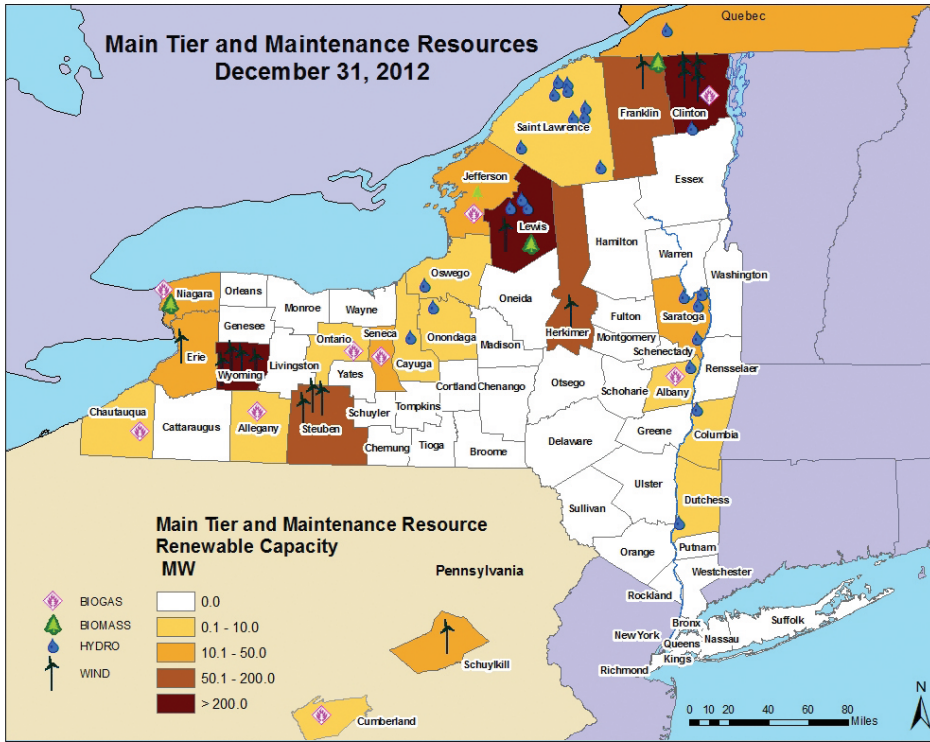
**Table 4. Project Development Status for Contracted Main Tier Projects as of December 31, 2012**

	<b>MW Operating</b>	<b>MW In Development / Construction</b>	<b>Total MW</b>	<b>Number Operating</b>	<b>Number in Development / Construction</b>	<b>Total Number</b>
<b>Wind</b>	1,560.6	92.8	1,653.4	16	1	17
<b>Hydroelectric</b>	48.4	2.9	51.3	23	2	25
<b>Biomass</b>	26.0	43.3	69.3	1	1	2
<b>Biogas</b>	60.1	0	60.1	10	0	10
<b>Totals</b>	<b>1,695.1</b>	<b>138.9</b>	<b>1,834.0</b>	<b>50</b>	<b>4</b>	<b>54</b>

The Main Tier facilities with active RPS contracts are owned by or affiliated with 29 different entities, as shown in Appendix A. A map identifying the location of each Main Tier and Maintenance Resource facility under contract or with NYSERDA can be found in Figure 1.

<sup>27</sup> “New Renewable Capacity” generally refers to the Nameplate Capacity of facilities under contract in the RPS that did not exist prior to the start of the RPS program, including any portion not under contract with NYSERDA.

Figure 1. Main Tier and Maintenance Resources, December 31, 2012

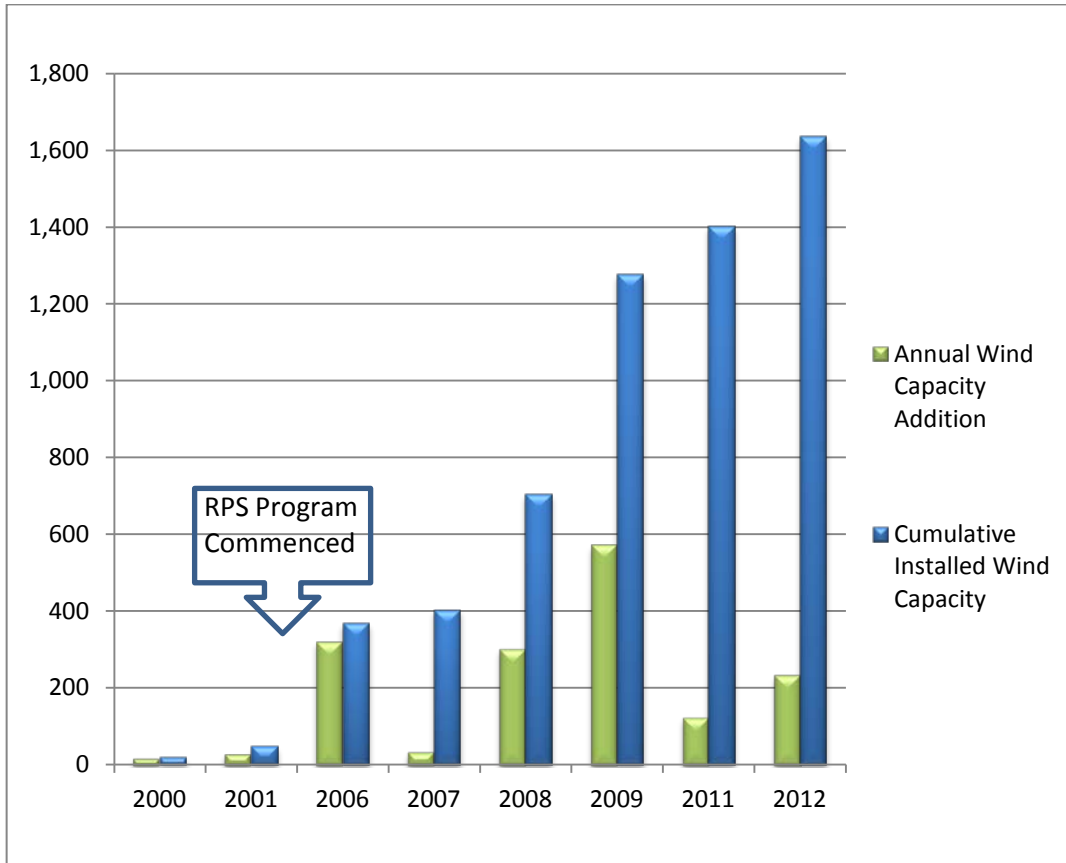


### 4.3 Wind Power Capacity Additions to New York State

More than 230 MW of wind power capacity associated with the Main Tier RPS program entered commercial operation during 2012. The cumulative installed wind capacity in New York through the end of 2012 has grown to more than 1,600 MW, which is more than 34 times the capacity that existed prior to the New York RPS. New York State is in 12th place in the United States with regard to installed wind power capacity.<sup>28</sup> Figure 2 shows the Wind Power Capacity Additions to New York State by year.

<sup>28</sup> American Wind Energy Association, U.S. *Wind Industry Fourth Quarter 2012 Market Report*, (January 2012).

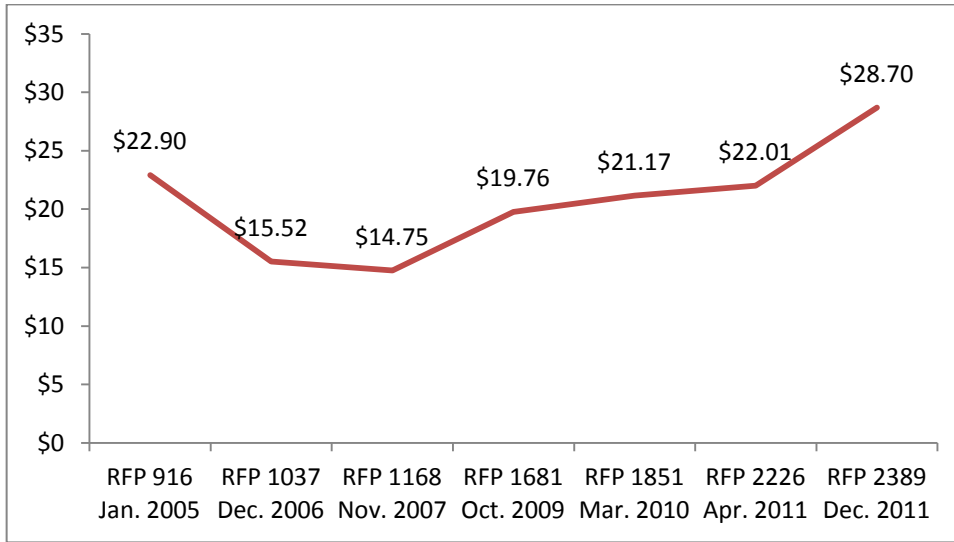
**Figure 2. Wind Power Capacity Additions to New York by Year**



#### 4.4 Weighted Average Award Price Trends

The aggregate MWh weighted average award price from the seven Main Tier solicitations is \$19.25. The seventh solicitation yielded the highest weighted average award price (\$28.70), whereas the third solicitation resulted in the lowest (\$14.75). As illustrated in Figure 3, average contract award prices for the second (RFP 1037) through the sixth (RFP 2226) Main Tier solicitations were lower than the first Main Tier solicitation (RFP 916). Prices for the seventh (RFP 2389) trended higher, reflecting expectations that future wholesale power prices will be lower, as previously described.

**Figure 3. Average Main Tier Weighted Bid Price Trends**



## 4.5 Performance-Related Contract Adjustments

Underproduction, project delays and setbacks were anticipated in Main Tier program and contract design. To ensure that the Main Tier target is met and other projects are afforded timely opportunities for funding, NYSERDA’s Main Tier contracts require that each project deliver at least a minimum percentage of the quantity of energy associated with its bid during each year. If a project fails to meet this percentage for a specified number of consecutive years, the annual quantity of RPS Attributes that NYSERDA is obligated to purchase from that project may be reduced for the remaining years of the contract.<sup>29</sup> The funding associated with this reduction in the RPS Attribute commitment is then disencumbered and can be applied toward making up the lost production in subsequent solicitations.

Through December 31, 2012, seven Main Tier RPS facilities had not met their contractual obligation to deliver the required minimum of contracted energy output for three consecutive years. As a result, the facilities’ contracted bid quantity was reduced for the remaining seven years under each contract. The funds associated with that quantity were disencumbered and are now available for subsequent solicitations. It is likely that additional contract adjustments will be implemented in future years due to:

- Difficulties in predicting long-term wind speeds and wind abundance.
- Imperfect science of micro-siting of the wind turbines themselves.
- Natural inter-annual variability in water/hydrological flows.

<sup>29</sup> Percentages and number of years vary by RFP and facility type (such as wind or hydro).



## 4.6 RPS Program Funding

NYSERDA's activities and responsibilities under the RPS are funded through quarterly payments made to NYSERDA by Central Hudson, Con Edison, New York State Electric and Gas, National Grid, Orange and Rockland, and Rochester Gas and Electric pursuant to a Memorandum of Understanding approved by the Commission. These utilities recoup the payments made to NYSERDA through a System Benefits/RPS Charge on the delivery portion of retail customer utility bills.

In its April 2, 2010 Order, the Commission specified a total program budget through 2024 in an amount totaling approximately \$2.998 billion.<sup>30</sup> NYSERDA was to use this funding for long-term contracts for Main Tier and Maintenance resources, Customer-Sited Tier incentives, NYSERDA administration and program evaluation, Customer-Sited Tier system Quality Assurance/Quality Control (QA/QC), and New York State cost recovery fees.

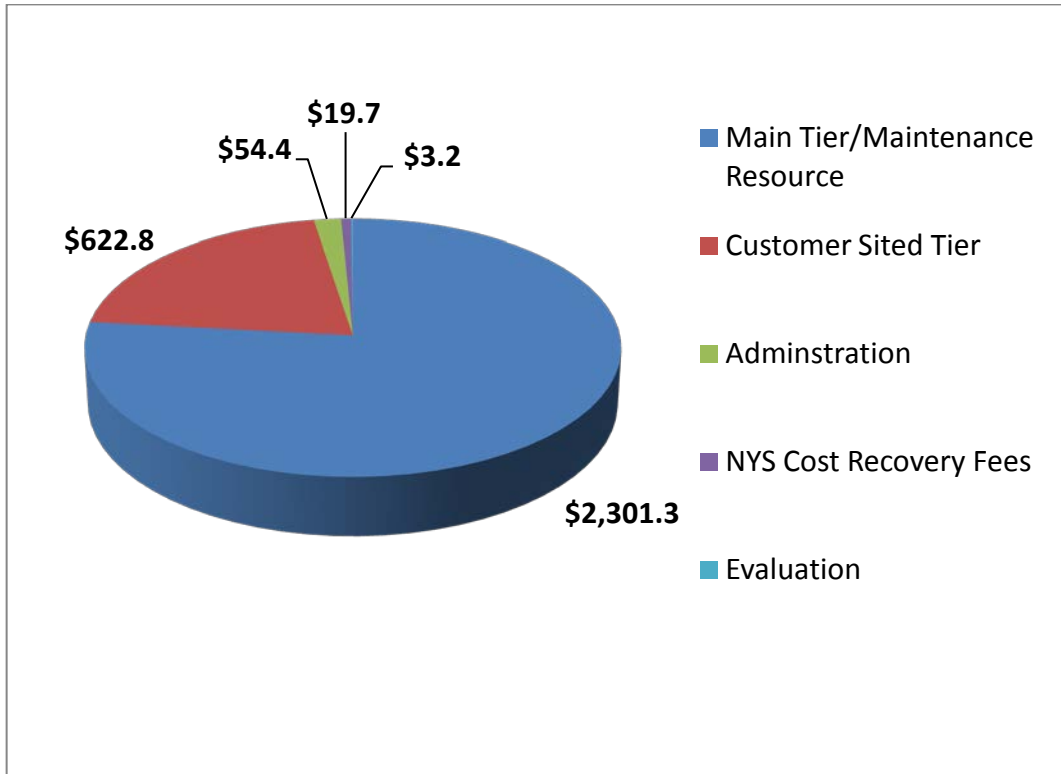
The major categories and amounts of funding by each category, based on Commission decisions rendered through the close of 2012 are presented in Figure 4.<sup>31</sup>

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<sup>30</sup> *Proceeding on Motion of the Commission Regarding a Retail Renewable Portfolio Standard*, "Order Authorizing Customer-Sited Tier Program through 2015 and Resolving Geographic Balance and Other Issues Pertaining the RPS Program;" issued and effective April 2, 2010.

<sup>31</sup> In January 2013, NYSERDA made its third annual filing to the Commission with regard to recommended allocations of unencumbered CST program funding balances as of end-of-year 2012. NYSERDA, Petition Regarding Unencumbered CST Funds. (January 30, 2013). <http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={3088BB94-7424-4B26-B960-B2D5E8A821A7}>

**Figure 4. RPS Program Budget through 2024 (in millions) as of December 31, 2012**

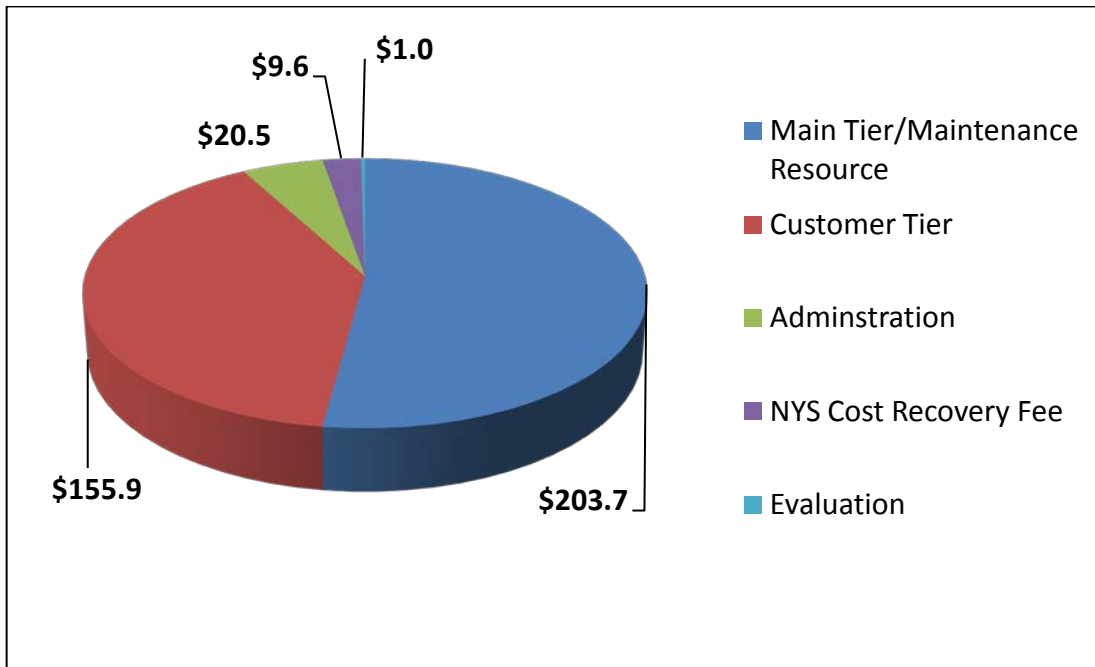


As of December 31, 2012, approximately \$1.2 billion, or roughly 40% of the total approved RPS funding, has been expended or committed to achieving NYSERDA’s 2015 targets (inclusive of administration and NYS fees). This includes \$876.6 million for program resource acquisition costs in the Main Tier, inclusive of Maintenance resource obligations, and \$280.8 million for the Customer-Sited Tier.<sup>32</sup>

NYSERDA’s actual expenses through December 31, 2012 have totaled \$390.8 million, or approximately 13% of the total RPS budget. The large majority of these expenses, \$359.7 million have resulted from payments for Main Tier and Maintenance resource contracts as well as Customer-Sited Tier incentives. Figure 5 illustrates NYSERDA’s major expenses through December 31, 2012.

<sup>32</sup> The funding commitments do not include Customer Sited Tier solicitation pre-encumbered funds for which awards were not made by December 31, 2012.

Figure 5. RPS Program Expenses through December 31, 2012 (in millions)



## 5 Methodology

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### 5.1 Introduction

Evaluating the impact and effectiveness of the RPS Main Tier policy entails considering a range of factors. It starts with determining what renewable energy generation sources have so far fulfilled, and are likely in the future to fulfill, the Main Tier procurements by successfully bidding into NYSERDA's Main Tier requests for proposal (RFPs). It requires accounting for both the direct cost of RPS procurements to ratepayers, and assessing the direct investment impacts on the New York State economy. It requires modeling the impact of RPS generation resources on the New York State wholesale electric system, compared to what would have occurred in the absence of the RPS procurements. These impacts include identifying what types of generation are displaced, what types of existing generating units are retired, and what generating units are not built as a result of injecting additional renewable energy supply, and the effect on locational-based marginal prices (LBMPs) in NYISO's competitive wholesale electric energy markets. Evaluation encompasses assessing the environmental benefits resulting from the displacement of conventional generation, including avoided fossil fuel use and reduced emissions. Together, this information can allow the Commission to assess and compare the direct benefits and costs of the RPS program.

But changes in spending as a result of the program impact the State's economy beyond these direct effects. Evaluation of the RPS therefore also encompasses analysis of the indirect and induced macroeconomic impacts on New York's economy triggered by direct spending by RPS generators in New York State, as well as the economic impact of redirecting ratepayer spending towards NYSERDA Main Tier contracts, and the reduction in spending due to the displacement of conventional generation. The macroeconomic impacts also include assessing the current and future change in employment in New York triggered by the RPS related economic activity.

Finally, RPS program evaluation entails considering all of these factors from a number of perspectives, including ratepayers and New York State's consumers as a whole. Through such an assessment, the Commission can evaluate the effectiveness of the RPS Main Tier policy in meeting objectives detailed in Section 3.1.

Evaluating the Main Tier RPS necessitates both a retrospective view comprised of reporting the actual and estimating future impacts of commitments made to date, and a projection of commitments yet to be made. An overview of the approach to the various analyses supporting this study is structured as follows, with each step detailed in the individual subsections that follow.

Starting with the actual renewable electricity generation attributable to the RPS procurements, the retrospective analysis consists of the following components:

- **Direct Cost:** Actual Main Tier expenditures to date associated with the Current Portfolio and two Maintenance Resource projects, and an extrapolation of expected expenditures through the end of those contract’s durations.
- **Direct Investment:** The reported and verified direct expenditures in New York by renewable electricity generators under contract to NYSERDA, the projection of these expenditures for the full output and expected life of each project, and the extrapolation of expenditures to the remaining projects with Main Tier contracts.
- **Electric System Impacts and Environmental Impacts:** Past electric system impacts attributable to the supported renewable electricity generators as modeled relative to a base case with no RPS policy investment, and projected impacts resulting from continued operation of these generators.
- **Benefits and Costs:** The various costs and benefits estimated in the components above are compiled into a summation of direct costs and direct benefits, leading to the calculation of a benefit cost ratio.
- **Macroeconomic Analysis:** Impacts and changes to jobs in New York – positive and negative – resulting from the costs and benefits as estimated using a macroeconomic model representation of the New York economy.

The prospective analysis includes projections of the impacts of renewable electricity generation projects providing RPS Attributes under future Main Tier RPS contracts. Costs and benefits are measured relative to a specified base case, and the stages of analysis mirror categorically the components identified for the retrospective analysis. However, the specifics differ in that the exercise is entirely forecast-based, and require an additional projection of future contracts through the use of a cost study, as described further in Section 5.8. Additionally, sensitivity analyses can be conducted, following all or a subset of the same analytical framework as outlined. Sensitivity analyses can provide the Commission insight into the potential impacts of exogenous issues which might materially change the impacts such as changes in federal financial incentives or natural gas costs, as well as future policy design choices.

## 5.2 Direct Investment in New York

A unique aspect of the approach to this Program Review relates to the analysis and extrapolation of verified direct investments in New York State for RPS-funded projects which was collected through the programmatic implementation of RPS contractual requirements.<sup>33</sup> NYSERDA’s RPS contracts require each contractor to demonstrate, after three years of facility operations, that at least 85% of the direct investments in New York State that were claimed in the contractor’s Bid Proposal – and incorporated into the RFP scoring evaluation – have actually accrued to New York. These investments, defined as in-state expenditures by each project through its development, construction, and operations and maintenance, have significant direct and indirect economic impacts on the New York State economy.

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<sup>33</sup> This analysis only considered the direct investments in New York associated with RPS-funded projects, with no consideration given to the total investments associated with these projects.

RPS Main Tier contracts instruct that failure to provide this demonstrable evidence will result in a proportionate reduction in the contract bid price for the remaining seven years of the contract term.<sup>34</sup> This requirement is based on a Commission Order that authorized the 30% economic benefits evaluation criteria, which stated that “the economic benefits category shall be designed such that any project, regardless where located, would have the same opportunity to quantitatively demonstrate its likely – and verifiable – economic benefits to New York.”<sup>35</sup>

Through December 31, 2012, NYSERDA program staff completed a comprehensive assessment and audit of direct investments in New York State associated with 18 Main Tier and Maintenance resource projects. These facilities include 8 wind farms, 2 biomass facilities and 8 hydroelectric facility upgrades, which are all located in New York. Through a comprehensive and detailed review process, NYSERDA examined more than 30,000 documents received.<sup>36</sup> Ultimately, all 18 facilities were determined to be at or above their compliance obligation of NYSERDA-verified spending of at least 85% of the claimed direct investments in New York State through the first three years of commercial operation.

The direct investment data collected by NYSERDA as part of its RPS Program administration was then provided to NYSERDA’s consultants and extensively analyzed in an effort to better understand the scope and type of direct economic benefits resulting from incentivizing renewable energy development within the State. NYSERDA’s consultants examined the verified direct spending data from the 18 RPS projects and projected these benefits through the life of each project. The resulting metrics were then used in concert with additional data associated with other projects under contract with less than 3 years of operating history to extrapolate the anticipated New York State specific economic benefits of the Current Portfolio. The aggregated spending data associated with the projects with verified direct investments and associated analyses for the full portfolio of current Main Tier projects was summarized in a Direct Investments in New York Report published as an appendix to Volume 2 of the Main Tier Program Review Report.

The direct investments in New York State data were also used as an input to a macroeconomic analysis and an assessment of costs and benefits based on meeting current RPS program goals. These data will also be used to project spending associated with future procurements under scenarios considered in the Program Review.

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<sup>34</sup> For example, if through the verification process a contractor demonstrates the accrual of 75% of the economic benefits claimed, the bid price payable will be reduced by 25%.

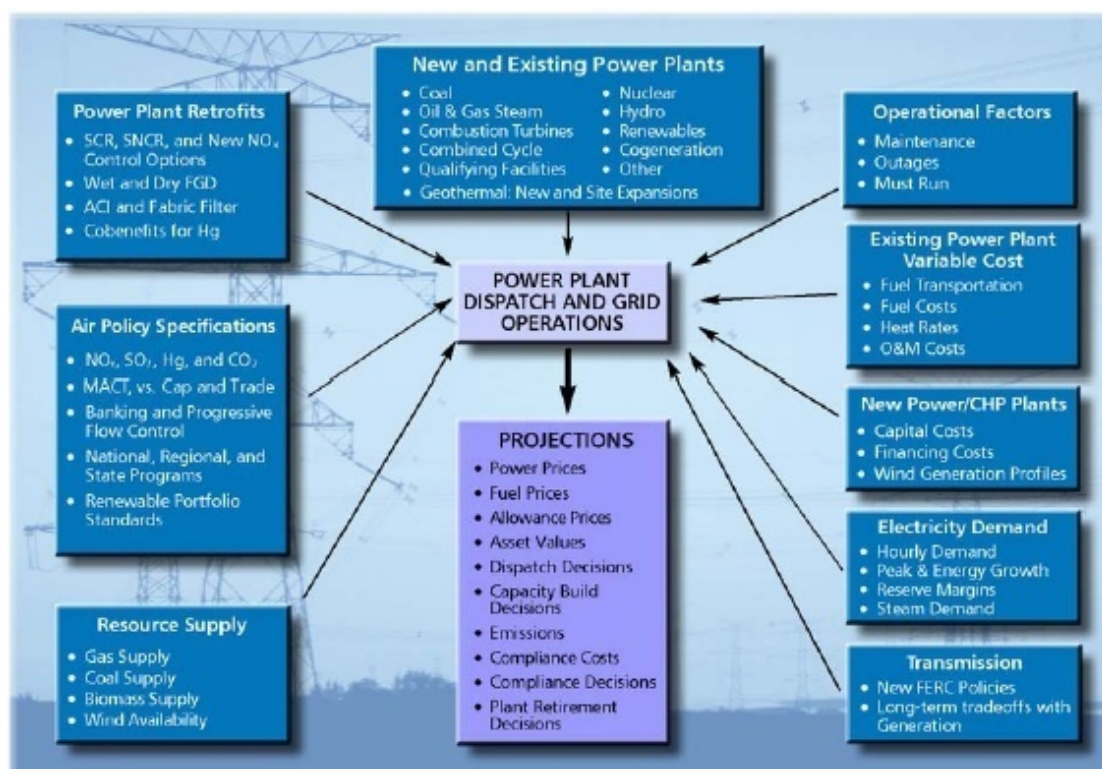
<sup>35</sup> *Proceeding on Motion of the Commission Regarding a Retail Renewable Portfolio Standard*; “Order Authorizing Solicitation Methods and Consideration of Bid Evaluation Criteria and Denying Request for Clarification,” issued and effective October 19, 2006, p. 16.

<sup>36</sup> A complete description of NYSERDA’s verification process can be found in: NYSERDA. Reply Comments, Petition for Modification of RPS Main Tier Program. (March 2013). <http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={0FE1F9AC-BEA4-4C41-AFF0-9B08874C1937}>

### 5.3 Electricity System Impacts

Electricity system impacts were assessed using the Integrated Planning Model (IPM<sup>®</sup>), ICF International's proprietary engineering/economic capacity expansion and production-costing model of the power and industrial sectors. IPM<sup>®</sup> is a multi-region model that endogenously determines capacity and transmission expansion plans, unit dispatch and compliance decisions, and power, fuel and allowance price forecasts, all based on power market fundamentals. IPM<sup>®</sup> explicitly models gas, oil and coal markets, power plant costs and performance characteristics, environmental constraints (air, ash and water), and other power market characteristics. Figure 6 illustrates the key inputs and outputs of IPM<sup>®</sup>.

**Figure 6. Key Inputs and Outputs of IPM<sup>®</sup>**



All existing boilers and generators are modeled in IPM<sup>®</sup>, as well as cogeneration facilities that sell firm capacity into the wholesale market. ICF relies on a number of data sources to characterize these units, including U.S. Energy Information Administration, U.S. Environmental Protection Agency, and commercially available datasets, supplemented with ICF's internal research and datasets. The IPM<sup>®</sup> database contains multiple characteristics for all generating units including location and zoning information, owner, efficiency (heat rate), current capacity, boiler and generator type, variable and fixed costs, emissions rates by pollutant, and pollution control status.

IPM<sup>®</sup> models its own set of regions that closely resemble NERC regions. These regions are further divided based on ICF's assessment of commercially significant transmission bottlenecks (i.e., subregions in which spot prices are expected to significantly diverge) and Independent System Operator zones. All IPM<sup>®</sup> regions are provided with a representation of the electric transmission system that connects them to neighboring regions. These inter-regional transmission connections allow for the transfer of both capacity and energy, and allow for broad price equilibrium when transmission capacity is available. IPM<sup>®</sup> models five regions for State based on NYISO Zones: (1) Zones A-E, (2) Zone F, (3) Zones G-I, (4) Zone J, and (5) Zone K.

IPM<sup>®</sup> analyzes wholesale power markets and assesses competitive market prices of electrical energy, balancing supply options and demand projections to project regional wholesale market power prices, power plant dispatch, fuel consumption and prices, inter-regional transmission flows, environmental emissions and associated costs, capacity expansion and retirements, and pollution control retrofits. IPM<sup>®</sup> also projects an annual "pure" capacity price. The model does not extrapolate from historical conditions but rather provides a least cost optimization projection given a set of future conditions which determine how the industry will function (e.g., new demand, new power plant costs, new fuel market conditions and new environmental regulations). The optimization routine has dynamic effects (i.e., it looks ahead at future years and simultaneously evaluates decisions over a specified time horizon). All major factors affecting wholesale electricity prices are explicitly modeled, including detailed modeling of existing and planned units, with careful consideration of fuel prices, environmental allowance and compliance costs, transmission constraints and operating constraints.

IPM<sup>®</sup> incorporates limitations on emissions into its optimization process. Those constraints are specified on the basis of target-rates, cap-and-trade policies, dollars per ton emitted tariffs or command-and-control policies, and applied to individual generating units or groups of units. Units have a variety of options to comply with those constraints, including reduced dispatch, fuel switching, retrofitting, purchasing allowances, or retiring. IPM<sup>®</sup> also allows for the specification of allowance banking across any number of years. The incentive to bank is driven by the cost of compliance in a future year – if the discounted future cost is higher than the cost of compliance today, the model will choose to bank allowances for withdrawal in that future year.

IPM<sup>®</sup> generates its outputs with dynamic projections for specific model years over a time horizon. For this analysis, the time horizon runs through 2035. Output from IPM<sup>®</sup> run years are therefore interpolated and extrapolated for remaining years in the study period. For each model year, IPM<sup>®</sup> provides results for levels ranging from unit to national. For units, IPM<sup>®</sup> projects dispatch, fuel use (quantity and type), emissions, pollution control compliance and retirement decisions, operating costs, energy and capacity revenues, and delivered fuel prices. At the regional and zonal level, IPM<sup>®</sup> generates energy prices by season and hour, capacity prices, capacity expansion by type and year, transmission, and all aggregated unit results. Finally, IPM<sup>®</sup> outputs also contain some overarching national-level results such as commodity and natural gas prices, and total system costs aggregated from the regional analysis. In



addition, IPM<sup>®</sup> projects allowance prices for all cap and trade programs for the population of affected units, and minemouth coal prices at the basin-level for various coal types (as defined by heat and pollutant content).

Importantly, IPM<sup>®</sup> solves for all of these projections simultaneously, and therefore, the impacts of changes in one parameter affect all other related factors. For example, the addition of a CO<sub>2</sub> policy in the model can result in increased gas prices, and, depending on the stringency, a greater number of coal retirements, thereby impacting other key indicators such as capacity additions and prices.

## 5.4 Key Assumptions for RPS Modeling Cases

The modeling cases for this analysis relied on the same assumptions as the draft 2013 State Energy Plan (SEP) Reference case. NYSERDA worked closely with NYISO and other stakeholders in developing key modeling input assumptions used in SEP modeling.

The following three key input assumptions should be noted:

- With the exception of any sensitivity specifically stating otherwise, the Indian Point Nuclear Facility was assumed to be in-service for all model run years. Note that the NYISO included Indian Point in its 2012 Reliability Needs Assessment (RNA) Base Case and its 2013 Congestion Assessment and Resource Integration Study (CARIS) Base Case. The RNA and CARIS studies support the NYISO's overall Comprehensive System Planning Process (CSPP).
- With the exception of any sensitivity specifically stating otherwise, a Regional Greenhouse Gas Initiative (RGGI) cap of 165 million tons was assumed in place throughout the analysis which resulted in a CO<sub>2</sub> allowance price of \$1.89 per ton (in 2010 dollars) for all years. Note that, on February 7, 2013, RGGI states proposed to lower the RGGI cap by 45% and phase in the reduction from 2014 to 2020. It is possible that such a cap reduction could lead to higher allowance prices than seen in the model results.
- For all cases and sensitivities, the transmission system was represented as it existed at the time the 2013 draft SEP modeling was done. No effort was made to project and include future transmission system upgrades.

## 5.5 Environmental Impacts

### 5.5.1 Air Emissions Impacts

The installation of renewable electricity generators in New York State is expected to positively impact the environment by reducing use of fossil fuels by conventional electricity generators. Fossil fuels create environmental burdens at every stage of their fuel cycle, from ecosystem and human health impacts associated with the extraction process, to air and water pollution from plant operation, to disposal issues associated with toxic waste products. By reducing the use of fossil fuel by power plants, these negative impacts should be reduced. The analysis examines the impacts of reduced output from conventional generation resources, caused by increased output from RPS Main Tier renewable resources, on CO<sub>2</sub>, NO<sub>x</sub>, SO<sub>2</sub>, and mercury emission levels. Emission levels from power plants are provided for IPM<sup>®</sup> model run years and interpolated and extrapolated for remaining years in the study period.

A base case of grid operation is used to estimate a baseline for the total of the emissions produced by electricity generators, which is then compared to a case with RPS Main Tier funded renewable capacity additions. The IPM<sup>®</sup> model measures emission levels in New York State and the control areas outside of New York. Because changes in the New York State generation dispatch can affect the dispatch in other control areas (in both the United States and Canada) through changes to import and export levels, emissions impacts are also calculated for regions outside of the state. For the purposes of measuring CO<sub>2</sub> and mercury impacts, total changes in the United States are used because carbon emissions, regardless of the source, have a global impact. In the case of CO<sub>2</sub>, emission changes in Canada are also included. For SO<sub>2</sub> and NO<sub>x</sub>, total changes in Cross State Air Pollution Rule (CSAPR) Tier 1 are used to measure benefits. CSAPR Tier 1 includes Illinois, Indiana, Iowa, Kentucky, Maryland, Michigan, Missouri, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and Wisconsin.

For the cost and benefit analysis, a value of \$15/ton value for carbon (in 2010 dollars) was applied for monetizing carbon impacts.<sup>37</sup> The New York State Department of Public Service uses this current value as part of its electricity generation sector benefit-cost tests. An upper bound of \$85/ton (in 2000 dollars) was also used to place an upper bound on the value of carbon. This upper bound was developed for the United Kingdom's government as part of the Stern Review and reflects the net cost to society from climate change.<sup>38</sup>

Applying both a lower bound and an upper bound assumption for the value of CO<sub>2</sub> reductions (also included in the cost-benefit analysis methodology) permits the calculation of a range for the estimated net present value of these reductions consistent with the uncertainty in the societal cost of greenhouse gas emissions. The difference between these two values can be significant and can materially influence the cost-benefit analysis conclusions.

To monetize the health benefits from a reduction in criteria pollutants, the dollars-per-ton reduction values used for NO<sub>x</sub>, SO<sub>2</sub> and mercury were drawn from these previous research efforts:

- Monetary benefits of a reduction on NO<sub>x</sub> and SO<sub>2</sub> were calculated using the method developed by Resources for the Future.<sup>39</sup> In the paper, dollars-per-ton values (1999 dollars) are developed for SO<sub>2</sub> and NO<sub>x</sub> (\$3,500/ton, and \$1,100/ton respectively) based on the changes in health status expected to occur due to changes in pollutant concentrations. Health status changes include the number of chronic disease cases, the number of days of acute morbidity effects, and the number of statistical lives lost. Monetary values, including a statistical life value of 2.25 million (1999 dollars), are applied to these health effects to generate the final dollars/ton values.

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<sup>37</sup> The base value has been used for similar benefit-cost studies in New York, such as the 2012 Solar Study. This valuation is included in addition to the carbon dioxide value that is assessed as part of RGGI allowance auctions for in-region generation. Any carbon dioxide emissions that occur outside of the RGGI region (such as emissions attributed to imports of electricity) would not be associated with a RGGI allowances. As such, any accounting for RGGI allowance prices in the valuation of carbon dioxide emission reductions would need to exclude the out-of-region emission reductions.

<sup>38</sup> Stern Review. (2006). *The economics of climate change*. Cambridge, UK: Cambridge University Press.

<sup>39</sup> Resources for the Future. 2002. *Efficient Emission Fees in the US Electricity Sector*. October.

- Monetary benefits of a reduction in mercury (Hg) were calculated using the method developed by members of Northeast States for Coordinated Air Use Management.<sup>40</sup> In the paper, a value of \$194.5 million/ton of mercury reduced (2000 dollars) is developed based on the change in health effects from human exposure to methylmercury through fish consumption, the primary pathway of human exposure, due to decreased mercury concentrations in fish. A cost-of-illness approach is used to value both cardiovascular illness, and decreased cognitive abilities, with values of \$16,500 (2000 dollars) per Intelligence Quotient (IQ) point lost, and \$6 million (2000 dollars) per premature fatality used to generate the final dollars/ton value.

For all three pollutants, these monetary values are based on health benefits only, and do not attempt to monetize ecosystem benefits (such as reductions in acidification of lakes, streams and forests, and eutrophication of estuaries and coastal waters) or aesthetic impacts (such as visibility improvements in natural parks and wildlife viewing areas). As such, these values are considered conservative.

## 5.5.2 Fossil Fuel Use Impacts

A baseline of the New York grid operation was defined and compared to a case that included Main Tier RPS funded renewable capacity additions under different scenarios. Results from the IPM<sup>®</sup> modeling framework were examined for changes in coal, natural gas and oil usage by fossil-fuel powered generators in New York State.

## 5.6 Benefit-Cost Analysis

This analysis framework focuses on costs and benefits to New York State consumers. Costs and benefits examined include the direct cost of RPS procurements to ratepayers, wholesale price reduction,<sup>41</sup> environmental benefits through displaced fossil fuel consumption, and the direct economic impacts to New York State of additional economic activity from the renewable energy construction, operation, and service activities and, similarly, economic activities that are forgone through the displacement of non-RPS resources.

Table 5 shows the benefit and cost components that were used in the overall benefit-cost analysis.

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<sup>40</sup> Northeast States for Coordinated Air Use Management. 2005. *Economic Valuation of Human Health Benefits of Controlling Mercury Emissions from U.S. Coal-Fired Power Plant*. February.

<sup>41</sup> The wholesale electricity price reduction is a benefit from the perspective of New York's ratepayers. It is generally considered a transfer payment from generators (a majority of generation owners are assumed to be out-of-state entities) to in-state ratepayers. See Felder, F. A. 2011. "Examining Electricity Price Suppression Due to Renewable Resources and Other Grid Investments." *The Electricity Journal*, 24 (4).

**Table 5. Benefit and Cost Perspectives**

	<b>Premium Required for Renewable Generation</b>	<b>Net Electricity Ratepayer Impact</b>	<b>Statewide Benefit-Cost</b>
<b>Costs</b>			
Price to Install and Maintain Renewable Generation	✓	✓	✓
Investment and Expenditures Not Made			✓
<b>Benefits</b>			
Wholesale Market Revenues	✓	✓	✓
Federal, State, and Other RPS Incentives	✓	✓	✓
Electric Wholesale Price Reduction		✓	✓
Avoided Carbon			✓
Health Benefits			✓
Renewable Generation Investment and Expenditures			✓

The columns in Table 5 represent the three benefit-cost perspectives that are used in the analysis. As shown, the cost and benefit categories are additive (but not duplicative). Thus the last benefit-cost framework (Statewide Benefit-Cost Analysis) includes all the benefit-cost components included in the other frameworks.

The first column (Premium Required for Renewable Generation) represents the premium payments to RPS project owners to construct and service) and operate the facilities. This premium represents the difference between the total costs to build (after adjusting for all federal, state, and other incentives, such as tax credits, grants and low-interest financing) and the wholesale market revenues received from the energy and capacity markets.

The second column (Net Electricity Ratepayer Impact) includes wholesale price reduction impacts along with the RPS premium paid as renewable energy displaces conventional generation with higher variable and fuel costs in the energy market, and renewable capacity eliminates the need for more conventional resources in the capacity market. This benefit-cost construct is used as a measure of “net” ratepayer impact.

The third column (Statewide Benefit-Cost Analysis) includes benefits and costs that would be borne by New York State residents and businesses but would not directly impact electricity rates and bills. This perspective adds emissions-related benefits (or costs) due to changes in emissions as a result of more renewable energy deployment.<sup>42</sup> Emissions overall are expected to decrease because renewable energy technology, exclusive of biomass, does not directly produce any emission of CO<sub>2</sub>, NO<sub>x</sub>, SO<sub>2</sub>, or mercury. However, there may be emission increases in certain years as additional conventional generation may be necessary under certain conditions. This perspective also includes the impacts of the renewable energy investment and the forgone investment in conventional generating resources to New York. As renewable energy is deployed through the RPS program, there will be in-state spending to construct, operate, and maintain these facilities. By contrast, the construction of these renewable energy facilities displaces the construction of conventional facilities that would have been built and maintained in response to economic signals or to meet reliability needs. As a result, inclusion of this disbenefit (or cost) is necessary, because this reduction in economic activity was directly related to the renewable energy deployment.

In addition to the costs and benefits previously listed, there may be changes to other retail supply charges (such as ancillary services, NYISO related costs, load balancing costs, and retail supplier fees and markups) that are not included in wholesale energy and capacity market values (or the IPM<sup>®</sup> model output).

Moreover, there are a number of difficult-to-quantify benefits not included in the table. These include:

- Improved fuel diversity.
- Zero running cost generation that can serve as hedges.
- A boost to improved technology as New York contributes to global development of nascent renewable generation technologies.
- Grid security enhancements.
- Unaccounted for environmental benefits such as reduced primary particulates and enhanced ecosystem services.

Generally, it is thought that the difficult-to-quantify benefits exceed the difficult-to-quantify costs, both of which were beyond the scope of the current study and were not included in the overall calculations of net benefit (or cost). As a result, the benefit-cost estimates using this methodology may understate the benefit and that net benefits would be slightly higher (or net costs slightly lower) if these retail supply charge components were included.

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<sup>42</sup> The beneficiaries of a reduction in carbon dioxide emissions are spread throughout the world because climate change is a worldwide phenomenon. Accordingly, in a statewide perspective, only a very small percentage of the benefit of a reduction in carbon dioxide emissions would be realized as a benefit by New York. Nevertheless, the full, worldwide, benefit has been included given the magnitude of potential impacts of climate change.

### 5.6.1 Required Premium

The first step in analyzing the costs and benefits is to consider the incentive costs, or “premium”, borne by ratepayers through the applicable collection mechanism(s) necessary to support renewable energy (RE) deployment (e.g., SBC charges or RPS/Renewable Energy Certificate (REC) charges passed on by electricity suppliers).

Specifically:

$$\text{RE Premium} = (\text{Price to Install and Maintain RE}) - (\text{RE Wholesale Electrical Revenues})$$

This premium can be calculated by modeling the costs to construct, operate and maintain a renewable facility over its useful life and comparing those costs to revenue streams from the market and other sources, such as federal incentive programs. The size of the “above-market” costs is generally the key determinant of the benefit-cost ratios throughout all the different benefit-cost perspectives discussed in this section. For the RPS retrospective work, the RE premium is the actual payments under the RPS contract to RPS facility owners. For additional procurements, this information flows from the cost study described in the next section.

The retail rate impact (as a percentage of bills) is calculated as the total above market costs (as determined by the premiums paid) divided by total annual electricity expenditures in New York State. Thus, it is assumed for these purposes that the total costs of the policy options will be borne by all ratepayers in proportion to their total bill. EIA’s Annual Energy Outlook 2013 Early Release reference forecast for the three New York regions (New York City/Westchester, Long Island, and Upstate) was used to calculate a weighted average total retail revenue (delivery and supply charges) for each year in the study period. For years after 2036 (the last year in the EIA forecast), the compound average annual growth rate over the 2013-2036 period is applied in each year.

### 5.6.2 Net Electricity Ratepayer Impact

Net rate impacts are calculated by adjusting the renewable energy premium calculations. Specifically:

$$\text{Electric Ratepayer rate impacts} = (\text{RE Premium}) + (\text{Wholesale Price Reduction})$$

Wholesale price reduction (in both energy and capacity markets) is considered a benefit to consumers, and represents a transfer effect from producers to consumers. For this study, the price reduction benefits were calculated by using IPM<sup>®</sup> to measure the wholesale energy and capacity price changes related to the addition of Main Tier RPS renewable resources. The price differences on a per unit basis (\$/MWh) are multiplied by total load levels (which are constant case-to-case) to estimate the total dollar value saved by consumers due to the presence of the RPS resources.

It was assumed that savings to consumers due to wholesale price reduction would apply to all loads. However, particularly in the very near term, consumers may not fully realize the estimated wholesale price reduction benefits due to legacy long-term contracts for load entered into prior to deployment of renewable energy and production used for self-supply by resources owned or controlled by load-serving entities, neither of which would be impacted by renewable energy deployment. The load-serving entities that are responsible for most of New York's load have divested their generation assets and regularly procure energy to serve their load through frequent short term market solicitations, assuming that customer savings apply to all load may overstate the price reduction benefits. As a result, price reduction benefits are adjusted downward by multiplying the total price suppression benefits by 0.73, which is the portion of New York load not attributed to LIPA and NYPA.

This net rate impact concept should be considered an estimate of the ultimate cost responsibility that all New York State ratepayers will eventually pay.

### 5.6.3 Statewide Benefit-Cost

The Statewide Benefit-Cost calculations utilize the net ratepayer impact benefit-cost analysis from the prior section and consider the costs and benefits associated with changes in air emissions and the direct economic impacts. The direct economic impacts are also included in the macroeconomic discussion described in this section, where additional indirect and induced impacts on the economy are modeled. Specifically:

NYS Benefit-Cost = (RE Premium) + (Wholesale Price Reduction) + (Avoided Carbon Emissions) + (Health Benefits-Capital Investment and Operation & Maintenance (O&M) Expenditures Not Made) + (RE Capital and O&M)

As previously noted, the IPM<sup>®</sup> model was used to project the total amount of air emissions avoided from the deployment of renewable energy resources across the State. The IPM<sup>®</sup> allows the effects on emissions to be evaluated on a marginal basis by identifying the specific marginal resources that are affected by the deployment of renewable energy in New York State.

The RGGI program is modeled using a hard emission cap<sup>43</sup> with allowance trading. IPM<sup>®</sup> solves for the allowance price needed to meet the cap, but subject to the floor price specified for the RGGI auction. The allowance price affects energy prices which can influence investment decisions. At a future reduced cap of 91 million tons per year and with all things equal, electricity prices would be higher and thereby decrease the required RE premium (and increasing the wholesale price reduction and unclear impacts on other emission reductions).

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<sup>43</sup> Assumes the 165 million tons per year cap in place at the time the State Energy Plan was conducted, and does not reflect the reduced 91 million tons per year cap (declining at 2.5% per year thereafter) embedded in the proposed model rule.

Only in-state direct impacts are included in the benefit-cost analysis, hence capital investment and O&M expenditures not made (based on extrapolated IPM<sup>®</sup> results) are de-rated to only include the New York portion of these expenditures. As previously described, the renewable energy capital and O&M expenditures were calculated in terms of in-state economic activity to assure consistency between the two sets of metrics.

## 5.6.4 Study Period and Calculation of Net Present Value

The study period for the calculation of costs and benefits encompasses the first year and last year of all relevant cost and benefit streams. In other words, for the evaluation of project commitments through 2012, the period is 2002-2037. For each benefit-cost perspective previously described, a net present value (NPV) of net benefits (or costs) is calculated in the following manner: Each year in the study period will be converted to constant (or real) 2012 dollars and a real discount rate of 5.5% will be applied. As a result, all NPV calculations will be in real 2012 dollars.

## 5.7 Macroeconomic Analysis

### 5.7.1 Overview of REMI PI+ Model

The macroeconomic and jobs analysis portion of this review utilizes the REMI model,<sup>44</sup> an advanced economic forecasting model that combines an input-output model at its core with an additional ability to forecast shifts in prices, competitiveness factors and business attraction over time. This latter feature makes the system dynamic and allows the model to “forecast” an economic trajectory under a set of conditions. These conditions can describe a reference case (sometimes called business-as-usual), or a proposed policy event that has economic implications.

A REMI model of the State of New York (Version 1.4.2) was chosen for the purposes of this study because an estimate of the macroeconomic effects from wholesale and retail electricity price changes was needed. In addition, the REMI model is well-qualified to measure impacts of such changes. Additionally, compared to a simple input-output model, REMI is specifically set up to measure year-by-year impacts of the policy being examined. This set-up is important when evaluating a long-term policy like the Main Tier RPS.

Prior applications of the REMI model include assessments of energy efficiency, renewable energy and/or energy pricing policies for New York, California, Wisconsin, Iowa, Wyoming, Massachusetts, New Jersey, New England, other RGGI/NESCAUM<sup>45</sup> states, and the eastern Canadian provinces. Additionally, REMI has been used to assess impacts of regulatory changes and shifts in energy fuels and technologies in studies for Maine, Missouri, Illinois, Michigan, Connecticut, Vermont, New Jersey, Florida, New York, other NESCAUM states, and the Midwest.

<sup>44</sup> Developed in 1986 by Regional Economic Models, Inc. See <http://www.remi.com/the-remi-model> for more information about the model.

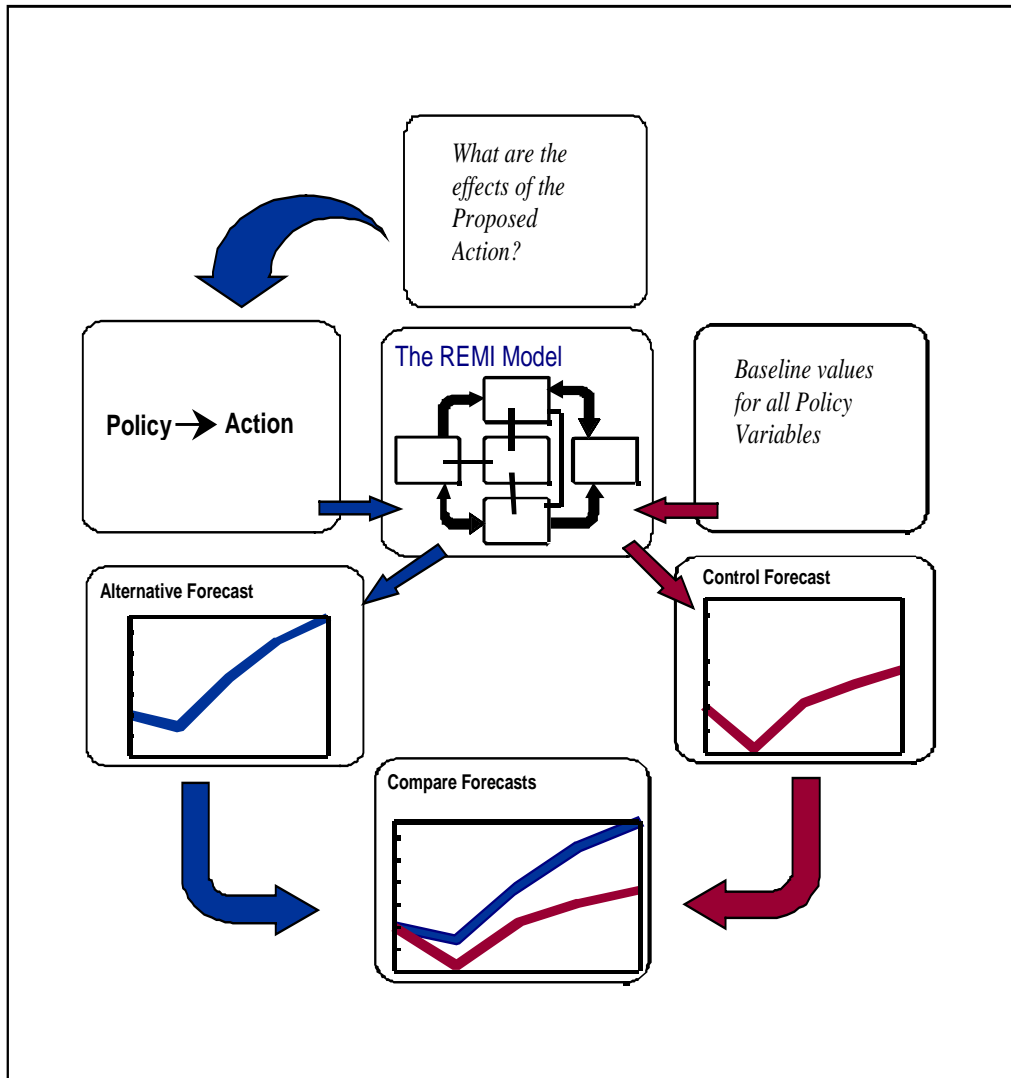
<sup>45</sup> [Northeast States for Coordinated Air Use Management \(NESCAUM\)](#) states are Connecticut, Maine, Massachusetts, New Hampshire, New York, New Jersey, Rhode Island, and Vermont. Regional Greenhouse Gas Initiative (RGGI) States are Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont.



### 5.7.2 Impact Analysis Model

Using the dynamic annual forecasting capability of the REMI model, an alternative to business-as-usual (or no policy) economic forecast can be generated reflecting the influence of a program or policy (e.g. a deployment of RPS Main Tier projects). Figure 7 illustrates generally how two economic paths are examined (business-as-usual and alternative case), with the difference in output metrics (e.g., jobs, business output, dollars of gross state product, or labor income) representing the macroeconomic impacts of the alternative.

**Figure 7. Identifying Annual Economic Impacts with a REMI Model (Source: Regional Economic Modeling, Inc.)**



The end result is that the REMI model forecasts year-by-year changes in industry-level and statewide aggregates for employment, dollars of output, value-added (or gross state product), wages, labor income, personal income, exports, investment, prices, government spending, inflation, taxes, population, labor force, labor force participation rates, and capital utilization by industry of the New York State economy. Two key macroeconomic metrics are the focus of this study:

- **Jobs.** The number of workers (wage and salary positions or self-employed individuals, working in the private-sector or public sector) as a result of the policy’s overall effect. When summed over an analysis interval, jobs are measured in units of job years. A job year simply means one job for one year.
- **Gross State Product (GSP).** GSP is calculated as the value-added portion of business sales, which is the value of business sales minus cost of inputs from supplying (or intermediate) industries. GSP represents the sum of worker income and corporate (profit) income.

### 5.7.3 General Assumptions Used for the REMI Analysis

The mapping of deployment scenario effects into specific REMI economic events is designated through the choice of model lever (described later in this section) for a specific industry, group of industries, or other economic entities, such as the household sector or the public sector. This designation dictates a majority of how the REMI scenarios will be structured. One important assumption involves how key changes in spending related to:

- Future capacity investment.
- O&M spending within the existing fossil fleet.
- Fuel purchases.
- Direct investment spending by renewable resources, impact New York State firms.

Changes in spending often involves imported equipment purchases but enlists in-state labor for the installation portion of the investment, or some specialized services.

REMI provides the user with lever choices in modeling changes to spending levels, including most notably both a demand lever and a sales lever. If the sales concept is chosen, REMI assumes that the incremental output is produced exclusively by New York State businesses. If the demand concept is selected, REMI assumes the output will be provided by a combination of internal and external producers based upon the model’s calibration of regional purchase coefficients<sup>46</sup> (RPCs). These industry-specific RPCs determine how much of the demand change becomes an output (sales) change occurring across New York State for the industry. The RPCs in REMI vary greatly by the specific industry in which the spending occurs, based, in part, on the concentration of that industry type entrenched in New York State.

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<sup>46</sup> The RPC is an industry-specific and region-specific parameter that is econometrically measured within economic impact models (input-output models as well as CGE models). This parameter (based on historical trend of data) ranges from a value of 0 to 1.0, with the lower bound indicating that none of the local (or in-state) production from an industry is sold to meet local demand. The upper bound would indicate that 100 percent of local production is sold to fulfill local demand.

As a general rule in constructing the RPS Main Tier analysis, the sales lever was used where NYSERDA staff verified with reasonable certainty that the incremental output for a purchase was produced within New York State. Otherwise the demand lever was used as the default lever choice. For this analysis, specific lever choices made in modeling changes to spending levels include:

- The labor cost component of offsetting capacity disinvestment in light of the Main Tier additions was assumed to rely upon in-state construction firms and be handled as a loss of construction contract value.
- For the purposes of modeling direct spending by RPS renewable resource providers, the sales lever was used to represent the spending in the model since the Main Tier program's design was structured (through the initial bid application for a facility, and eventually, through verification three years later), to emphasize the in-state spending.

The primary data sources for the REMI inputs were: (1) IPM<sup>®</sup> electricity system model results (see Section 5.3) and (2) a Direct Investment analysis (see Section 5.2), which tracked Main Tier RPS resource hiring and spending patterns over time.

Specifically, IPM<sup>®</sup> results were used to estimate:

- Wholesale price reductions for all customers attributable to RPS resources.
- Displaced construction investment for conventional generation resources.
- Changes in conventional resource variable O&M spending.
- Reductions in generator purchases of fossil fuels.

The Direct Investment analysis was used to estimate:

- Main Tier renewable resource investment spending.
- Hiring and wages paid by RPS resources.
- Payments of fees and taxes to local governments.
- Payments made for land use.
- Other non-payroll O&M expenditures for the Main Tier facility.

## 5.8 Main Tier Cost Study

The cost study work uses a spreadsheet based model of the New York renewable electricity generation supply curve, electric energy and capacity price forecasts derived in the draft State Energy Plan (SEP), and the projected Main Tier RPS procurement budget for a given scenario to estimate the least-cost mix of renewable resources procured and corresponding renewable premiums for each year in the study period. The supply curve model, initially developed by Sustainable Energy Advantage, LLC and La Capra Associates for New York renewable energy policy cost study analysis,<sup>47</sup> and maintained and updated by La Capra Associates, has been used in previous analyses of RPS program compliance costs, but key modeling assumptions have been updated for this effort.

The cost study model compares the annual incremental budget with the incremental available undeveloped supply, sorted from least to highest renewable generation cost. The intersection of incremental supply and incremental demand (i.e., annual RPS procurement and budget) establishes the choice of resource and associated market clearing price. This market clearing price, in dollars per megawatt hour, represents the projected cost of all renewable attributes<sup>48</sup> to be procured. While to date the Main Tier RPS solicitations have been applied on an as-bid rather than clearing price auction, the approach used assumed that over time, bid prices will tend to converge toward the clearing price with increased market experience, liquidity and transparency.

### 5.8.1 Supply Curve

In constructing the supply curve, the renewable resources evaluated must meet New York RPS eligibility rules and it is assumed that the resources are connected directly to the electrical grid in New York State. The following new renewable resources were included in the supply curve:

- Wind (on-shore and off-shore).
- Hydroelectric (consisting of new low-impact hydro, i.e. <30 MW, run-of-river, no new storage impoundment, and the incremental production associated with any upgrades to existing facilities so long as no new impoundments are created).
- Landfill methane.
- Biomass (combined heat and power and other technologies using eligible fuels).<sup>49</sup>
- Solar.

There are other resources that are eligible under the RPS, but were not included as part of the Main Tier supply curve, mainly due to higher costs, relatively small quantities available over the study period, or technologies not yet commercial. Examples include manure digesters, geothermal, ocean (e.g. tidal, wave); and fuel cells using any fuel).

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<sup>47</sup> Grace, Robert C. K. Cory and D. Smith. 2001. *Cost Estimate of N.Y. Executive Order 111 Renewable Energy Purchase Provisions NYSEDA Report 7092*, October.

<sup>48</sup> The terms renewable attributes, RPS Attributes (the term used in the RPS Maine Tier solicitations), and renewable energy certificates or credits (RECs) are used interchangeably throughout this report.

<sup>49</sup> All potential non-waste biomass fuel feed stocks were considered eligible except for contaminated fuels such as particleboard and treated wood.

The supply curve approach represents a logical model of a well-ordered world, fitting economic theory, in which the next available least-cost supply source is the one that gets built to meet the next increment of RPS demand. In practice, the real world is not as well-ordered and accurately modeling the real world is challenging. Practical constraints that interfere with an orderly, least-cost-first development path include, but are not limited to:

- Permitting feasibility and timelines (i.e., some locations are easier and/or faster to permit than others, independent of economics).
- Transmission availability, bottlenecks and timelines (i.e., the interconnection pathway to the most cost-effective wind may depend on transmission not yet designed, permitted or built).
- Generation equipment availability and cost (which can fluctuate, or be driven by multi-year frame agreements).
- Project design features (which may impact whether ideal hub heights or blade lengths are viable).

The implications of these real-world constraints is that projects may be higher cost in the near term than as projected under an idealized least-cost-first supply curve, but also that some of the lower cost (but still feasible for development) resources may be available at a later date. Therefore, it should be understood that the model results represent a reasonable approximation for resource selection and costing.

The potential supply was estimated for each of the listed resources through an analysis of resource-specific potential and grouping this potential into blocks of eligible supply having common characteristics by broadly-defined locations. Per-unit costs and an associated renewable premium measured in dollars per megawatt-hour (\$/MWh) were calculated for each supply block. As renewable resources have electricity commodity markets available to them as a primary revenue source, constructing supply curves require one to determine the supplemental revenue stream necessary to attract capital to build a new renewable resource. The difference between the minimum revenue necessary to bring a resource on-line (which from the consumer’s perspective represents “cost”) and the projected commodity market value of a plant’s production represents this minimum required supplemental revenue stream, which can be referred to as that resource’s renewable generation premium (RGP).<sup>50</sup>

For the purposes of developing renewable attribute premiums for different resources representative of the 10-year fixed price bids that developers are likely to propose, several steps were taken in the calculation. Because NYSERDA is procuring only the RPS attributes associated with renewable energy through its contracts, the remaining revenue streams (energy and capacity) for developers are still exposed to the volatile wholesale market. Developers have two primary avenues to mitigate the long-term risk of these commodity revenues, either through signing long-term contracts or buying financial derivatives to hedge prices. An estimate of this cost to achieve stability is reflected in the study as a hedging cost that reduces the potential revenue from energy and capacity.

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<sup>50</sup> Grace, Robert C. K. Cory and D. Smith. 2001. *Cost Estimate of N.Y. Executive Order 111 Renewable Energy Purchase Provisions NYSERDA Report 7092*, October.

The steps in calculating the premium for renewable generation are:

- Develop levelized<sup>51</sup> cost (\$/MWh) of renewable generation over the life of the project using a carrying charge that was calculated for each type of resource and associated variable costs and Production Tax Credit, if any.
- Develop production weighted annual revenue streams (\$/MWh), consisting of commodity energy and capacity, for each resource.
- Levelize the stream of revenues over the project life. Discount the potential revenue stream by a hedging cost.
- Calculate the difference between cost and revenue streams for each resource.
- Adjust the premium to reflect front-loading of project costs as a result of contracts being a maximum of 10-years, shorter than the assumed project life. A small residual value of \$5/MWh is assumed for the renewable attributes after the first 10-years.

### 5.8.2 Commodity Price Forecast Assumptions

The cost-effectiveness of renewable resources will depend, in part, on the (commodity) market value of their electrical output. Under the New York State wholesale market design, commodity market revenues will depend on energy locational based marginal prices (LBMP) available to resources located in each of the eleven NYISO zones. For purposes of efficiency and transparency of the analysis, the 11 NYISO zones were aggregated into three “Megazones” as shown in Figure 8 that capture the vast majority of market price differentials across the state, based on an analysis of the IPM regional prices (as discussed in Section 5.3):

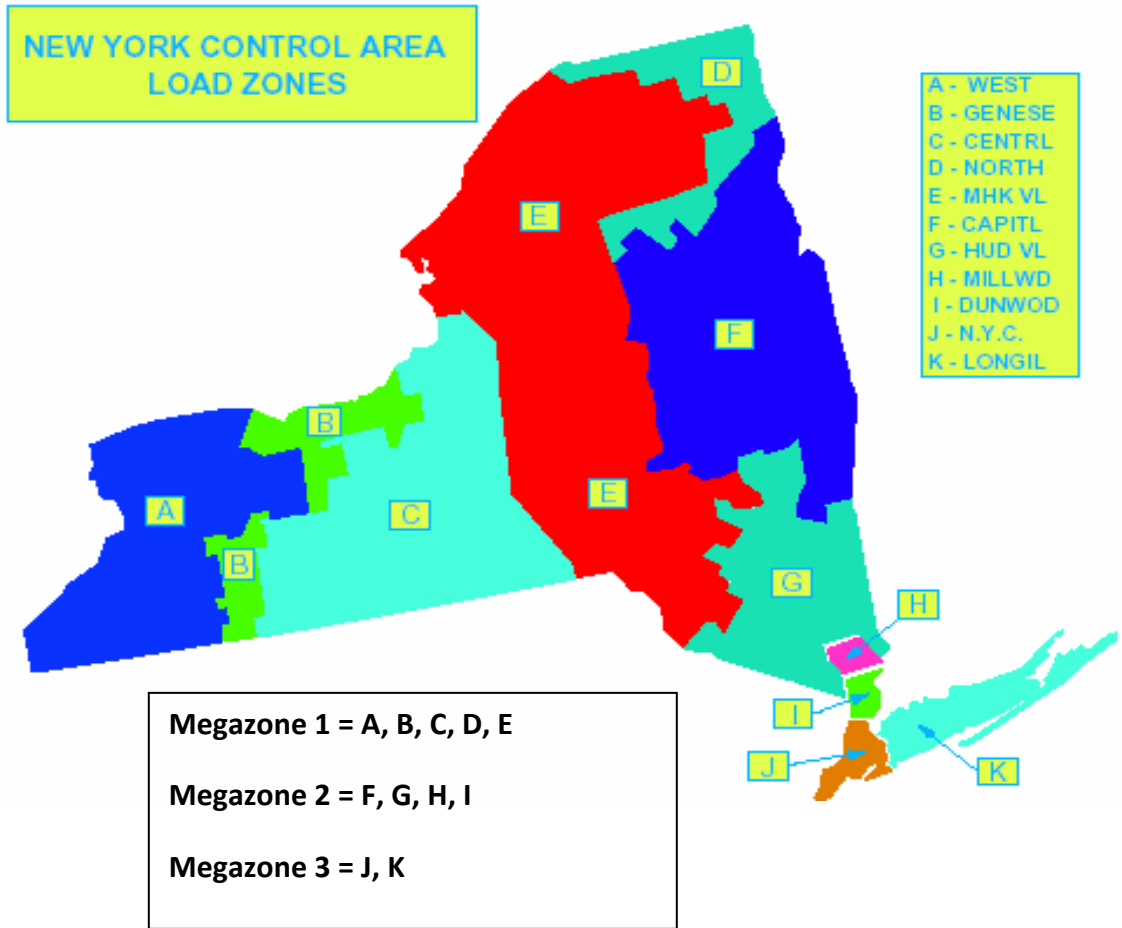
- Megazone 1 = IPM Region 1 = NYISO Zones A, B, C, D and E.
- Megazone 2 = IPM Regions 2 and 3 = NYISO Zones F, G, H and I.
- Megazone 3 = IPM Regions 4 and 5 = NYISO Zones J and K.

Within each Megazone, prices are generally very similar, and transmission constraints are small relative to the constraints between Megazones. The energy and capacity forecasts for each Megazone were developed using output from the IPM<sup>®</sup> analysis.

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<sup>51</sup> A major component of the total cost of energy from renewable power projects is the up-front project capital cost of procuring and constructing the power producing facility. Applying a carrying charge to the estimated project capital costs provides a way to represent these costs on an annualized basis, for use in the derivation of total cost of energy. Fixed costs typically capitalized at the commencement of commercial operation were converted to levelized \$/MWh by applying an annual carrying charge (after-tax) applicable to each resource type. For this analysis, a carrying charge for each renewable technology was established by considering the typical economic life of the technology, likely financing requirements, and current tax treatment. A market-based rate of return approach was employed to determine the stream of levelized revenues that, if attained, would provide return of and on capital. Such an approach mimics the revenues a generator would obtain if it entered into a Power Purchase Agreement with a fixed, price over the life of the project.

**Figure 8. New York Grouped Zones**



### 5.8.3 Federal Production Tax Credit

The Federal Production Tax Credit (PTC) is currently slated to expire for projects not reaching an under construction milestone by December 31, 2013, with further extension uncertain. Two PTC cases were developed: a Base case in which the PTC is in effect for the entire study period and a PTC Phase-Out sensitivity case in which the PTC is reduced beginning in 2015 and eventually eliminated in 2019. In both the Base case and the PTC Phase-Out sensitivity case, it was assumed that offshore wind and solar were eligible for and utilized the 30% federal investment tax credit (ITC) throughout the study period.<sup>52</sup>

<sup>52</sup> Currently, the 30% ITC is available to solar installations reaching commercial operation prior to the end of 2016. No such policy is currently in place for offshore wind, although congressional committees have considered proposals for an offshore wind-specific incentive for the first few thousand MW of offshore wind installations.

In the Base case, the PTC is assumed to remain in effect. For wind, the PTC is modeled as 2.3 cents/kWh in 2013 and escalated annually with inflation for the study period. In the PTC Phase-Out sensitivity case, it is assumed that the PTC will be phased out on a schedule similar to that proposed by the American Wind Energy Association (AWEA).<sup>53</sup> The PTC Phase-Out schedule is shown in Table 6.

**Table 6. PTC Cases (Percent of Current Level)**

Case	2014	2015	2016	2017	2018	2019 and later
Base Case	100%	100%	100%	100%	100%	100%
PTC Phase-Out Case	100%	80%	70%	60%	60%	0%

In the case where the PTC is phasing out, this study assumes that the overall cost of capital declines, on a project basis, because there is less of a need for expensive tax equity.<sup>54</sup> From a modeling and analysis perspective, this phaseout is accomplished through the replacement of expensive tax equity with lower cost sources of capital such as traditional equity investors and slightly increased use of debt.

A carrying charge<sup>55</sup> is calculated for each technology in estimating its levelized costs. This carrying charge is lower due to lower financing costs in the PTC Phase-Out sensitivity for PTC-eligible technologies. Tables 7 and 8 show the financing assumptions in the PTC Phase-Out sensitivity and the Base case. Note that biomass co-firing, and new hydropower are not eligible for the PTC, so the financing assumptions are the same in both the Base case and the PTC Phase-Out sensitivity.

<sup>53</sup> AWEA Press Release on PTC phase-out. <http://www.awea.org/MediaCenter/pressrelease.aspx?ItemNumber=4696>. Accessed May 21, 2013. For modeling purposes, the PTC is assumed to be available for projects that come online one year later than AWEA's proposal, through 2014, because the PTC was extended to projects which begin construction by the end of 2013 after AWEA proposed its Phase-out schedule.

<sup>54</sup> With the PTC in effect, there has been substantial competition between projects for a limited pool of equity investors with sufficient tax appetites to fully utilize PTC benefits, which has resulted in a higher cost of financing (or put differently, there has been little competition among tax investors). Even though the cost of financing is higher, utilization of the PTC is still a net benefit, as the incentive outweighs the required higher return on equity.

<sup>55</sup> Applying a carrying charge to the estimated project capital costs provides a way to represent project capital costs on an annualized basis, for use in the derivation of total cost of energy. For the cost study analysis, a carrying charge for each renewable technology was established by considering the typical economic life of the technology, likely financing requirements, and current tax treatment. A market-based rate of return approach was employed to determine the stream of levelized revenues that, if attained, would provide return of and on capital. Such an approach mimics the revenues a generator would obtain if it entered into a Power Purchase Agreement with a fixed, price over the life of the project.



**Table 7. Base Case Financing Assumptions**

Technology	Project/ Contract Life	Debt %	Equity %	Cost of debt	Cost of Equity	Loan term (years)	Carrying Charge
<b>Biomass co-firing</b>	10	50%	50%	7.00%	12.5%	10	18.50%
<b>Biomass (wood)</b>	20	60%	40%	7.00%	14.0%	15	14.88%
<b>Landfill Methane</b>	20	50%	50%	7.00%	14.0%	10	13.70%
<b>Onshore Wind</b>	20	55%	45%	5.75%	12.0%	15	10.52%
<b>Onshore Wind (Medium/Small)</b>	20	55%	45%	7.00%	12.5%	15	11.26%
<b>Hydro (upgrades)</b>	25	60%	40%	7.00%	14.0%	20	13.30%
<b>Hydro (new)</b>	25	60%	40%	7.00%	14.0%	20	13.30%

**Table 8. PTC Phase-out Financing Assumptions**

Technology	Project/ Contract Life	Debt %	Equity %	Cost of debt	Cost of Equity	Loan term (years)	Carrying Charge
<b>Biomass co-firing</b>	10	50%	50%	7.00%	12.5%	10	18.50%
<b>Biomass (wood)</b>	20	75%	25%	7.00%	13.3%	15	12.69%
<b>Landfill Methane</b>	20	55%	45%	7.00%	13.3%	10	12.87%
<b>Onshore Wind</b>	20	80%	20%	5.75%	11.0%	15	7.95%
<b>Onshore Wind (Medium/Small)</b>	20	80%	20%	7.00%	11.0%	10	8.50%
<b>Hydro (upgrades)</b>	25	75%	25%	7.00%	13.3%	20	10.91%
<b>Hydro (new)</b>	25	60%	40%	7.00%	14.0%	20	13.30%

The Review also includes analysis of different future levelized cost of energy for onshore wind, described in more detail in the following sections. The analysis explores two scenarios: the first assumes that continued technology (and associated cost) improvements reduce levelized costs over time and the second assumes that the levelized cost of energy remains constant in real terms. These assumptions are coupled with the PTC assumptions as follows: the Base case assumes no future improvements and the PTC Phase-Out sensitivity case assumes continued future improvements.<sup>56</sup>

<sup>56</sup> The rationale for this grouping is that technology improvements would bring wind costs down sufficient to enable a viable wind industry in the future without PTC support.

#### 5.8.4 Decreased Wind Levelized Costs due to Technology Improvement

Recent research funded by the International Energy Agency and conducted by the National Renewable Energy Laboratory, projects substantial decreases in the levelized costs of onshore wind power from improvements in wind turbine technology between now and 2030. The projected decreases in levelized costs ranged from 0 to 40% by 2030, with the central 60% of industry projections showing a mean decline of 20 to 30% by 2030.<sup>57</sup> A technology improvement case was modeled in which the cost of wind was assumed to decrease 2% per year in real terms. Because the cost study model accommodates a single fixed capacity factor for each resource block (not varying over time), the net impact on levelized cost of energy expected to result from the product of declines in installed cost and increases in annual capacity factor were modeled by decreasing the installed capital cost at the rates noted previously, as a proxy.

#### 5.8.5 Combined Wind and PTC Cases

Four combinations of wind improvement and PTC were run for each scenario. The Base case assumes PTC is in effect and that there are no wind technology improvements. The PTC Phase-Out sensitivity includes the PTC Phase-Out assumption and the wind technology improvements. These first two combinations are considered most likely because lower wind costs are more likely to lead to the PTC Phase-Out.

The two other combinations, PTC with wind technology improvements and PTC Phase-Out without technology improvements, were also run. Although considered less likely, these combinations serve to bound the analysis at the low and high end.

#### 5.8.6 Cumulative Onshore Wind Resources

To reflect the challenges to siting and permitting wind in New York, NYSERDA established a 3,500 MW upper limit to wind resource development within the State for the purposes of this study. This amount corresponds to about a doubling of existing wind capacity and number of sites. Currently, there are 1,734 MW of wind power online, under construction or under contract in the State. Therefore, the cost modeling assumes 1,766 MW of additional wind could be available for development.

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<sup>57</sup> National Renewable Energy Laboratory. *The Past and Future Cost of Wind Energy*. IEA Wind Task 26. NREL/TP--6A20--53510. May 2012, page 7.

## Appendix A. Active Main Tier Facilities as of December 31, 2012

Facility	Contractor	County/ Province
<b>BIOGAS</b>		
Albany Energy LLC	Fortistar Methane Group LLC	Albany
DANC LFGE	Innovative/DANC, LLC	Jefferson
Hyland LFGE	Hyland Facility Associates	Allegany
Chautauqua LFGE	County of Chautauqua	Chautauqua
Seneca Energy	Seneca Energy II, LLC	Seneca
Modern LFGE	Modern Innovative Energy, LLC	Niagara
Ontario LFGE	Seneca Energy II, LLC	Seneca
Clinton Co. Landfill	New England Waste Services of	Clinton
Cumberland County (Community Refuse)	PPL EnergyPlus, LLC	Cumberland (Pennsylvania)
<b>BIOMASS</b>		
Niagara Generating Facility	Niagara Generation, LLC	Niagara
Black River Facility	ReEnergy	Jefferson
<b>HYDRO</b>		
Spier Falls	Erie Boulevard Hydropower LP	Saratoga
Norfolk	Erie Boulevard Hydropower LP	St. Lawrence
Oswego Falls	Erie Boulevard Hydropower LP	Oswego
Browns Falls	Erie Boulevard Hydropower LP	St. Lawrence
Raymondville	Erie Boulevard Hydropower LP	St. Lawrence
Colton	Erie Boulevard Hydropower LP	St. Lawrence
East Norfolk	Erie Boulevard Hydropower LP	St. Lawrence
Allens Falls	Erie Boulevard Hydropower LP	St. Lawrence
Eagle	Erie Boulevard Hydropower LP	Lewis
Higley Falls	Erie Boulevard Hydropower LP	St. Lawrence
Norwood	Erie Boulevard Hydropower LP	St. Lawrence
Piercefield Hydro	Erie Boulevard Hydropower LP	St. Lawrence
Sherman Island	Erie Boulevard Hydropower LP	Saratoga
Effley Hydro	Erie Boulevard Hydropower LP	Lewis
High Falls	Brookfield Energy Marketing, LP	Quebec (Canada)

School Street Hydro Project	Erie Boulevard Hydropower, LP	Albany
Stewarts Bridge Hydro Project	Erie Boulevard Hydropower, LP	Saratoga
Taylorville Hydro Project	Brookfield Renewable Power	Lewis
Wappingers Falls Hydroelectric	Wappingers Falls Hydroelectric LLC	Dutchess
Mechanicville Hydroelectric Project	Albany Engineering Corporation	Saratoga
Stuyvesant Falls Hydroelectric	Albany Engineering Corporation	Columbia
Wave Hydro	Wave Hydro LLC	Onondaga
Black Brook Hydro	Oakvale Construction Co., Ltd.	Clinton
Mill Street Dam Hydroelectric Generation Facility	City of Auburn	Cayuga
<b>WIND</b>		
Maple Ridge	Flat Rock Windpower, LLC	Lewis
Dutch Hill Wind Farm	Canandaigua Power Partners II,	Steuben
Cohocton Wind Farm	Canandaigua Power Partners, LLC	Steuben
Clinton Windpark I	Noble Environmental Power LLC	Clinton
Ellenburg Windpark	Noble Environmental Power LLC	Clinton
Bliss Windpark	Noble Environmental Power LLC	Wyoming
Altona Windpark	Noble Environmental Power LLC	Clinton
Chateaugay Windpark I	Noble Environmental Power LLC	Franklin
Wethersfield Windpark	Noble Environmental Power LLC	Wyoming
Hardscrabble	Iberdrola Renewables, Inc	Herkimer
Marble River Wind Farm	Horizon Wind Energy	Clinton
Steel Winds II	First Wind	Erie
High Sheldon Wind Farm	Sheldon Energy LLC	Wyoming
Howard Wind Farm	Howard Wind LLC	Steuben
Stony Creek Wind Farm	Stony Creek Energy LLC	Wyoming
Locust Ridge Wind Farm	PPL EnergyPlus, LLC	Schuylkill (Pennsylvania)

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Andrew M. Cuomo, Governor

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## Renewable Portfolio Standard Main Tier 2013 Program Review

### Volume 1 — Program Review Introduction

Final Report  
September 5, 2013

**New York State Energy Research and Development Authority**  
Richard L. Kauffman, Chairman | Francis J. Murray, Jr., President and CEO