

New York State Energy Research and Development Authority

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**NYSERDA**

# Renewable Portfolio Standard Main Tier 2013 Program Review

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**

**Summary**

*Final Report*

Prepared by:

**New York State Energy Research and Development Authority**

Albany, NY



# Summary

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## Introduction

The Renewable Portfolio Standard (RPS), established by the New York State Public Service Commission (Commission) and administered by the New York State Energy Research and Development Authority (NYSERDA), has been New York'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>

This summary presents findings associated with the RPS Main Tier<sup>3</sup>, including an evaluation of the benefits and costs associated with the portfolio of currently contracted resources as of December 31, 2012 (the Current Portfolio).<sup>4</sup> It also presents an assessment of the prospects for meeting Main Tier targets (established in 2009/2010) using available uncommitted funds. The program review is comprised of three volumes of work:

- **Volume 1: Program Review Introduction.** This volume provides an overview of the RPS Policy and Orders, a summary of the Program Review approach, a Main Tier 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.
- **Volume 2: Current Portfolio Analysis.** This volume presents an evaluation of all RPS Main Tier projects in the Current Portfolio.<sup>5</sup> The evaluation includes an analysis of the associated direct investment made in New York State, the electricity system impacts of the new renewable generation, a summary of environmental benefits, a detailed benefit-cost analysis, and an assessment of the macroeconomic impacts including net-job creation.
- **Volume 3: Projected Impact from Using Available Uncommitted Funds.** This volume presents an analysis of new renewable resources that could be procured under future Main Tier solicitations by expending the remaining authorized but uncommitted funds. Because the cost, quantities procured, resource mix and timing are highly dependent on the underlying assumptions, Volume 3 presents a base case and various sensitivity analyses.

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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> 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. The Commission also established a separate tier called the Customer-Sited Tier (CST), which is smaller, "behind-the-meter" resources, such as photovoltaic systems, fuels cells, wind facilities, anaerobic digester gas, and similar technologies that for the most part produce electricity for use on site.

<sup>4</sup> A separate report has been prepared for the RPS Customer-Sited Tier.

<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.

## Approach

In fulfillment of the terms of the January 2010 Order, NYSERDA is filing this report with the Commission for public review. This report is intended to assist the Commission in assessing the Main Tier's progress toward meeting its goals and objectives, provide information to assist in the assessment of the various impacts of the program, and assist the Commission in the development of the State's continuing policy and investment strategies in the clean energy sector.

Many areas of the program were extensively considered in the 2009 Program Evaluation Report<sup>6</sup> and addressed through subsequent Commission Orders. As noted in Section 2 of this Summary, these activities have subsequently impacted the scope and emphasis of the evaluation review for 2013. Therefore, the Main Tier 2013 Program Review Report focuses on:

- Main Tier status.
- Main Tier direct economic impacts.
- Main Tier benefit/cost analyses.
- Main Tier macroeconomic effects.
- 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 Main Tier's contributions, and to shed light on how best to continue the State's public investment in the achievement of the RPS Program goals. This report was prepared by NYSERDA and a competitively procured team of contractors in cooperation with Department of Public Service staff. This report presents key findings provided by NYSERDA and contractors Sustainable Energy Advantage, LLC and its subcontractors, La Capra Associates and Economic Development Research Group, as well as ICF International.

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<sup>6</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).

## Main Tier Program Status (Volume 1)

### Program Performance

The original modeling work to establish the 2015 Main Tier target was conducted in 2009. In its April 2, 2010 Order, the Commission established NYSERDA Main Tier and Customer-Sited Tier program targets for supporting the production of approximately 10.4 million MWh of renewable energy annually by 2015.<sup>7</sup> Including recent changes in the allocations of these targets based on the 2012 Customer-Sited Tier Program Operating Plan<sup>8</sup>, this consists of approximately 9.5 million MWh from the Main Tier and 0.9 million MWh from the Customer-Sited Tier.

As of December 31, 2012, Main Tier contracted projects are expected to produce 4.49 million RPS Attributes<sup>9</sup> in 2015, representing about 47% of the Main Tier target.<sup>10</sup> 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.

Therefore, the RPS Main Tier results to date have been achieved more cost-effectively than originally projected.

NYSERDA has conducted seven competitive Main Tier solicitations and is in the process of completing an eighth Main Tier solicitation in pursuit of the Main Tier target. As of December 31, 2012, the seven completed solicitations have resulted in active contracts to procure RPS Attributes from 54 large-scale electricity generation projects, facility upgrades or facility repowerings. Contracts with four generators expired under their terms prior to the end of 2012.<sup>11</sup> These solicitations resulted in facilities under contract from a variety of renewable generation types including wind, biomass, biogas, and hydroelectric. Wind comprises the majority of contracted projects, representing approximately 79% of generation. When all of the currently contracted projects reach commercial operation, approximately 1,834 MW of new renewable capacity<sup>12</sup> will be added.

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<sup>7</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 to the RPS,” issued and effective April 2, 2010.

<sup>8</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}>

<sup>9</sup> One RPS Attribute is generated by the production of one megawatt-hour (MWh) of energy production from an eligible renewable generator. RPS Main Tier contracts only allow RPS Attribute payments to be made upon their generation and delivery to New York State. Therefore, funding associated with underperforming projects can be reallocated to procure new renewable resource Attributes that contribute to achievement of the Main Tier target.

<sup>10</sup> NYSERDA counts toward the MWh program targets only the portion of a project’s output or potential output that is under contract. Under the RPS rules, the maximum amount eligible for bid is 95% of output; some facilities have bid and are under contract for less than 95%.

<sup>11</sup> RFP 916 permitted contract delivery terms of less than 10 years.

<sup>12</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.

## Current Portfolio Impact Analysis (Volume 2)

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 State's 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 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.

## Analytic Findings

The overall benefit-cost analysis with respect to the Current Portfolio yielded the following key findings:

- Approximately \$2.7 billion dollars of direct investments in New York State are expected over the projected life of the renewable energy facilities.
- Fossil fuel usage is expected to be reduced by 1% or approximately 130 trillion Btus.
- CO<sub>2</sub> emissions are expected to be reduced by more than 50 million tons. 15 million tons each of NO<sub>x</sub> and SO<sub>2</sub> emissions reductions are also expected.

## Summary

- Program costs are expected to comprise less than 0.2% of total retail electricity expenditures.
- Taking into account wholesale electricity price reductions resulting from the program, the program's cumulative net rate impact is projected to be essentially zero.
- Net electricity imports are expected to decline by approximately estimated 4.7%, or an average of 1.17 million MWh per year.
- Under base CO<sub>2</sub> value assumption, the statewide benefit-cost analysis shows a net benefit of approximately \$1.6 billion, with a benefit to cost ratio of approximately 5 to 1.<sup>13</sup>
- Under high CO<sub>2</sub> value assumption, with approximately \$3.5 billion in net benefits, benefit to cost ratio is approximately 9 to 1.<sup>14</sup>
- There is expected to be a per year net gain of approximately 670 jobs in the New York economy.
- The cumulative net growth in gross state product, taking into account all stimulative and depressive factors, is expected to be approximately \$2 billion.

The analysis of quantifiable benefits and costs demonstrates that public investment through the RPS Main Tier has a positive impact on the State economy and the environment. The positive economic impact is in part attributed to the fact that every \$1 of State RPS funding invested captures on average almost \$3 in direct investments in New York.

The renewable energy generation that is supported by the public investment displaces electricity imported from out-of-state (estimated to decrease by almost 5% over the study period) and natural gas generation that is supplied with largely out-of-state fuel. Therefore, in-state renewable energy investments help keep New Yorkers' money in the State, fueling economic growth and the creation of approximately 670 jobs, even after accounting for any jobs lost due to the depressive effect of building fewer conventional plants. The cumulative gross state product (GSP) gain is expected to be approximately \$2 billion, with a net present value (NPV) of \$921 million.

It is critical to note that generation displaced by the operation of new renewable energy facilities is the most expensive generation, which sets the prices for the entire market. By displacing this generation, the wholesale electricity price paid by in-state ratepayers is reduced, which has two effects: (1) increasing consumer purchases of in-state goods and services creating in-state jobs, and (2) reducing profits to existing generators whose owners largely reside out-of-state. From 2002 to 2037, electricity system modeling results show that New York generators produce approximately 37.5 million more megawatt-hours of electricity in-state in the current generation profile. This generation results in a cumulative GSP gain of approximately \$1.1 billion, with an NPV of \$414 million.

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<sup>13</sup> A base value of \$15/ton CO<sub>2</sub> (in 2010 dollars) was used.

<sup>14</sup> An upper bound of \$85/ton CO<sub>2</sub> (in 2000 dollars) was used to place an upper bound on the value of carbon.

Positive environmental impacts are attributed to the fact that the portfolio of renewable generation is dominated by wind energy, a zero-emission resource that displaces a significant amount of fossil fuel combustion, avoiding the emissions of greenhouse gases and criteria air pollutants. Between 2014 and 2025, the peak years of renewable energy generation from the Current Portfolio, it is estimated that 2.6 million tons of CO<sub>2</sub> per year will be avoided (equivalent to removing 510,000 cars off the road), as well as displacing about 15 million tons each of NO<sub>x</sub> and SO<sub>2</sub> from 2006 through 2037.

## **Projected Yield from Commitment of Remaining Main Tier Funds (Volume 3)**

NYSERDA conducted an analysis of new renewable resources that could be procured under future Main Tier solicitations by expending the remaining \$1.316 billion of authorized but uncommitted funds. Depending on the underlying assumptions, there may be different results for cost, quantities procured, resource mix and timing. The analysis therefore included a number of sensitivity analyses to show the impact of critical assumptions.

The cost study work uses a model of the New York 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 has been used in previous analyses of RPS program compliance costs, and key assumptions have been updated for this effort.

### **Analytic Findings**

Of the various input assumptions, two factors predominantly impact the amount of renewable generation that can be expected from spending the remaining approved Main Tier budget of \$1.316 billion<sup>15</sup>: the future availability of the Federal Production Tax Credit (PTC), and the future trajectory of the cost and performance of on shore wind power. Therefore two cases were explored, yielding the following outcomes:

- The first case assumes that the PTC is extended in its current form, and incorporates on shore wind technology improvements to date, but assumes that further technological (and associated cost and performance) improvements do not occur throughout the period 2013 through 2015. In this case the available funding is projected to procure an additional 3,700 GWh per year of renewable energy. Combined with the Current Portfolio, total program progress would approach 8,200 GWh per year, representing 86% of the Main Tier target.

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<sup>15</sup> This available budget anticipates a re-allocation of \$108 million from Main Tier budgets to support the NY-Sun Initiative in 2014 and 2015.

- The second case assumes that the PTC is phased out by 2019, and on shore wind technological (and associated cost and performance) improvements continue throughout the period 2013 through 2015.<sup>16</sup> In this case the available funding is projected to procure a reduced total of 3,000 GWh of additional renewable generation per year resulting in total program progress of 7,500 GWh per year, representing 79% of the Main Tier target. Although the PTC phase-out has a material impact on the Main Tier's buying power, this impact could be partially offset by an expected decline in the overall cost of capital, as more expensive tax equity required to monetize tax credits would be replaced by lower cost sources of capital such as traditional equity and slightly increased use of debt.<sup>17</sup>

## Factors Influencing Program Progress

As a result of a variety of market conditions, the outlook for meeting RPS Main Tier program goals in 2015 appears more challenging than a few years ago. 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. Total authorized funding for Main Tier program procurements was established by the Commission based on expectations of future market conditions. Market conditions, most critically the expected future prices of natural gas, have changed substantially from what was expected back in 2009. Although the results to date for the Main Tier program have been achieved more cost-effectively than originally projected, current market conditions and future projections suggest that the remaining authorized Main Tier funding doesn't appear sufficient to achieve the 2015 program targets that were established in 2009/2010.

Various factors influence the premium required to support renewable energy project development, thus the ultimate achievements of the program. Factors that limit the program's ability to achieve its prescribed target within the given budget include:

- Continued low natural gas prices result in reduced wholesale revenues for projects, exacerbate financing and hedging difficulties, and ultimately drive up ratepayer premiums to develop renewable energy.
- The continuing uncertainties and stop/start nature of federal renewable energy tax credits and grants have disrupted the renewable energy market nationwide.
- Challenges persist in siting and permitting projects in New York State, which result in higher project costs and reduce the pace of development of market-ready projects.

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<sup>16</sup> The PTC Phase-out case includes an examination of potential future technology improvements beyond recent improvements as the PTC Phase-out would most likely be justified based on future technology improvements. The impact of the PTC Phase-out is therefore partially offset by these improvements.

<sup>17</sup> This expected decline is anticipated due to the fact that currently there are limited suppliers of the tax equity required to utilize the PTC. This limited supply and high demand for tax equity increases the cost of capital. Without the PTC more traditional financing mechanism become available at more reasonable costs, and this lower cost financing partially offsets the impacts of losing federal tax incentives.

In part because of these factors, many projects in New York State are only in the early stages of development and are likely not in a position to respond effectively to any near-term RPS solicitation, which requires considerable financial security for commercial operation milestones that they will have difficulty satisfying.

Factors that enable program success include onshore wind turbine cost and technology advancements, which are expected to result in reduced cost per MWh and a greater number of MWh produced per installed MW. These enabling factors are potentially significant but are not expected to be large enough to off-set the limiting factors described above.

## Considerations for Future Program Implementation

Not all influences are outside the control of the program such as the chosen pace of procurements, contract tenor and other design features. New York State may benefit from a renewed consideration of these features in addition to alternative financing strategies, such as those that may emerge through the State's Green Bank initiative and expanded renewable energy policy objectives.

New York State should consider proceeding carefully so that it can capture cost-reducing innovations in the renewable industry over time, avoid less-than-optimal program outcomes by only supporting technologies and projects that are market-ready, benefit from remaining federal subsidies<sup>18</sup> and enjoy the benefits of new financing options<sup>19</sup> that may emerge in response to reducing federal subsidies.

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<sup>18</sup> If federal incentives are extended, re-accelerating project development would take some time initially, and the structure of any federal commitment (particularly any phase-out schedule) would hopefully account for this lag; if not, projects in New York State might be at a disadvantage as time to re-engage and move through permitting processes in New York could result in New York projects foregoing higher levels of federal incentives available in the early years of any phase-out schedule.

<sup>19</sup> Master limited partnerships (MLPs) and real estate investment trusts (REITs) are examples of financing innovations being developed or considered that could potentially reduce the cost of financing capital-intensive renewable energy projects. Legislative changes may be required to enable such financing vehicles.

New York State Energy Research and Development Authority

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Volume 1 — Program Review Introduction

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# 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;
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- 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>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 NYSEDA 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, NYSEDA 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 NYSEDA 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. NYSEDA 2015 RPS Energy Targets (MWh).

**Table 1. NYSEDA 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.

<p>PSC Order Clarifying NYSDERDA Main Tier RPS Target and Resolving Main Tier Eligibility Issues</p>	<p>April 2010</p>	<p>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.</p>
<p>NYSDERDA Files 2010 CST Operating Plan Setting Forth Revised Program Specification Budgets and Targets</p>	<p>June 2010</p>	<p>Revised the CST budgets and targets.</p>
<p>PSC Order Regarding Acceptance of Permanent Tariff Levels for RPS Collections</p>	<p>October 2010</p>	<p>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.</p>
<p>PSC Order Allowing Main Tier "Behind The Meter" Contracts and Wholesale Delivery to Utility/Municipal Utility/Public Authority Entities, Applicable to Future Solicitations Only</p>	<p>November 2010</p>	<p>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>

<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.

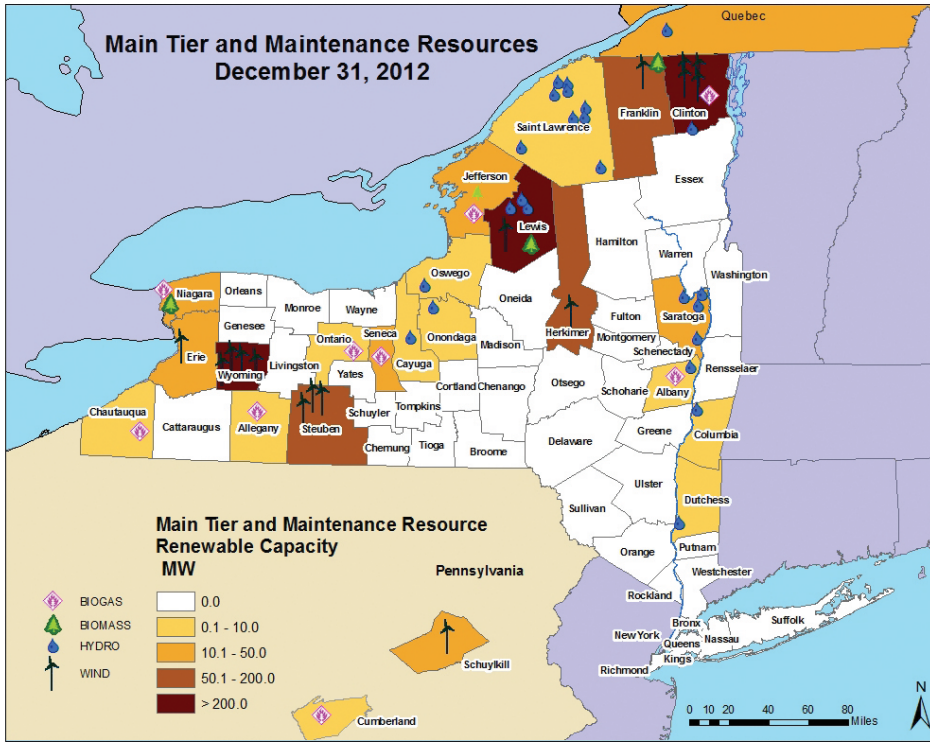
**Table 4. Project Development Status for Contracted Main Tier Projects as of December 31, 2012**

	<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

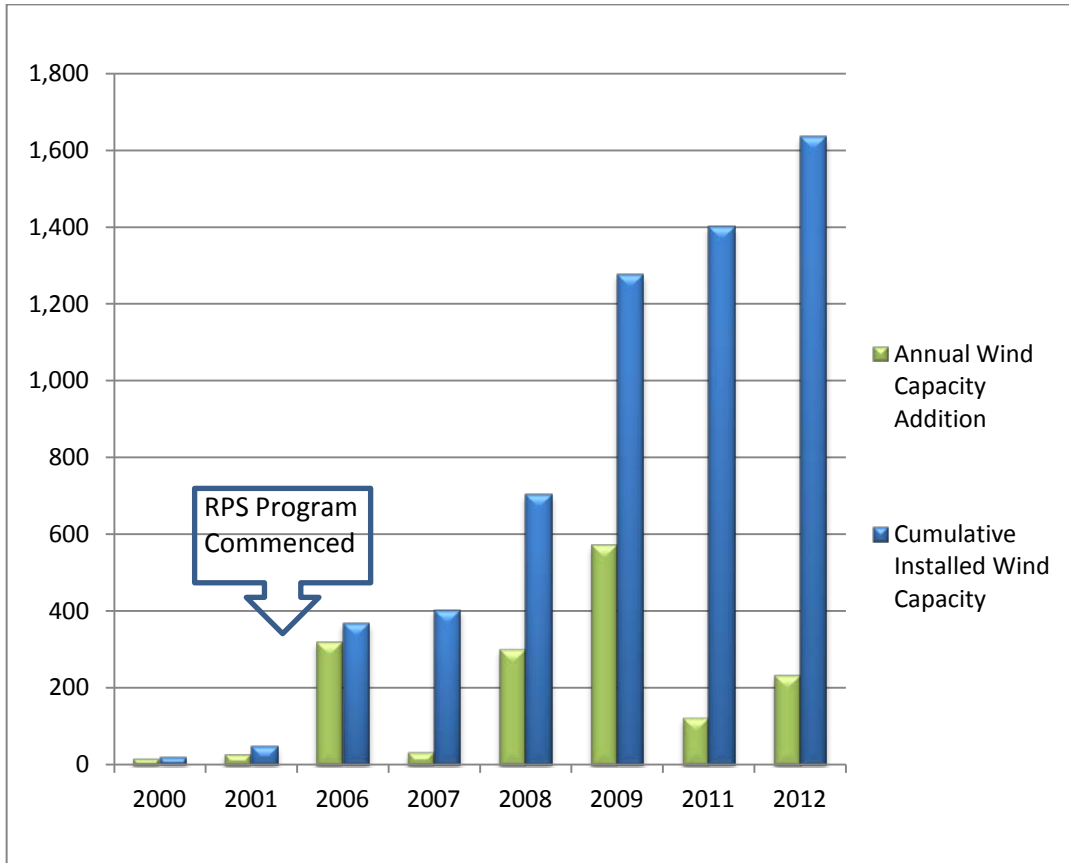


### 4.3 Wind Power Capacity Additions to New York State

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).

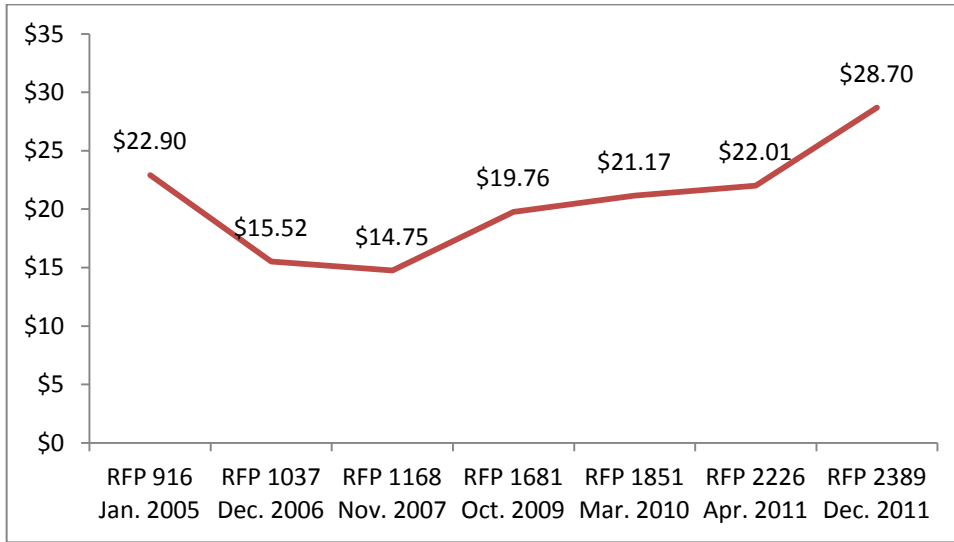
**Figure 2. Wind Power Capacity Additions to New York by Year**



#### 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.

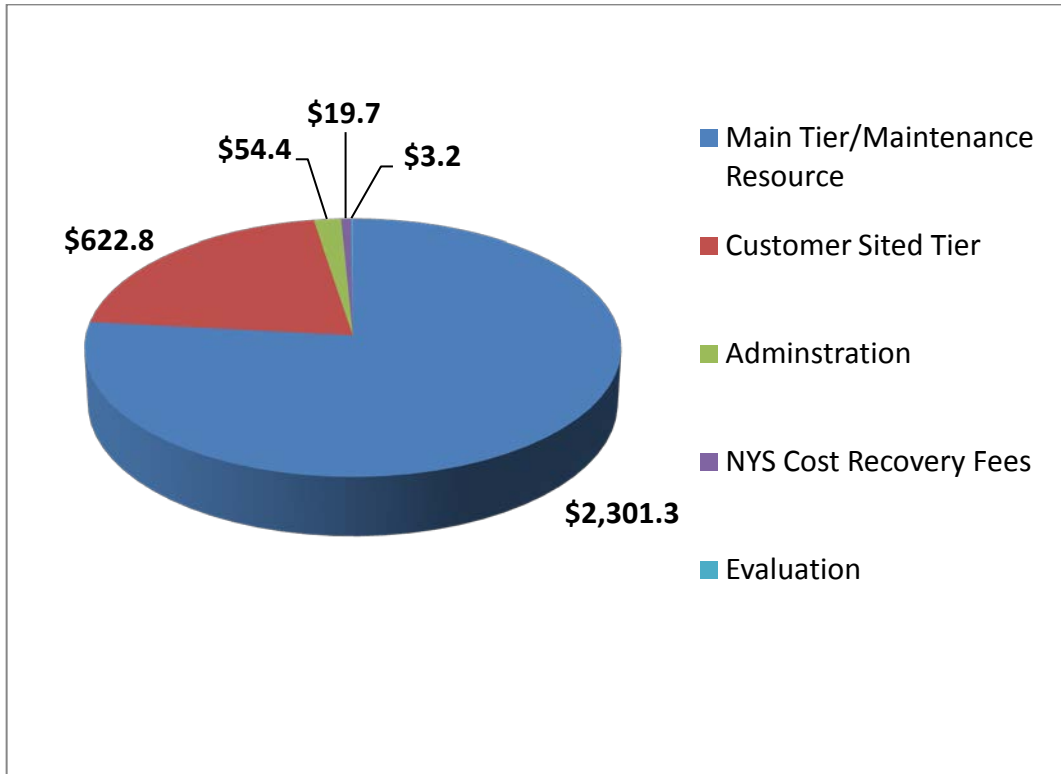
The major categories and amounts of funding by each category, based on Commission decisions rendered through the close of 2012 are presented in Figure 4.<sup>31</sup>

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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**

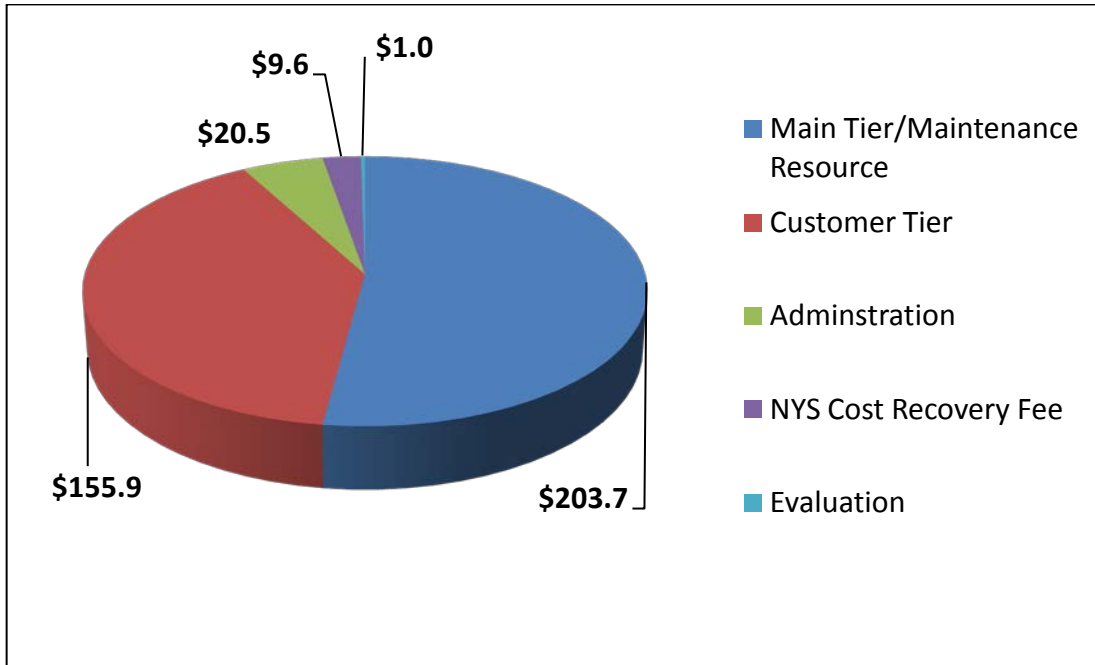


As of December 31, 2012, approximately \$1.2 billion, or roughly 40% of the total approved RPS funding, has been expended or committed to achieving NYSERDA’s 2015 targets (inclusive of administration and NYS fees). This includes \$876.6 million for program resource acquisition costs in the Main Tier,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

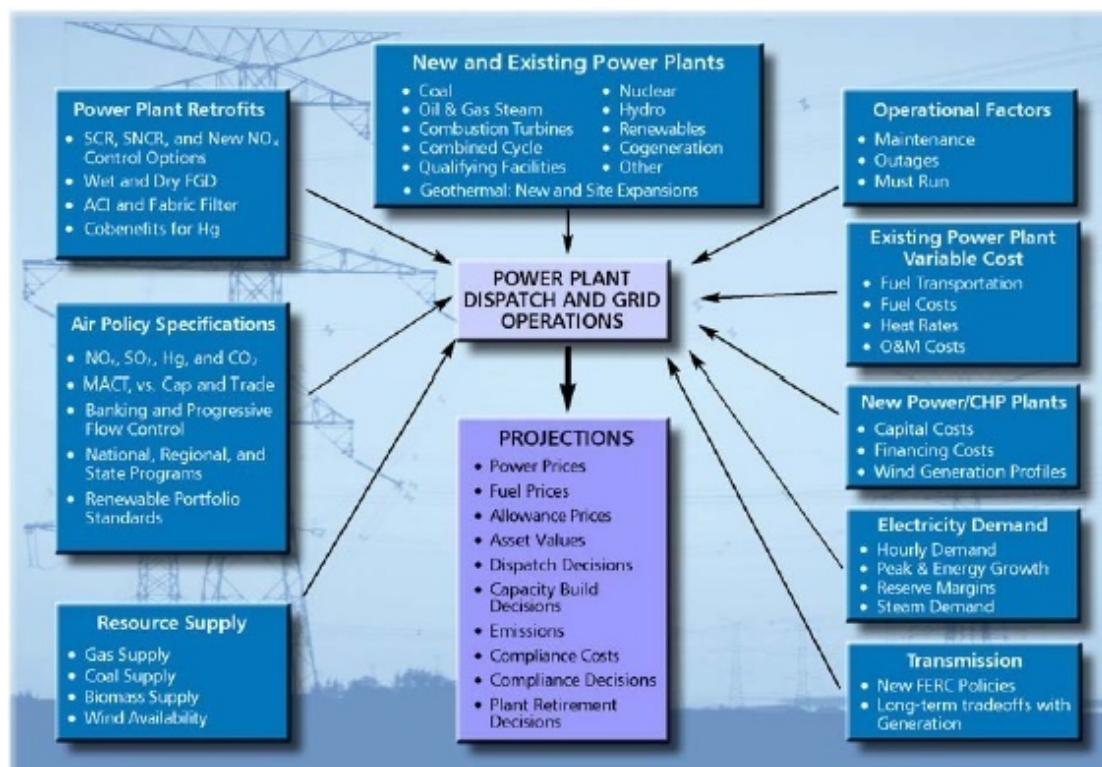
<sup>35</sup> *Proceeding on Motion of the Commission Regarding a Retail Renewable Portfolio Standard*; “Order Authorizing Solicitation Methods and Consideration of Bid Evaluation Criteria and Denying Request for Clarification,” issued and effective October 19, 2006, p. 16.

<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.

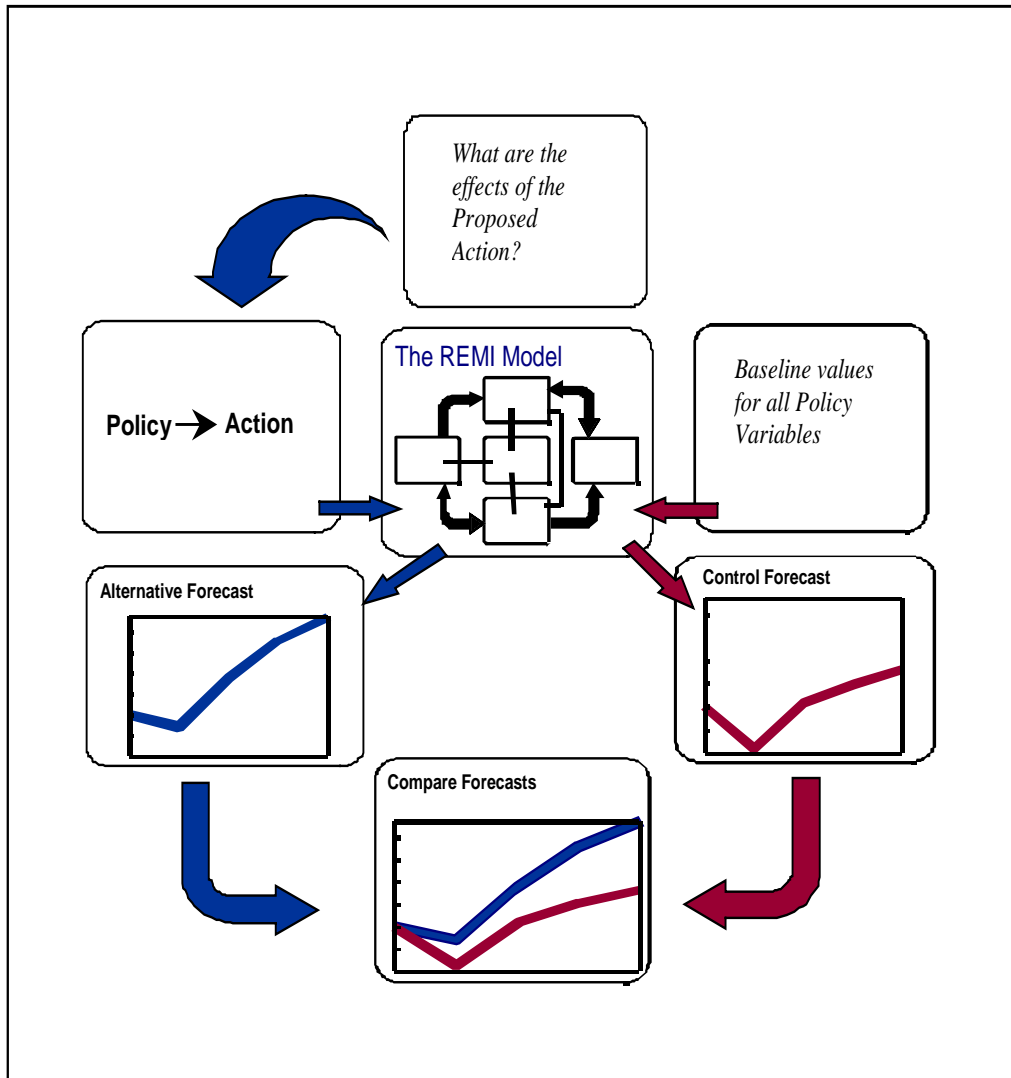
<sup>44</sup> Developed in 1986 by Regional Economic Models, Inc. See <http://www.remi.com/the-remi-model> for more information about the model.

<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):

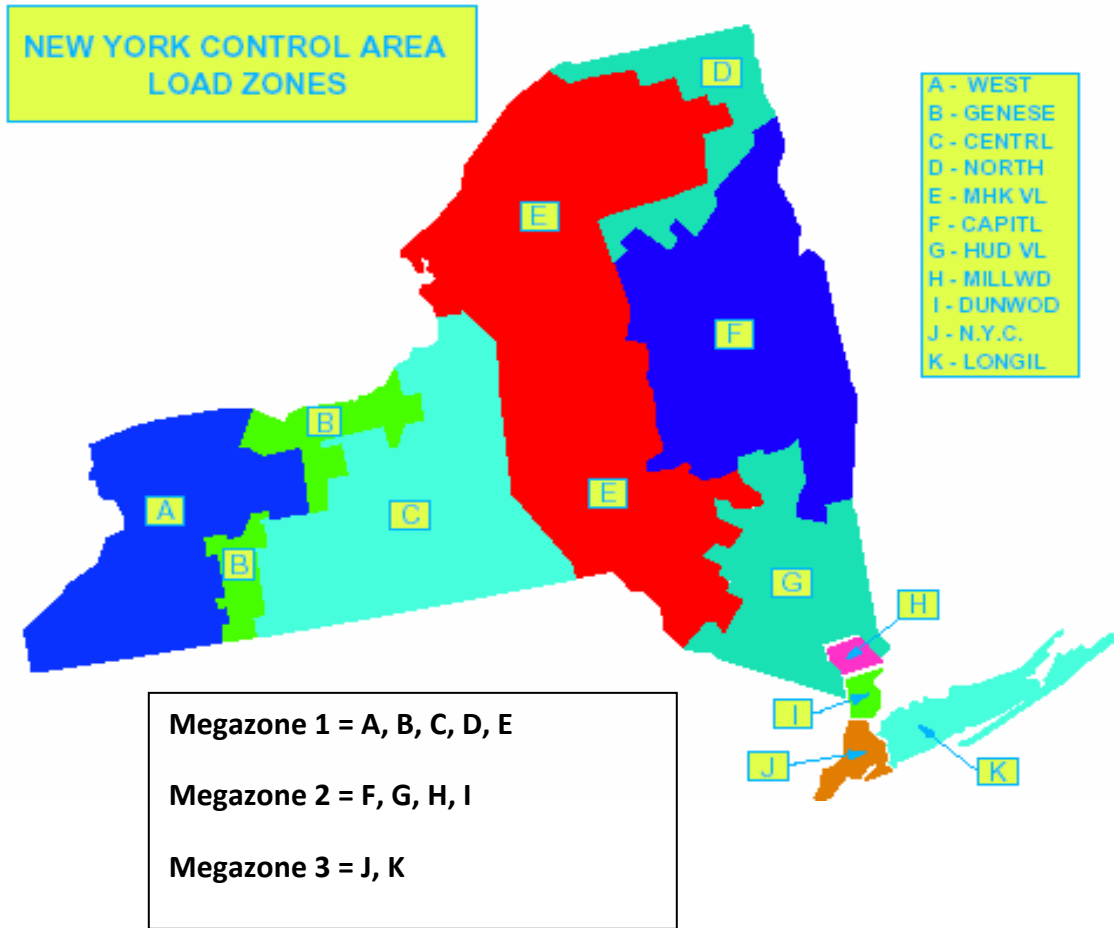
- Megazone 1 = IPM Region 1 = NYISO Zones A, B, C, D and E.
- Megazone 2 = IPM Regions 2 and 3 = NYISO Zones F, G, H and I.
- Megazone 3 = IPM Regions 4 and 5 = NYISO Zones J and K.

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)

New York State Energy Research and Development Authority

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**NYSERDA**

# Renewable Portfolio Standard Main Tier 2013 Program Review

Volume 2 — Main Tier Current Portfolio Analysis

Final Report

September 5, 2013



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

**Volume 2**  
**Main Tier Current Portfolio Analysis**

*Final Report*

Prepared by:

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

September 5, 2013

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## Executive Summary

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Volume 2 of NYSERDA's 2013 Renewable Portfolio Standard (RPS) Main Tier Program Review focuses on an evaluation of the current portfolio of RPS Main Tier projects.<sup>1</sup> 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 the Public Service Commission (Commission) with 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. Evaluation of the Main Tier therefore also encompasses analysis of statewide macroeconomic impacts on the State, including changes in employment.

### Main Tier Status

As of December 31, 2012, Main Tier contracted projects are expected to produce 4.49 million<sup>2</sup> RPS Attributes in 2015, representing about 47% of the Main Tier target.<sup>3</sup> 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. Therefore, the RPS Main Tier results to date have been achieved more cost-effectively than originally projected. Although a range of renewable energy technologies have participated in the Main Tier solicitations, wind energy comprises the majority of expected generation at nearly 80% of the portfolio. Furthermore, wind energy is expected to continue to dominate the supply in the pending eighth solicitation and future Main Tier procurements, as wind energy comprises the majority of least cost renewable energy supply.

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<sup>1</sup> The 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.

<sup>2</sup> One RPS Attribute is generated by the production of one megawatt-hour (MWh) of energy production from an eligible renewable generator.

<sup>3</sup> NYSERDA counts toward the MWh program targets only the portion of a project's output or potential output that is under contract. Under the RPS rules, the maximum amount eligible for bid is 95% of output; some facilities have bid and are under contract for less than 95%.

## Evaluation of Benefits and Costs

From this analysis of quantifiable benefits and costs, it can be concluded that public investment in Main Tier renewable energy resources is having a positive impact on the State economy and the environment. The positive economic impact is in part attributed to the fact that every \$1 that the State invests in RPS Main Tier projects captures on average almost \$3 in direct investments in New York. Furthermore, the renewable energy generation that is supported by the public investment displaces electricity imported from out-of-state (estimated to decrease by almost 5% over the study period) and natural gas generation that is supplied with largely out-of-state fuel. Therefore in-state renewable energy investments help keep New Yorker's money in-state, fueling economic growth and the creation of approximately 670 jobs, even accounting for any jobs lost due to the depressive effect of building fewer conventional plants. Finally, it is critical to note that the displaced generation is the most expensive generation, which sets the prices for the entire market. By displacing this generation, the wholesale electricity price paid by in-state ratepayers is reduced, which has two effects: (1) increasing consumer purchases of in-state goods and services creating in-state jobs, and (2) reducing profits to existing generators whose owners largely reside out-of-state.

The positive environmental impacts are attributed to the fact that the portfolio of renewable generation is dominated by wind energy, a zero-emission resource that displaces a significant amount of fossil fuel combustion, avoiding the emissions of greenhouse gases and criteria air pollutants. Between 2014 and 2025 are considered the peak years of renewable energy generation. During that time period, an estimated 2.6 million tons of CO<sub>2</sub> per year will be avoided, which is equivalent to removing 510,000 cars off the road.

Key findings from the analysis include:

- Approximately \$2.7 billion dollars of direct investments in New York State are expected over the projected life of the renewable energy facilities.
- Fossil fuel usage is expected to be reduced by 1% or approximately 130 trillion Btus.
- CO<sub>2</sub> emissions are expected to be reduced by more than 50 million tons. 15 million tons each of NO<sub>x</sub> and SO<sub>2</sub> emissions reductions are also expected.
- Program costs are expected to comprise less than 0.2% of total retail electricity expenditures.
- Net electricity imports are expected to decline by an estimated 4.7%, or an average of 1.17 million MWh per year.
- Taking into account wholesale electricity price reductions resulting from the program, the program's cumulative net rate impact is projected to be essentially zero.

- Under base CO<sub>2</sub> value assumption, the statewide benefit-cost analysis shows a net benefit of approximately \$1.6 billion, with a benefit to cost ratio of approximately 5 to 1.
- Under high CO<sub>2</sub> value assumption, with approximately \$3.5 billion in net benefits, benefit to cost ratio<sup>4</sup> is approximately 9 to 1.
- There is expected to be a per year net gain of approximately 670 jobs in the New York economy.
- The cumulative net growth in gross state product, taking into account all stimulative and depressive factors, is expected to be approximately \$2 billion.

## Structure of the Report

Volume 2 is a companion piece to Volume 1 and Volume 3 of the overall RPS Main Tier Program Review.<sup>5</sup> This volume presents an evaluation of the current portfolio of RPS Main Tier projects.

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<sup>4</sup> The base CO<sub>2</sub> value assumption is \$15/ton CO<sub>2</sub> (in 2010 dollars), the high CO<sub>2</sub> value assumption is \$85/ton CO<sub>2</sub> (in 2000 dollars).

<sup>5</sup> Volume 1 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. Volume 3 presents an analysis of new renewable resources that could be procured under future Main Tier RPS solicitations by expending the remaining authorized but uncommitted funds.

# 1 Introduction and Approach

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## 1.1 NYSERDA Progress Through December 31, 2012

As of December 31, 2012, 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. Table 1 outlines the award announcement dates of the seven completed Main Tier solicitations (also referred to herein as Requests for Proposals [RFPs]).

**Table 1. Main Tier Solicitation Award Dates**

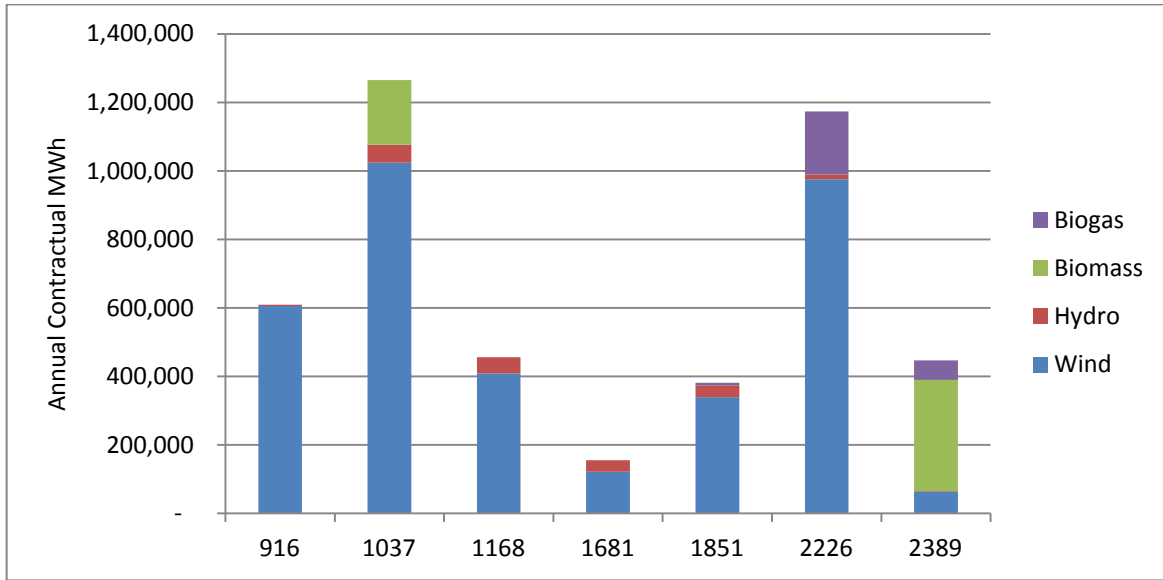
<b>Request for Proposals</b>	<b>Award Date</b>
RFP 916	January 2005
RFP 1037	February 2007
RFP 1168	January 2008
RFP 1681	December 2009
RFP 1851	March 2010
RFP 2226	April 2011
RFP 2389	December 2011

The original RPS Order required NYSERDA to seek Commission authorization prior to issuing a solicitation. In 2010, the Commission changed its policy and authorized NYSERDA to issue solicitations at least annually, to provide greater predictability to the market. Since that time, NYSERDA has completed two solicitations and released an eighth solicitation (RFP 2554) in late 2012.

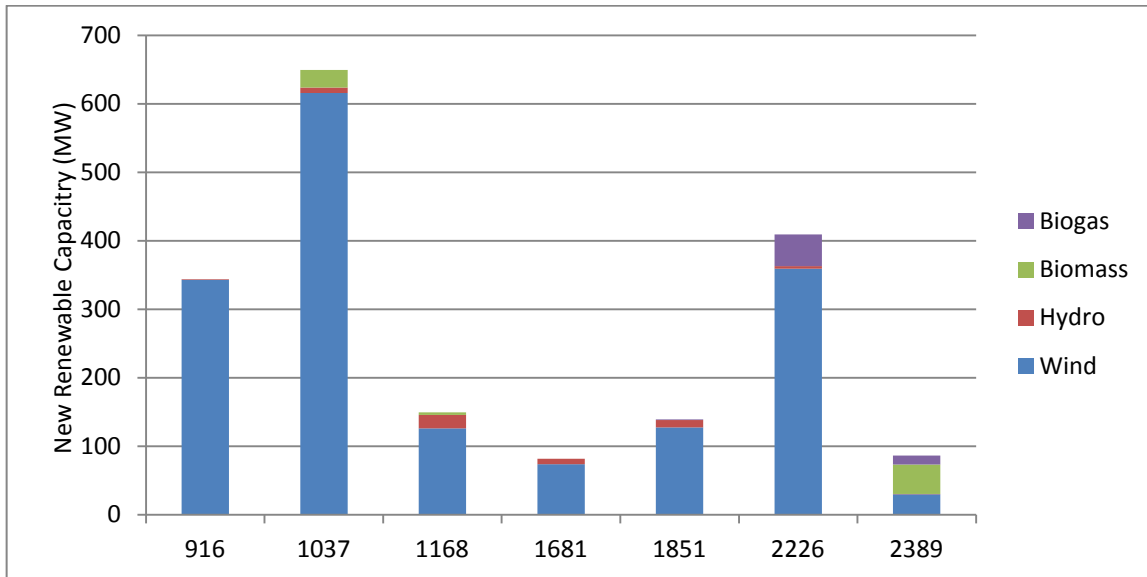
### 1.1.1 Main Tier Progress by Procurement

The results of the first seven Main Tier procurements are summarized in Figures 1 and 2 for expected annual RPS Attribute deliveries (in MWh) and capacity (MW), respectively, based on contracted values as of December 31, 2012.

**Figure 1. Annual Contracted Generation by RFP as of December 31, 2012**



**Figure 2. New Renewable Capacity<sup>6</sup> by RFP as of December 31, 2012**

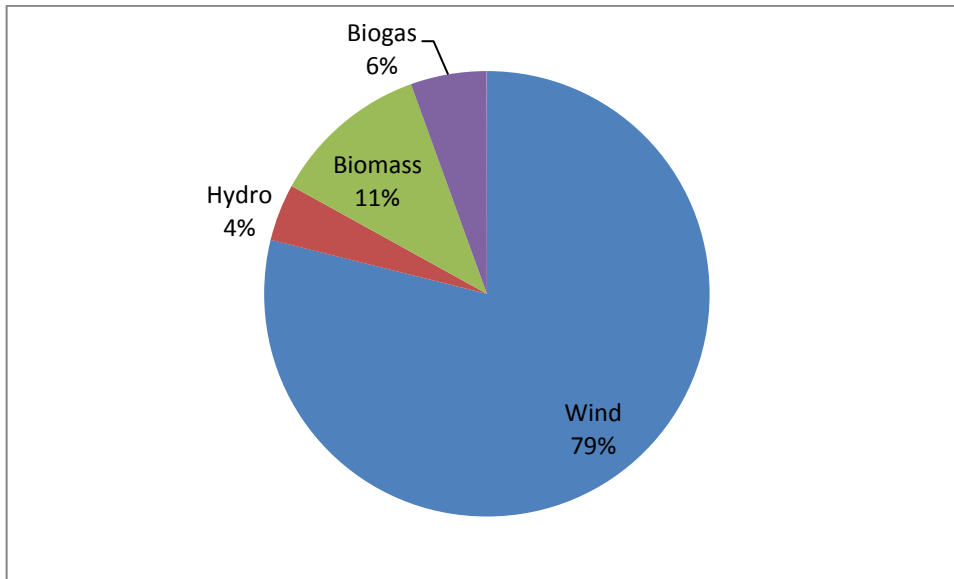


<sup>6</sup> New Renewable Capacity generally refers to the Nameplate Capacity of facilities under contract in the RPS that did not exist prior to the start of the RPS program, including any portion not under contract with NYSERDA.

### 1.1.2 Main Tier Status

As of December 31, 2012, Main Tier contracted projects are expected to produce 4.49 million RPS Attributes<sup>7</sup> in 2015, representing about 47% of the Main Tier target.<sup>8</sup> These solicitations resulted in facilities under contract from a variety of renewable generation types including wind, biomass, biogas, and hydroelectric. Wind comprises the majority of generation (79%) as shown in Figure 3. Wind is expected to continue to dominate the supply in the pending eighth solicitation and future Main Tier procurements, as wind comprises the majority of least cost renewable energy supply.

**Figure 3. Cumulative Annual Contracted Generation by Resource Type**



### 1.1.3 Main Tier Project Development Status

Through seven completed Main Tier solicitations, NYSERDA has current contracts to procure RPS Attributes from 54 large-scale electricity generation projects, facility upgrades, or facility repowering. Contracts with four generators ended prior to the end of 2012. Most contracts secure RPS Attributes for NYSERDA for a period of 10 years.<sup>9</sup>

<sup>7</sup> One RPS Attribute is generated by the production of one megawatt-hour (MWh) of energy production from an eligible renewable generator.

<sup>8</sup> NYSERDA counts toward the MWh program targets only the portion of a project’s output or potential output that is under contract. Under the RPS rules, the maximum amount eligible for bid is 95% of output; some facilities have bid and are under contract for less than 95%.

<sup>9</sup> RFP 916 permitted contract delivery terms of less than 10 years.

When all of the projects reach commercial operation, they will represent approximately 1,834 MW of new renewable capacity,<sup>10</sup> of which 1,787 MW will be located in New York. Wind power is the predominant generating technology in the Main Tier and represents 1,653 MW of new renewable capacity under contract 1,561 MW of which was in operation at the end of 2012. The balance of new capacity is comprised of hydroelectric upgrades, landfill gas to electricity (shown as biogas in Table 2, and biomass (direct and co-fired) facilities. As of December 31, 2012, 50 projects representing approximately 1,695 MW were in operation, and four remaining projects representing approximately 139 MW were expected to be in operation by September 30, 2013. Further details on the status of Main Tier projects can be found in Table 2.

**Table 2. Project Development Status for Active 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>

## 1.2 RPS Main Tier Program Funding Commitments

As of December 31, 2012, 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.

## 1.3 Approach to Main Tier Retrospective Analysis

As discussed in greater detail in Volume 1 of this Program Review, evaluating the impact and effectiveness of the RPS Main Tier program entails considering a range of factors. This Volume includes analysis of the current portfolio of renewable energy generation sources that have been successful in bidding into NYSERDA's Main RFPs through December 31, 2012 (the "Current Portfolio")<sup>11</sup>. The results presented in this Volume account for the associated cost of Main Tier procurements to ratepayers, assess the direct investments in the New York State

<sup>10</sup> New Renewable Capacity as described differs from Bid Capacity, which reflects the portion of a facility's capacity that is under contract with NYSERDA.

<sup>11</sup> The "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.

economy, and model the impact of Main Tier generation resources on the New York wholesale electric system, compared to what would have occurred in the absence of the Main Tier procurements. These impacts include identifying what types of generation are displaced, what generating units are not built or retired as a result of injecting additional renewable energy supply and the effect on locational-based marginal prices (LBMPs) in the New York Independent System Operator (NYISO) competitive wholesale electric energy markets. This Volume also 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 Main Tier program.

But changes in costs and spending as a result of the program impact the State's economy beyond these direct effects. Evaluation of the Main Tier through December 31, 2012 therefore also encompasses analysis of the indirect and induced macroeconomic impacts on New York State's economy.

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.

## 2 Direct Investment in New York State

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The objective of this section is to present an assessment of the direct investments made in New York State that are associated with Main Tier contracts as of December 31, 2012 (“the Current Portfolio”). The analysis includes verified direct investments in New York associated with a subset of Main Tier and Maintenance resource<sup>12</sup> contracts along with estimates of those investments associated with the remaining projects with current Main Tier contracts. This data is further used as inputs for the overall Benefit-Cost and Macroeconomic analysis as discussed later in this Volume. The focus of this analysis is on direct investments in New York, which is a subset of the total amount spent by project developers, because the analysis provides an estimate of the direct economic development benefit realized in New York State. Some studies simply provide the total cost of project development, including imported hardware and services, so comparison to other economic development reports should be made with care.

Key findings of this analysis include:

- Approximately \$2.7 billion dollars of direct investments in New York State are expected over the projected life of the current portfolio of Main Tier RPS facilities, as measured in jobs, payments to public entities, in-state purchases and land leases.
- For every \$1 spent on the acquisition of RPS Attributes for the Current Portfolio of Main Tier RPS projects under contract with NYSERDA, on a Net Present Value (NPV) basis, New York State is expected to capture on average almost \$3 in direct investments associated with project spending over project lifetime.
- Overall, approximately \$27 in direct investments are produced as a result of project expenditures in New York for every 1 MWh of renewable energy that is generated under the Main Tier program.

### 2.1 Background

One of the key objectives of New York State’s RPS is to stimulate and capture for the State the direct investments associated with expanding the role of renewable energy in the State’s electricity supply mix. Specifically, in the Commission’s September 2004 Order,<sup>13</sup> it specified RPS Program Objectives that were used to guide the development of the RPS program. One such objective was defined as “Economic Benefits: develop renewable resources and advance renewable resource technologies in - and attract renewable resource generators, manufacturers - and installers to New York State.”

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<sup>12</sup> This effort includes stand-alone analyses of 17 Main Tier projects and one Maintenance resource project with verified benefits.

<sup>13</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.

As a result, in its design of most Main Tier procurements, NYSERDA has adopted the quantification of verifiable direct investments in New York as part of the evaluation criteria. Winning bids are determined based on a weighted combined score with RPS Attribute price comprising 70% and direct investments in New York at 30% of the weight. After three years of a Main Tier contracted project's operation, in-state direct investment data is made available to NYSERDA and verified, allowing NYSERDA to develop a reliable assessment of the direct investments in the State resulting from this program.

An analysis of direct investments in New York State was accomplished in late 2012 and early 2013 by first evaluating verified in-state direct investment data from 18 projects with NYSERDA Main Tier and Maintenance resource RPS contracts that had reached their three-year operating anniversary, and projecting these investments through the life of each project. The resulting data was then used to extrapolate New York-specific economic benefits attributable to all projects in the Main Tier Current Portfolio. The resulting Current Portfolio data was then analyzed in a variety of ways to assess the scope and location of the direct investments from this portfolio of projects. An investment ratio was also calculated, which is an analysis of the direct investments in New York from project development and operations versus the correlating Main Tier investment.

More detail on the methodology and results for this analysis can be found in the report titled "Renewable Portfolio Standard Main Tier 2013 Program Review: Direct Investments in New York Report," which is in Appendix A. This analysis focuses on the direct investment impacts of the Main Tier program, in terms of the scale and type of New York State spending previously incurred and expected to be incurred by Main Tier-contracted projects in the Current Portfolio for development and ongoing operations. These data are further used as inputs for the overall Benefit-Cost and Macroeconomic analysis discussed in Sections 5 and 6 of this report.

## **2.2 Scope of Direct Investments in New York Analysis**

The direct investments in New York State were calculated and analyzed for short and long-term economic impacts.

Short-term impacts included:

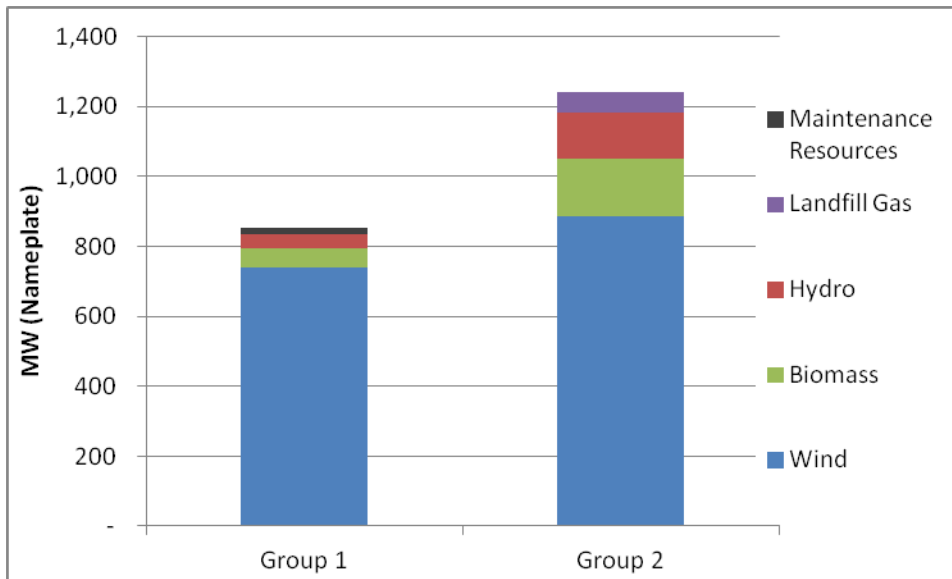
- Jobs lasting three years or less, such as construction, planning, engineering and legal jobs.
- Initial equipment or one-time capital expenditures for the development and construction of the project.

Long-term impacts included:

- Project ongoing operations and maintenance payroll (including salaries and benefits).
- Taxes or Payments in Lieu of Taxes to the state, municipalities, and schools (payments to public entities).
- Fuel purchases.
- Landowner payments.
- Other Operations and Maintenance in-state spending on equipment, supplies and services.

The Main Tier projects were analyzed in two groups. Group 1 projects have submitted, and NYSERDA has verified, three years of spending data, which were used as the basis for the direct investment analysis. Group 2 projects consist of the remaining projects under contract with NYSERDA, many of which submitted bid data on expected direct investments but have not operated under the NYSERDA contract for three years, the period after which reporting is required. Group 1 is smaller than Group 2, with approximately 834 MW versus 1,241 MW, as shown in Figure 4. The Group 1 total includes one 19 MW Maintenance resource project, which was used for the verified data analysis but not included in the Main Tier Current Portfolio analysis that followed.

**Figure 4. Nameplate MW by Technology and Group**



### 2.3 Projects With Verified Direct Investments in New York (Group 1)

The direct investments in New York State that had been verified for the eighteen Group 1 facilities formed the basis for projecting the direct investments which were anticipated to accrue to New York from the construction and operation of all projects with Main Tier contracts as of December 31, 2012. These facilities included 8 wind farms, 2 biomass facilities and 8 hydroelectric facility upgrades, which were all located in New York State.

The direct investment in New York State assessment was based on the verified dataset that included spending data through three years of operation. This three-year dataset was comprised of a mix of short-term spending, characterized as initial investments for project upgrades or development, and long-term spending for operations and maintenance. Expected long-term expenditures were extrapolated for each technology over the remainder of a project’s assumed useful life.

Despite having a robust dataset of verified spending from Group 1 projects, the study required developing a number of educated assumptions to complete the dataset for Group 1 projects. These assumptions included the split between short-term versus long-term spending within these datasets, anticipated project life, fuel cost, and the magnitude of New York impact of unreported long-term spending for capital replacements. Although a small portion of additional expenditures were treated as in-state benefits, the bulk of these expenditures were de-rated using regional price coefficients from the Regional Economics Model Inc. model to estimate the fraction of project expenses that are not expected to directly impact in-state businesses. This fraction was then removed from any estimate of in-state benefit.

Although the RPS contracts only obligate NYSERDA to pay for RPS Attributes<sup>14</sup> for a 10-year period, this analysis incorporated spending benefits and production for the entire project life, consistent with two key assumptions: the initial RPS contract enabled the project to be built, and the State will continue to experience the benefits of the associated in-state operation and maintenance (O&M) spending through the life of the projects. All projects were assumed to operate at maximum capacity for future years, while historic production data and associated RPS payments were used for reported years.

### **2.3.1 Projects Without Verified Spending (Group 2)**

Key metrics from Group 1 lifetime expenditures were utilized to estimate direct investments in New York State for Group 2 projects of the same resource types through their respective project lives. Due to the greater level of accuracy and reliability of verified data compared to project bid data, Group 1 verified expenditure data were utilized for this purpose instead of bid-based/proposed data whenever possible. When corresponding data were not available from the Group 1 data set, bid proposal data were used to project direct investments.

## **2.4 Results**

Combining the Group 1 and Group 2 results for a total portfolio analysis allowed for an overall evaluation of the Current Portfolio of Main Tier projects. The results in Table 3 show the total direct investments in New York combining Group 1 and Group 2 projects for a total portfolio analysis in both real (2012 dollars) and nominal dollars.

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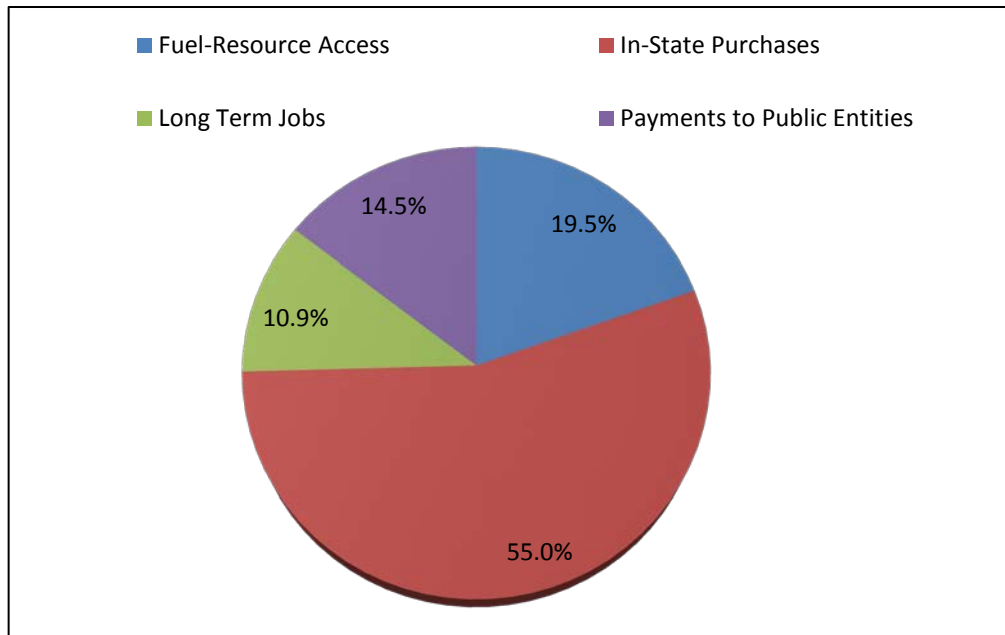
<sup>14</sup> RPS Attributes include any and all reductions in harmful pollutants and emissions, such as carbon dioxide and oxides of sulfur and nitrogen. RPS Attributes are similar to Renewable Energy Certificates that are commonly used in other RPS programs to catalog and recognize environmental attributes of generation.

**Table 3. Summary of Total, \$/MW and \$/MWh Direct Investments in New York<sup>15</sup>**

Technology	Nominal Dollars			2012 Dollars		
	Total (Millions)	\$/MW <sup>16</sup>	\$/MWh <sup>17</sup>	Total (Millions)	\$/MW	\$/MWh
Wind	2,065	1,269,000	26	1,951	1,199,000	24
Hydroelectric	55	323,000	12	51	298,000	11
Biomass	709	3,252,000	69	603	2,765,000	59
Landfill Gas	111	1,894,000	21	95	1,623,000	18
<b>Total</b>	<b>2,940</b>	<b>1,417,000</b>	<b>29</b>	<b>2,699</b>	<b>1,301,000</b>	<b>27</b>

Direct investments in New York for the Current Portfolio of Main Tier projects totaled approximately \$2.7 billion (2012 dollars), with the majority of investments occurring as long-term project expenditures for operating and maintaining the projects over their useful life as described in the next section. Due to extensive ongoing payments for fuel, biomass projects have the highest \$/MW and \$/MWh direct spending over the life of the projects. Figure 5 shows the breakdown of direct investments in New York State by category over the projected life of the current RPS Main Tier project portfolio, with in-state purchases being the largest portion.

**Figure 5. Current Portfolio Total Direct Investments in New York by Category (2012 dollars)**



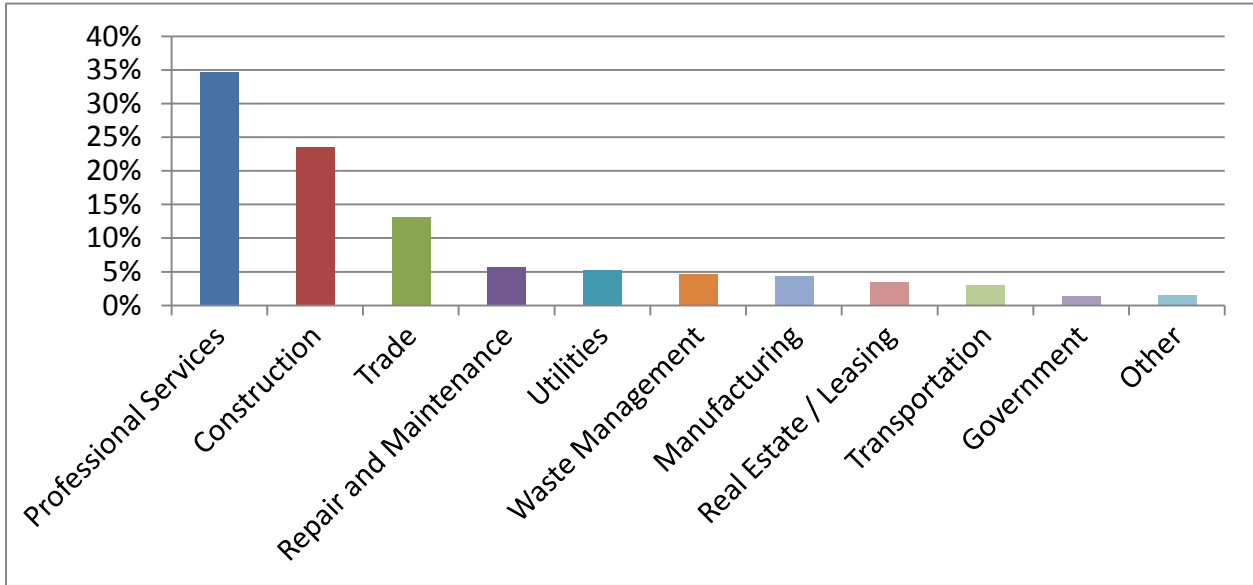
<sup>15</sup> The values in this table are not discounted.

<sup>16</sup> MW corresponds to the entire project’s full nameplate capacity, rather than the portion of capacity under RPS contract.

<sup>17</sup> MWh reflects expected production over a project’s lifetime, and is calculated based on the new renewable energy capacity enabled by the RPS contract, generally assuming that the RPS contract is for 95% of new renewable capacity.

These direct investments in New York also have a greater impact on some sectors of the economy than on others. Figure 6 shows the breakdown for in-state purchases by industry sector. The sectors with the greatest portion of benefits include Professional Services<sup>18</sup>, Construction, and Trade.

**Figure 6. Current Portfolio In-State Purchases by Sector (2012 dollars)**

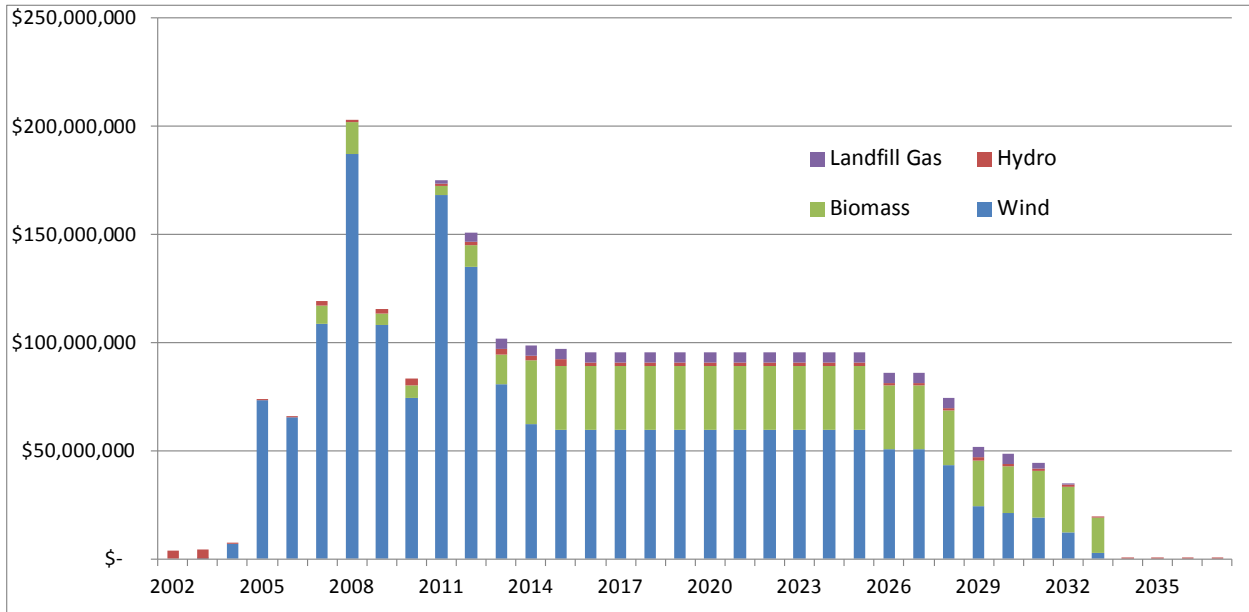


## 2.5 Direct Investments in New York by Technology

The results from the direct investments in New York study were used as inputs for the benefit-cost and macroeconomic analyses as discussed in Section 5 and Section 6 of this Volume. Both analyses required year-by-year spending summaries by technology, as well as some detail on the type of spending incurred in different categories and sectors. The previous section shows summaries of spending by category and sector. Figure 7 depicts the direct investments in New York by year, broken down by technology. Direct spending fluctuates in the early years as projects are being developed and installed, and then stabilizes as the portfolio of projects complete installation and commence stable long-term operations.

<sup>18</sup> Professional Services includes Finance & Insurance, Legal, and Architectural & Engineering Services.

**Figure 7. Direct Investments in New York by Year and Technology (2012 dollars)**



**Note:** For the purpose of this report, the study period for direct investments in New York State was 2002-2037.

## 2.6 Direct Investments Versus RPS Program Investment

In this analysis, an investment ratio was calculated that compares the current portfolio of project’s direct investments in New York State with the RPS investments in Main Tier and Maintenance Resource projects. The direct investments in New York State are calculated as all direct in-state spending over the project’s useful life, which extends beyond the 10-year RPS contract. The RPS Program investment portion of this comparison is the total RPS-related cost premium borne by ratepayers for procuring RPS Attributes over what is typically a 10-year term. The premise of this assumption is that the Main Tier program is responsible for stimulating construction and operation, whether or not NYSERDA contracts for the whole project output over a project’s entire useful life. Table 4 summarizes the Direct Investments in New York State and RPS Program Investment in nominal dollars for Group 1 and Group 2.

**Table 4. Total Direct Investments in New York State and RPS Program Investment (Nominal Dollars)**

<b>Technology</b>	<b>Total Direct Investments in New York (Millions)</b>	<b>Total RPS Program Investment (Millions)<sup>a</sup></b>
<b>Wind</b>	\$2,065	\$675
<b>Hydroelectric</b>	\$55	\$26
<b>Biomass</b>	\$709	\$163
<b>Landfill Gas</b>	\$111	\$58
<b>Total</b>	<b>\$2,940</b>	<b>\$922</b>

<sup>a</sup> For this calculation, RPS Program Investment included the actual historical payments and future contracted payments for RPS Attributes in addition to the historical and projected Administration costs for the Current Portfolio of Main Tier and Maintenance Resource projects.

Table 5 shows the Direct Investments in New York State and RPS Program Investments in 2012 dollars on a Net Present Value (NPV) basis, which is used to calculate an investment ratio for each technology. An investment ratio in excess of 1 reflects greater direct investment realized than what was spent to implement and execute RPS contracts. An investment ratio in excess of 1 was realized, or is expected, across technologies for the Current Portfolio of Main Tier projects. In total, the current project portfolio studied yielded much more benefit than cost, on average, with a ratio of 2.9.

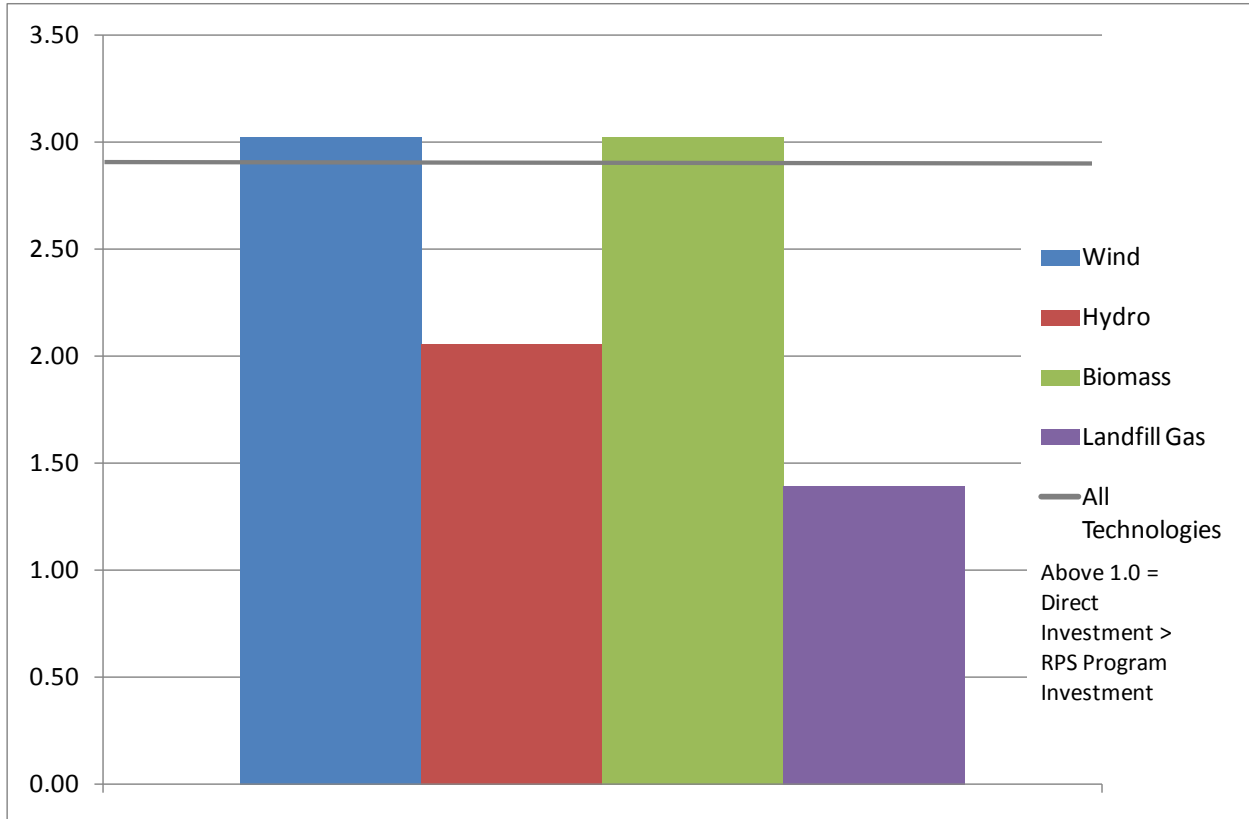
**Table 5. NPV of Total Direct Investments in New York, RPS Program Investment, and Investment Ratio (2012 dollars)**

<b>Technology</b>	<b>NPV Total Direct Investments in New York (Millions)</b>	<b>NPV Total RPS Program Investment (Millions)</b>	<b>Investment Ratio</b>
<b>Wind</b>	\$979	\$324	3.0
<b>Hydroelectric</b>	\$25	\$12	2.0
<b>Biomass</b>	\$214	\$71	3.0
<b>Landfill Gas</b>	\$34	\$24	1.4
<b>Total</b>	<b>\$1,252</b>	<b>\$431</b>	<b>2.9</b>

Wind and biomass had high investment ratios of 3.0, while the investment ratio for hydroelectric was 2.0, and landfill gas was 1.4. On the whole, the Current Portfolio of projects (including all technologies) yielded 2.9 times as much direct, in-state investment from project development and operations as was invested in the program.

Figure 8 visually depicts the investment ratio results, including the program average by technology.

**Figure 8. Investment Ratios by Technology**



## 3 Electricity System Modeling

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This section describes the electricity sector modeling analysis that was completed to evaluate the electricity system impacts of the RPS Main Tier program.

Key findings of the modeling analysis include:

- Generation output from Main Tier resources primarily displaces generation from in-State natural gas resources and imported electricity. Coal has been displaced, but is displaced less and less over time.
- Net electricity imports decline by an estimated 4.7%, from 2006 through 2037, or an average of 1.17 million MWh per year.
- Main Tier additions displace about 320 MW of cumulative combined-cycle capacity additions through 2037.
- On average, from 2006 through 2037, wholesale electricity prices are, or are expected to be, less than 1% lower due to Main Tier additions. These lower prices are a benefit to ratepayers.
- From 2006 through 2037, it is projected that Main Tier facilities will displace a total of more than 50 million tons of CO<sub>2</sub> and about 15 million tons each of NO<sub>x</sub> and SO<sub>2</sub>.

Electricity sector modeling was performed to analyze the market impacts of the RPS Current Portfolio. As described in Volume 1, the modeling tool used was the Integrated Planning Model<sup>®</sup> (IPM<sup>®</sup>), developed by ICF International. IPM<sup>®</sup> is a linear programming model, which incorporates the New York State electricity system, the systems managed by the Independent System Operator of New England (ISO-NE) and PJM Interconnection (PJM), as well as the systems extending throughout the rest of the United States and Canada. The objective function is to solve for the optimal system dispatch (including imports and exports), new capacity, retirements, and repowering, given the specified demand, system characteristics, reserve margins, and environmental constraints. Key input data include existing and firmly planned generation units, annual electricity demand by zone, load shapes, transmission system capacities and transfer limits, generation unit level operation and maintenance costs and performance characteristics, fuel prices, new capacity and emission control technology costs and performance characteristics, zonal reliability requirements, national and state environmental regulations, and financial market assumptions.

This section is organized as follows:

- Section 3.1 discusses the overall approach to setting up modeling cases and measuring impacts.
- Section 3.2 describes system impacts in terms of overall generation mix (including net imports), capacity mix, wholesale electricity prices, and emissions.

### 3.1 Modeling Cases

The modeling cases for this analysis relied on the same assumptions as the draft State Energy Plan (SEP) Reference case that was developed in 2012. NYSERDA worked closely with the NYISO and other stakeholders in developing key modeling input assumptions used in SEP modeling. (See Volume 1 for a listing of certain key assumptions.) To explore the impact of the Main Tier through 2012, a Base case was developed that represented what might occur in the absence of an RPS policy. The Base case removed all renewable capacity that had executed a contract with NYSERDA and was built to-date due to the Main Tier contract commitments. The Current case was developed by Current Portfolio altering the Base case to include all Main Tier funded renewable capacity that was in place or under contract from NYSERDA through the end of 2012. Therefore, any difference in modeling output between the cases can be attributed to the RPS policy itself. Both cases were run for 2012 through 2035.

Capacity additions and retirements that are not specified by NYISO planning assumptions or identified as Main Tier unit additions in the Current case are IPM<sup>®</sup> projections, which are based on the model's internal economic comparison of the present value of annual unit operating costs to expected long-term energy and capacity revenues.

### 3.2 Results From Base And Current Cases

#### 3.2.1 Generation Mix and Net Imports

As shown in Figure 9, in 2012 the Current case contained approximately 2,900 GWh of additional in-state generation from renewable resources as compared to the Base Case. In 2013 and beyond (as shown in the 2020 and 2030 case comparisons in Figure 9), when all Current case renewable capacity is assumed in-service, there is approximately 4,700 GWh of additional in-state renewable generation in the Current case as compared to the Base case.

In 2012, the in-State renewable generation displaced the following sources of generation:

- 1,247 GWh (43%) natural gas .
- 725 GWh (25%) coal.
- 928 GWh (32%) imported electricity.

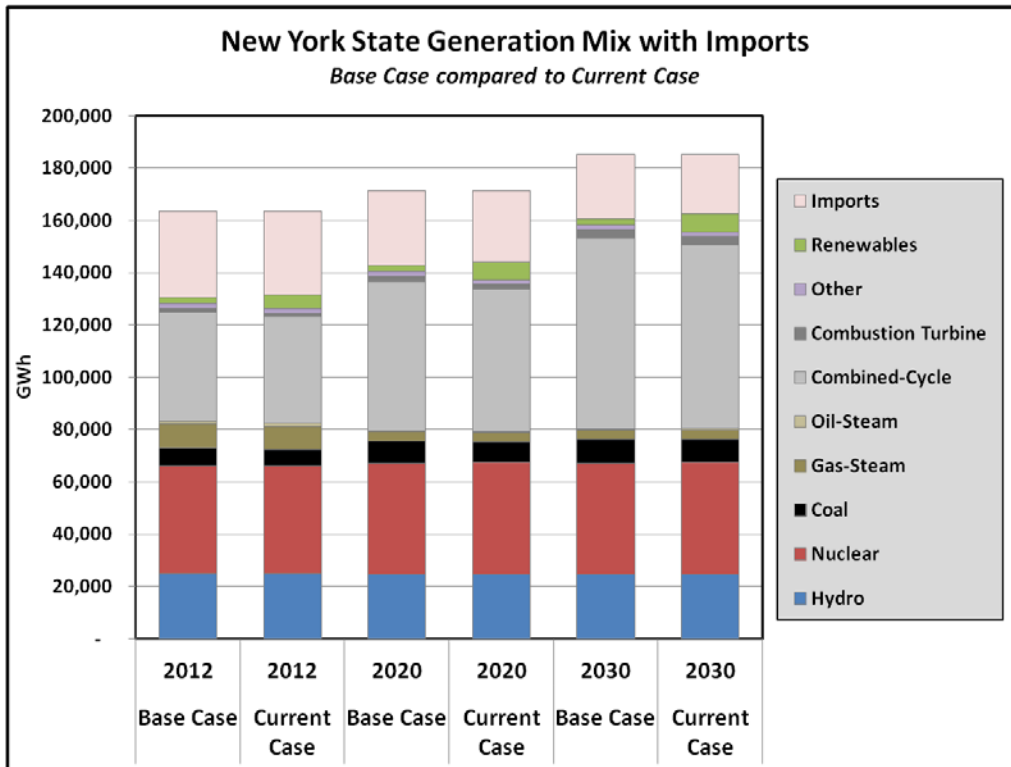
In 2020, the percentages shift to displacing:

- 2726 GWh (58%) natural gas.
- 470 GWh (10%) coal.
- 1504 GWh (32%) imported electricity.

Natural gas is displaced more often in future run years, because, in part, the average delivered natural gas price rises much faster than the coal price over time, causing natural gas to more frequently be the marginal fuel. For example, from 2012 to 2020, the average New York State delivered natural gas price to generators was assumed to rise approximately 59% in real terms versus an 8% increase in delivered coal costs over the same period. In addition, the IPM<sup>®</sup> model starts to add “economic” natural gas combined cycle capacity in both cases starting in 2020, contributing to a higher share of natural gas displacement as natural gas capacity makes up a higher share of the overall resource mix.

When comparing the Current case to the Base case, net imported electricity declines by a total of approximately 37.5 million MWh from 2006 to 2037, or an average of 1.17 million MWh per year during this period. This average equates to an estimated 4.7% reduction in total net imported electricity.

**Figure 9. Generation Mix and Imports in Base and Current Cases**

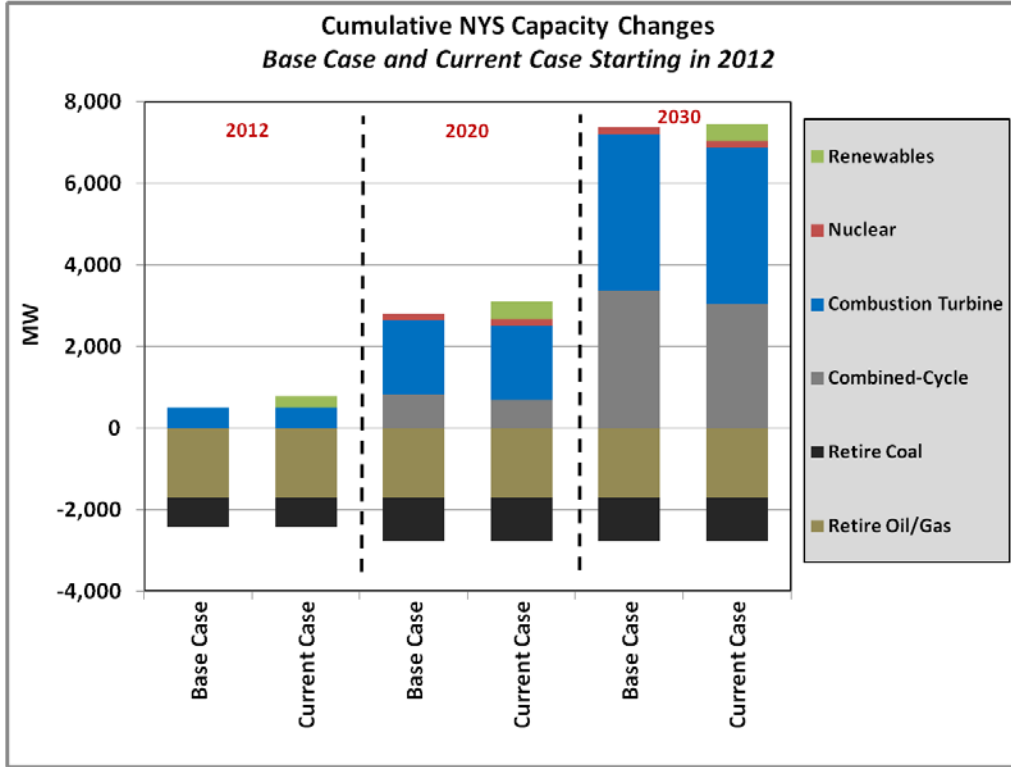


### 3.2.2 Capacity Build Mix

As shown in Figure 10, there is approximately 285 MW of renewable capacity added in 2012 in the Current case not added in the Base case. Note, however, that when considering the total difference in renewable capacity between cases in 2012 (also reflecting Main Tier capacity that was built prior to 2012 in the Current case that is not included

in the Base case), there is approximately 1,600 MW of additional in-state Main Tier capacity in the Current case in 2012. This figure grows to about 1,800 MW by 2013 as the final Current Portfolio projects are added.

**Figure 10. Cumulative Capacity Additions and Retirements in Base and Current Cases**



Other than the difference in renewable capacity described, there was no difference in capacity additions or retirements between cases until model year 2020. Cumulatively from 2020 to 2035 approximately 320 MW more combined-cycle capacity was added in the Base case as compared to the Current case. Total economic conventional capacity additions were 9,250 MW in the Base case from 2014 through 2035, compared to 8,928 MW in the Current case. There were no other meaningful differences in net capacity changes between the two cases.

Note that both cases contain approximately 670 MW of firm conventional capacity builds and 2,723 MW of firm conventional capacity retirements through 2035.

### 3.2.3 Wholesale Electricity Prices

As a result of the Main Tier program, from 2012 to 2035, the firm power prices (defined as including both energy and capacity prices) are, on average, less than 1% lower in the Current case than under the Base case. The price disparity peaks in model run year 2016 before decreasing substantially in model run year 2020 and beyond.

Firm price reductions in the Current case before 2020 are due to both energy and capacity price reduction effects. However, starting in 2020, due to ample load growth, IPM<sup>®</sup> builds economic combined-cycle capacity in both cases, effectively normalizing the total capacity in both cases and eliminating capacity related price reductions in the Current case. Therefore, starting in 2020, firm price reductions in the Current case decline substantially and are due primarily to modest price reduction effects in the energy market.

This reduction in firm power prices in the Current case benefits electricity customers in New York State, and, as described in Volume 1, this savings is considered a benefit in Section 5 of this Volume and is used an input for the modeling in Section 6 in this Volume.

### 3.2.4 Emissions

For the purposes of measuring emission benefits of the Main Tier program, emission changes by pollutant were considered in the following geographic regions:

- CO<sub>2</sub>: United States and Canada.
- NO<sub>x</sub>: Cross State Air Pollution Rule (CSAPR) Region Tier 1.
- SO<sub>2</sub>: CSAPR Region Tier 1.
- Mercury: United States.

Over the course of the 2002-2037 study period it is projected that Main Tier funded facilities will displace a total of more than 50 million tons of CO<sub>2</sub> and about 15 million tons each of NO<sub>x</sub> and SO<sub>2</sub>.

## 4 Environmental Benefits

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This section explores the environmental impacts of renewable deployment under the Current Portfolio. This section focuses on the changes in emission levels and identifies the reduction in fossil fuel usage due to the deployment of RPS funded facilities.

Key findings of this analysis include:

- Over the study period (2002 – 2037) Current Portfolio RPS facilities reduce fossil fuel usage by New York electrical generators by 133 trillion BTUs (or TBTUs), which represents a 1% reduction over this time period. This figure includes reductions from both coal and natural gas.
- Over the study period (2002 – 2037) Current Portfolio RPS facilities lower North American CO<sub>2</sub> emissions by more than 50 million tons. This reduction corresponds to 2.6 million tons per year during the 2014-2025 peak RPS generation period, equivalent to removing 510,000 cars from the road.
- The amount of CO<sub>2</sub> reductions remains small compared to the total reductions that were identified for the power generation sector in the *New York Climate Action Plan Interim Report*.<sup>19</sup> Over the peak RPS generation period (2014-2025), RPS facilities will reduce CO<sub>2</sub> emissions in New York by 1.2 million tons per year (equivalent to removal of 230,000 cars), or 3% of the average annual emissions from the electric generation sector.
- SO<sub>2</sub>, NO<sub>x</sub> and mercury all show decreases over the study period based on the areas examined.

For the purpose of measuring changes in emissions, the following areas were considered:

- CO<sub>2</sub>: United States and Canada.
- Mercury: United States.
- NO<sub>x</sub> and SO<sub>2</sub>: Cross State Air Pollution Rule (CSAPR) Tier 1 Region (Indiana, Iowa, Kentucky, Maryland, Michigan, Missouri, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and Wisconsin).

This section is organized as follows:

- Section 4.1 discusses the air emission impacts due to RPS facility deployment.
- Section 4.2 describes the amount of fossil fuel consumption reduced as a result of RPS facility deployment.

Table 6 summarizes the air emission reductions over the 2002-2037 study period from deployment of Current Portfolio RPS program facilities.

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<sup>19</sup> New York State Climate Action Council, Department of Conservation. 2010. *New York Climate Action Plan Interim Report*. <http://www.dec.ny.gov/energy/80930.html>

**Table 6. Air Emissions Reductions due to RPS Current Portfolio, 2002-2037**

<b>Air Pollutant</b>	<b>Emission Reduction</b>
SO <sub>2</sub>	14,987 tons
NO <sub>x</sub>	15,214 tons
Mercury	278 pounds
CO <sub>2</sub>	50,294,204 tons

For the 2002-2037 study period, it is projected that RPS facilities will displace a total of more than 50 million tons of CO<sub>2</sub>. This total includes impacts beyond New York (in the United States and Canada), because all CO<sub>2</sub> emissions have the same global warming potential. As discussed in Volume 1, applying both a base and high value assumption for the per-ton value of CO<sub>2</sub> reductions results in net present value benefits of between \$312 million and \$2.2 billion. The difference between these two values is large, and the choice of value has a significant impact on the benefit-cost analysis discussed in Section 5.

SO<sub>2</sub>, NO<sub>x</sub>, and mercury also show decreases over the study period, which are estimated to cause \$48 million in health benefits over the study period. NO<sub>x</sub> emission decreases would have been larger, but the reductions were partly offset by the emissions from biogas and biomass RPS facilities. SO<sub>2</sub> and mercury emissions are small due to the fact that natural gas is the predominate fuel on the margin and it contains no sulfur or mercury.

Based on the IPM<sup>®</sup> electricity system modeling conducted as part of this study, the average annual CO<sub>2</sub> emissions from the New York State electric generation sector during the years (2014-2025) of peak renewable generation<sup>20</sup> are approximately 36.5 million tons. The RPS facilities will reduce CO<sub>2</sub> emissions by about 1.2 million tons on average per year in this period (equivalent to removing approximately 230,000 cars from the road), or roughly 3% of the average annual projected emissions. The installation of renewable facilities will therefore contribute to the State’s overall goals to reduce CO<sub>2</sub> emissions in the electric power sector, but a broader portfolio of climate action strategies will be required if the State seeks to achieve an 80 by 50 greenhouse gas emission reduction goal (as had been identified in the New York State Climate Action Plan Interim Report).

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<sup>20</sup> Data from 2014-2025 were used to represent the “peak period” when renewable generation from the Current Portfolio was at its highest.

## 4.1 Fossil Fuel Use Impacts

In total, the Current Portfolio RPS facilities would reduce fossil fuel consumption in power plants by more than 133 trillion BTUs (or TBTUs). Table 7 shows the reductions by fuel. Fuel displacement is for coal and natural gas-powered generation with almost no impacts on oil consumption.

**Table 7. Fossil Fuel Reductions, Current Portfolio, 2002-2037**

<b>Fossil Fuel</b>	<b>Reduction (trillion BTUs)</b>
Coal	76
Natural Gas	58

To give a perspective on the impact of the Current Portfolio of RPS facilities on generator fuel usage, Table 8 lists the total amount of coal, natural gas and oil that the IPM<sup>®</sup> model projects will be consumed by NYS generators in the peak period as well as the projected reduction in consumption resulting from RPS installations. As previously discussed, renewable facilities displace coal and natural gas with no displacement of oil usage.

**Table 8. Total New York Fuel Reductions due to RPS Facility Deployment, 2014-2025**

<b>Fuel Type</b>	<b>Amount Consumed (trillion BTU)</b>	<b>Fuel Displaced in 2025 (trillion BTU)</b>	<b>% reduction in fuel consumption</b>
Coal	779	48	6%
Natural Gas	4,257	34	1%

## 5 Benefit-Cost Analysis

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This section describes the analysis of economic benefits and costs of the Current Portfolio of RPS commitments in New York State over the study period spanning 2002 through 2037. It estimates and analyzes the benefit-cost ratio using base and high carbon dioxide value assumptions and calculates net cost or benefits from three different benefit-cost perspectives.

Key points and findings of this section include:

- Program costs are expected to comprise 0.17% of total retail electricity expenditures over the study period on an NPV basis with a maximum annual impact of 0.62%.
- The program's cumulative (NPV basis) net rate impact is essentially zero over the study period taking into account wholesale electricity price reductions. The maximum annual net rate impact is 0.12%. On an NPV basis, rates are expected to decrease by about \$23 million over the entire study period (2002-2037) compared to a total retail expenditure level of \$256 billion (for affected New York ratepayers).
- The monetized emission reductions total \$312 million under base CO<sub>2</sub> value assumption and \$2.2 billion under high CO<sub>2</sub> value assumption.
- The primary benefits of the RPS under the statewide benefit-cost perspective include: (1) price reductions in wholesale energy and capacity markets, (2) renewable investment and expenditures, and (3) monetized CO<sub>2</sub> values and health benefits from avoided emissions.
- The primary costs under the statewide benefit-cost perspective include: (1) the actual payments to RPS program facilities for RPS Attributes under NYSERDA Main Tier RPS contracts plus associated program administration cost, and (2) non-renewable investment and expenditures that are not made as a result of renewable deployment.
- Over the study period, the statewide benefit-cost analysis shows a net benefit of approximately \$1.57 billion with a benefit-cost ratio of 4.6 assuming a base case CO<sub>2</sub> value, and \$3.45 billion in net benefits with a benefit-cost ratio of 9.0 assuming a higher CO<sub>2</sub> value.

This section is organized as follows:

- Section 5.1 discusses the premium required to support the RPS facilities. This section uses actual RPS program costs through 2012, and forecasted program costs starting in 2013.
- Section 5.2 includes the calculation of the net electricity ratepayer impact, which includes the required premium and the wholesale price reduction effects of the RPS facilities on wholesale energy and capacity markets.
- Section 5.3 discusses Current Portfolio statewide benefit-cost analysis, which includes the most expansive set of benefit-cost components.

## 5.1 Required Premium

The simplest way to examine costs and benefits is to consider the past and future “over market” incentive or program costs (or “premium”) borne by ratepayers through the applicable collection mechanism(s) (e.g., SBC charges, RPS/REC charges passed on by electricity suppliers, etc.) required to support renewable development. Table 9 shows that total program costs of the Current Portfolio on an NPV basis are expected to be slightly more \$431 million.

**Table 9. Required Premium, Current Portfolio, 2002-2037**

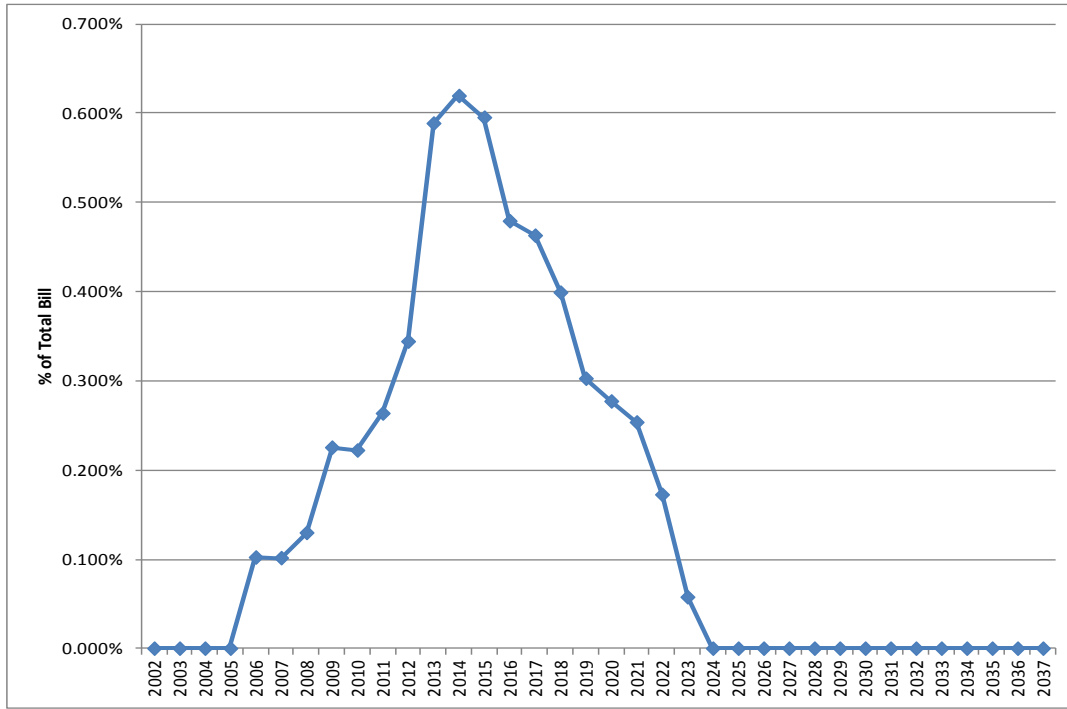
	<b>NPV Million 2012\$</b>
<b>Required Premium</b>	<b>431.37</b>

The rate impact of the premium (as a percentage of bills) is calculated as the total program costs divided by total annual electricity expenditures in New York State excluding ratepayers in the Long Island Power Authority (LIPA) and New York Power Authority (NYPA) service territories. Thus, it is assumed for these purposes that the total costs of the policy options will be borne by all investor-owned utility customers in proportion to their total bill. A statewide forecast of total retail electricity expenditures was developed as the denominator for use in calculating the annual average retail rate impact of the RPS build out as a percentage of total bills.

For the reference case, U.S. Energy Information Administration’s (EIA) Annual Energy Outlook 2013 reference forecast for the relevant New York regions — NYC/Westchester and Upstate — was used to calculate a weighted average total retail revenue (delivery and supply charges) for each year in the study period. For the year 2037 (which comes after the last year in the EIA forecast), the historical (2012-2036) compound average annual growth rate of 2.1% was applied.

Annual rate impacts were calculated by taking the required premium calculation for each year and dividing by the total retail expenditures for that year. For example, in 2014, and required premium is approximately \$93 million. Dividing that figure by the total forecasted retail electricity expenditures in that year of approximately \$20.6 billion yields a rate increase of 0.45% for that year. The annual rate impact of the required premium as a percentage of total bills is shown for each year in the study period in Figure 11.

**Figure 11. RPS Current Portfolio Program Cost (Premium) as a Percentage of Total Bill**



## 5.2 Net Electricity Ratepayer Impact

Net rate impacts are calculated by adjusting the required premium calculations discussed in previous sections for wholesale price reduction benefits. This net rate impact concept can be considered as an estimate of the ultimate cost responsibility that the ratepayers will eventually pay.

Table 10 shows the relationship between the net rate impacts to the required premium discussed in the prior section. Overall, the net ratepayer impact shows a decrease of \$23 million (in 2012 dollars) with a benefit-cost ratio slightly above 1.0, indicating the RPS program costs essentially equal the reductions in wholesale market costs. There is a maximum annual net rate increase of about a tenth of one percent, which occurs in 2020.

**Table 10. NPV of Net Ratepayer Impact, Current Portfolio, 2002-2037**

	<b>NPV Million 2012\$</b>	<b>Benefit/Cost Ratio</b>
Required Premium	431	n/a
Price Reduction	(454)	n/a
Net Ratepayer Impact	(23)	1.05

### 5.3 Statewide Benefit-Cost

The final benefit-cost perspective expands the net ratepayer impact benefit-cost analysis by including the benefits and costs associated with changes in emissions and direct investments. Benefits and costs associated changes in direct investment are also included as inputs to the macroeconomic analysis as discussed in the next section.

The value of avoiding CO<sub>2</sub> emissions is uncertain, and so results for the benefit-cost analysis are calculated using base (\$15/ton) and high-end (\$85/ton) value estimates. For monetization of health benefits from criteria pollutants, NO<sub>x</sub> and SO<sub>2</sub> were valued at \$3,500/ton and \$1,100/ton, respectively. A value of \$194.5 million/ton was used for mercury. For more information on these values, see Volume 1.

Table 11 and Figure 12 show a comparative analysis for the statewide benefit-cost perspective under base and high CO<sub>2</sub> value assumptions, as well as its buildup. Analyses in this section shows benefits as positive and costs as negative. Overall, the impacts of the capital and O&M spending (the direct investment) related to the RPS program facilities result in a relatively large benefit, which serves to increase net benefits to \$1.57 billion NPV over the study period. By contrast, the impact of expenditures not made (due to displacement of non-renewable facilities) is small. Monetized avoided emissions benefits total \$312 million under base CO<sub>2</sub> value assumptions and \$2.2 billion under high CO<sub>2</sub> value assumptions.

Direct investments in RPS Main Tier resources are significantly greater than investments otherwise not made by conventional resources in New York State for the following reasons:

- On a per MW basis, intermittent resources make a smaller reliability contribution to the system than conventional resources. Therefore, intermittent resources tend to displace a smaller amount of conventional resources (on a per MW basis). Hence, general construction related investment would be expected to be greater for RPS resources.
- Despite conventional resources running less after the addition of RPS Main Tier resources, total investment in variable O&M by conventional resources did not change materially.
- Over the course of the study period, RPS Main Tier resources displace about 37.5 million MWh of imported electricity which keeps more total investment in New York State.
- Over the study period, generation from RPS Main Tier resources led to more than \$2 billion in reduced purchases of fossil fuel by conventional resources. These purchases primarily benefit industries located outside of New York State.

**Table 11. NPV of Statewide Benefit-Cost Components, Base and High CO<sub>2</sub> Values, Current Portfolio, 2002-2037**

	<b>Base CO<sub>2</sub></b>	<b>High CO<sub>2</sub></b>
	<b>NPV (Million 2012 dollars)</b>	<b>NPV (Million 2012 dollars)</b>
RPS Program Cost	(431)	(431)
Price Reduction	455	455
Avoided CO <sub>2</sub>	312	2,196
Health Benefits	58	58
Direct Investments	1,252	1,252
Investments Not Made	(80)	(80)
<b>Statewide Benefit-Cost</b>	<b>1,566</b>	<b>3,450</b>
<b>Benefit-Cost Ratio</b>	<b>4.6</b>	<b>9.0</b>

**Figure 12. NPV of Statewide Cost Benefit Components, Current Portfolio, 2002-2037**

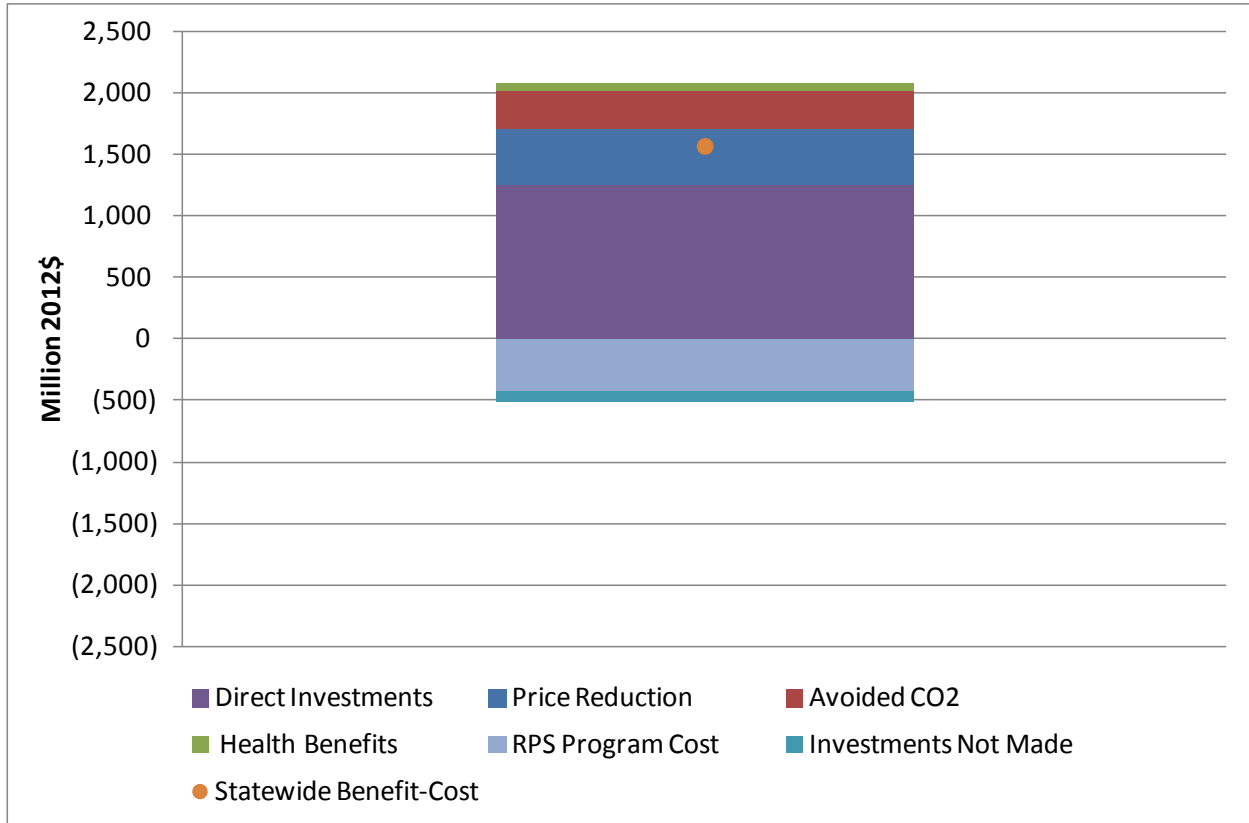


Figure 13 shows the value of each of the components in the statewide benefit-cost analysis (under the base CO<sub>2</sub> value assumptions) for each year of the entire study period. The black line represents the net cost on an annual basis. All numbers in this figure are in millions of constant 2012 dollars.

**Figure 13. Statewide Benefit-Cost Components, Current Portfolio, Base CO<sub>2</sub>, 2002-2037**

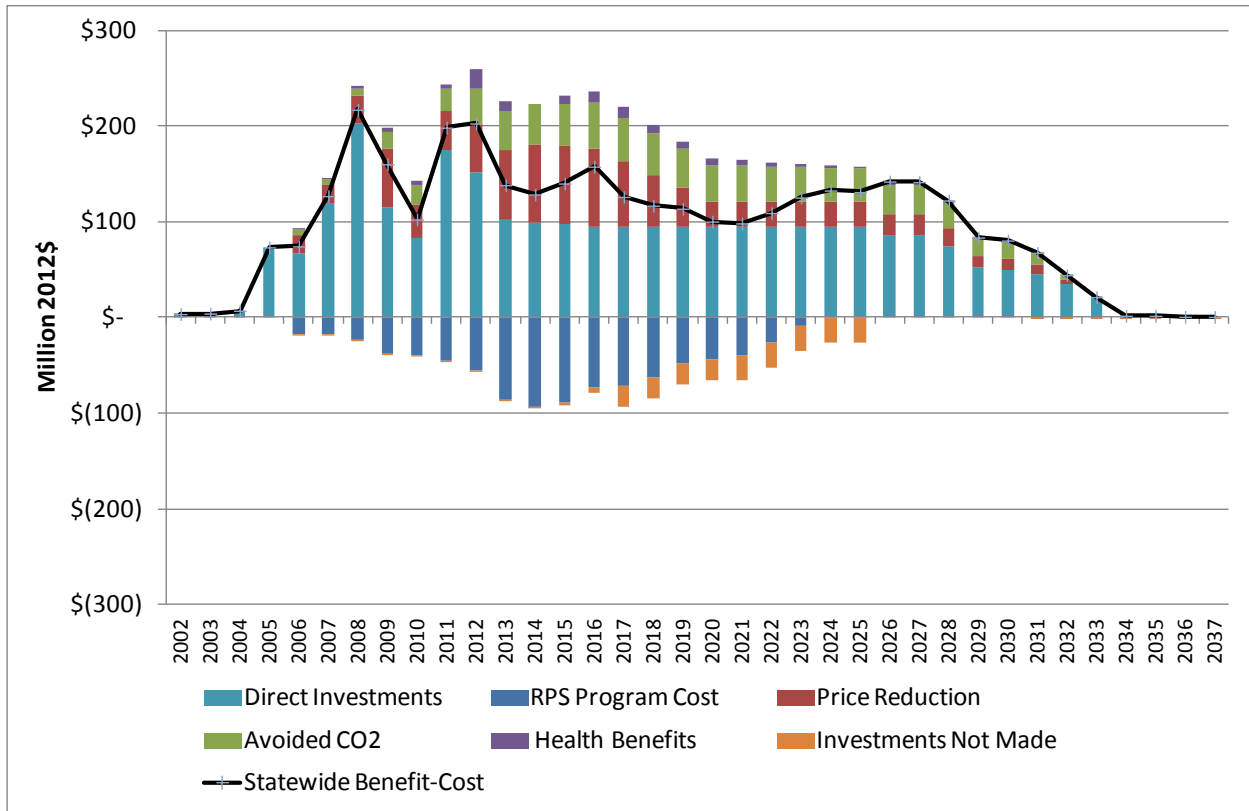


Figure 13 shows that for all years in the study period, benefits exceed costs under base CO<sub>2</sub> value assumptions. Net benefits for the current contract portfolio reach their peak in 2008 due to spending on renewable construction and installation, but overall benefits reach their peak in 2012. Operation and maintenance expenditures continue to be required for the RPS facilities at a relatively high expenditure level, which serves to support net benefits throughout the later years of the study period.

## 6 Macroeconomic Economy Wide Analysis

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This section estimates the economy-wide macroeconomic and jobs impacts from the addition of the Current Portfolio of RPS Main Tier facilities that were built or under contract with NYSERDA through the end of 2012. Net impacts on the New York State economy primarily in the areas of total employment and Gross State Product (GSP) are estimated and presented for the life of the mix of facilities. It should be noted that these results are not synonymous with job creation in the clean energy area, rather the analysis reflects a broader economic assessment.

The two primary data sources for macroeconomic modeling analysis inputs are: (1) IPM<sup>®</sup> electricity system model results; and (2) the Direct Investments analysis of the RPS Main Tier resources tied to their construction activities and subsequent operations. A full description of each of these projects is in Sections 3 and 2 of this Volume, respectively.

The REMI PI+ model of the New York State economy was the tool used to conduct the analysis. A detailed description of REMI PI+ model, along with a description of certain mechanical modeling methods used in this analysis, is in Section 5 of Volume 1.

This analysis examines the RPS Main Tier Current Portfolio commitments that result in approximately 1,800 MW of New York State renewable capacity in place or under construction through the end of 2012. All RPS capacity in this Current Portfolio analysis is assumed to be operational by the end of 2013. Wind, biomass, and landfill gas resources are assumed to operate over a 20-year useful life, while hydro resources are assumed to have a 25-year life. When fully operational, these capacity additions are assumed to generate approximately 4,700 GWh of annual energy, or the equivalent of 2.9% of New York State's 2012 electricity requirements.

RPS developers started making investments that impact the New York State economy in 2002, and the RPS Current Portfolio projects all see an expiration of the useful life by the end of 2037. Therefore, any macroeconomic impacts attributed to the Current Portfolio of projects before 2002 or after 2037 are assumed small and are not included in the results of this analysis.

Key findings of macroeconomic analysis (Gross State Product figures are in 2012 dollars):

- On average, there are expected to be approximately 668 more net jobs in the New York State economy (inclusive of multiplier effects) in each year during the study period, representing approximately 24,000 job-years. Total net jobs reflect all job impacts as a result of the Current Portfolio, including jobs added, saved, and lost. The cumulative GSP gain is expected to be approximately \$2.0 billion, with a net present value (NPV) of \$921 million.
- The three primary drivers of the positive impacts are:
  - The investments, tax and fee payments, and land use payments made by RPS Main Tier developers (or Direct Investments).
  - The net increase in generation sales by in-State generation resources (also known as import substitution).
  - The wholesale electricity price reduction.
- As a result of the Direct Investments in New York State for the RPS, there is on average an estimated 680 additional total jobs per year in the study period, of which 430 represent direct jobs.
- Estimated direct job additions from the Direct Investments analysis are most prominent in the following areas:
  - Renewable generator operation and maintenance.
  - Forestry (biomass fuel feedstock)..
  - Construction.
  - Professional and technical services (primarily engineers, lawyers, and architects).
- The addition of the RPS renewable resources in the Current Portfolio results in an increased reliance on in-state generation resources to meet New York's electricity needs. From 2006 to 2037, IPM<sup>®</sup> electricity modeling results show that New York generators produce approximately 37.5 million more megawatt-hours of electricity in-state in the Current Portfolio. This results in a cumulative GSP gain of approximately \$1.1 billion, with an NPV of \$414 million.

### 6.1.1 Scenario Inputs

The following list shows the data inputs metrics to the REMI model that drove the analysis results:

- Wholesale Price Reduction
  - Wholesale electricity savings for electricity ratepayers caused by the addition of RPS Main Tier facilities.
  - Lower New York generation sector GSP caused by lower generator revenues from electricity sold at lower wholesale prices.
  - Lower investment returns caused by lower New York State generator profits.
- Direct Investments from Renewable Resource Construction and O&M Spending and Related Activity
  - Hiring of on-site employees by RPS resource developers.
  - Project spending of the RPS resource during its development.

- Various taxes and fees paid to New York State local governments.
- Payments made to landowners, municipal landfills, and biomass developers.
- Increased Production from In-State Electricity Generators – import substitution effect whereby new renewable energy units based in NYS crowd out generation from out-of-state.
- Retail Rate Increase Necessary to Fund RPS Activity.
  - Higher retail electricity rates to fund program activity.
  - Administration of RPS program.
- Displaced Direct Investments from Conventional Generation Resources (IPM<sup>®</sup> output).
- Displaced Purchases of Fossil Fuel (IPM<sup>®</sup> output).
- Changes to Conventional Generator Variable Operating & Maintenance (VOM) Costs (IPM<sup>®</sup> output).

The information in Appendix B shows actual REMI Model input values for various years and cumulative inputs by category from 2002 to 2037. The REMI Lever Assignment(s) are also shown.

### 6.1.2 Current Portfolio Results

Table 12 presents aggregate total employment and GSP impacts.

**Table 12. Aggregate Impacts of the Current Portfolio Case, 2002-2037**

Differences from Baseline Level								
Variable	Units	2006	2012	2020	2030	2037	2002-2037	NPV
Total Employment	(Jobs-Years)	819	1,427	522	483	3	24,043	n/a
Percent of NYS Economy	%	0.007%	0.013%	0.004%	0.003%	0.000%	n/a	n/a
Gross State Product	Millions of 2012\$	\$61	\$100	\$44	\$63	(\$9)	\$2,012	\$921
Percent of NYS Economy	%	0.006%	0.008%	0.003%	0.004%	0.000%	n/a	n/a

Tables 13 and 14 respectively show the decomposed employment and GSP impacts of the RPS Current Portfolio. Totals may not perfectly match the sum of the values in a given year due to rounding and due to impacts in REMI of running effects in a disaggregated versus rolled-up fashion.

**Table 13. Employment Impacts of the RPS Main Tier Current Portfolio Case Analysis, 2002-2037**

<b>Total Employment (Annual Job Impacts)</b>	<b>2006</b>	<b>2012</b>	<b>2020</b>	<b>2030</b>	<b>2037</b>	<b>Average Annual Impact (2002-2037)</b>
Direct Investments: Construction Related (Short Term)	701	898	(40)	19	18	227
Direct Spending: O&M Related (Long Term)	94	530	810	342	(29)	442
Wholesale Electricity Price Reductions Benefit to Ratepayers	124	443	372	162	47	274
In-State Impact of Reduced Revenues to Existing Generators (Wholesale Electricity Price Reduction Effect)	(6)	(14)	0	0	0	(4)
Retail Rate Increase Necessary to Fund RPS Current Case Activity	(96)	(420)	(481)	(57)	(43)	(243)
Displaced Direct Investment from Conventional Resources	0	1	(157)	18	(6)	(34)
Displaced Purchases of Fossil Fuel	0	(7)	(8)	6	14	0
Changes to O&M Spending from Conventional Resources	2	(5)	26	(7)	4	3
<b>Total</b>	<b>819</b>	<b>1,427</b>	<b>522</b>	<b>483</b>	<b>3</b>	<b>668</b>

**Table 14. GSP Impacts of the RPS Main Tier Current Portfolio Case Analysis, 2002-2037**

<b>GSP (Millions of 2012 dollars)</b>	<b>2006</b>	<b>2012</b>	<b>2020</b>	<b>2030</b>	<b>2037</b>	<b>NPV (2002- 2037)</b>
Direct Benefits: Construction Related (Short Term)	\$60	\$82	(\$10)	\$0	\$1	\$459
Direct Spending: O&M Related (Long Term)	\$7	\$41	\$61	\$19	(\$11)	\$460
Net Increase in New York State Wholesale Electricity Sales	\$9	\$23	\$45	\$33	\$0.3	\$414
Wholesale Electricity Price Reductions Benefit to Ratepayers	\$11	\$53	\$57	\$24	\$4	\$547
In-State Impact of Reduced Revenues to Existing Generators (Wholesale Electricity Price Reduction Effect)	(\$17)	(\$46)	(\$23)	(\$13)	0	(\$409)
Retail Rate Increase Necessary to Fund RPS Current Case Activity	(\$10)	(\$51)	(\$71)	(\$6)	(\$4)	(\$504)
Displaced Overnight Capital Costs from Conventional Resources	\$0	\$0	(\$17)	\$4	\$0	(\$43)
Displaced Purchases of Fossil Fuel	\$0	(\$1)	(\$1)	\$0	\$0	(\$3)
Changes to O&M Spending from Conventional Resources	\$0	(\$1)	\$2	(\$1)	\$0	\$4
<b>Total</b>	<b>\$61</b>	<b>\$100</b>	<b>\$44</b>	<b>\$63</b>	<b>(\$9)</b>	<b>\$921</b>

The decomposed results from Table 13 and Table 14 above are presented in Figures 14 (employment) and 17 (GSP). Figure 15 shows total job years by industry from 2002 through 2037. Table 15 and Figure 16 show a disaggregation of all job impacts from the Direct Spending analysis.

The following notes explain why certain results may not add up perfectly or may be somewhat counter-intuitive:

- The average annual jobs from Direct Investment in Table 12 (669 as represented in first two rows) does not match average annual jobs in Table 14 (680) due to rounding and running the inputs in different disaggregation bundles in REMI.
- Regarding the wholesale price reduction effect, the relationship between the positive impacts to ratepayers and the negative impacts on NYS generators changes over time. The year-after-year electricity savings to non-residential customers has a more lasting positive impact than the negative impact on generators. When businesses see their cost of production decrease (i.e., lower electricity costs), for example, REMI shifts the imports and exports to find a new cost-effective solution and a business sees its market share increase. And it takes time for these trading relationships to unwind.

Figure 14. Net Employment Impacts of RPS Current Portfolio

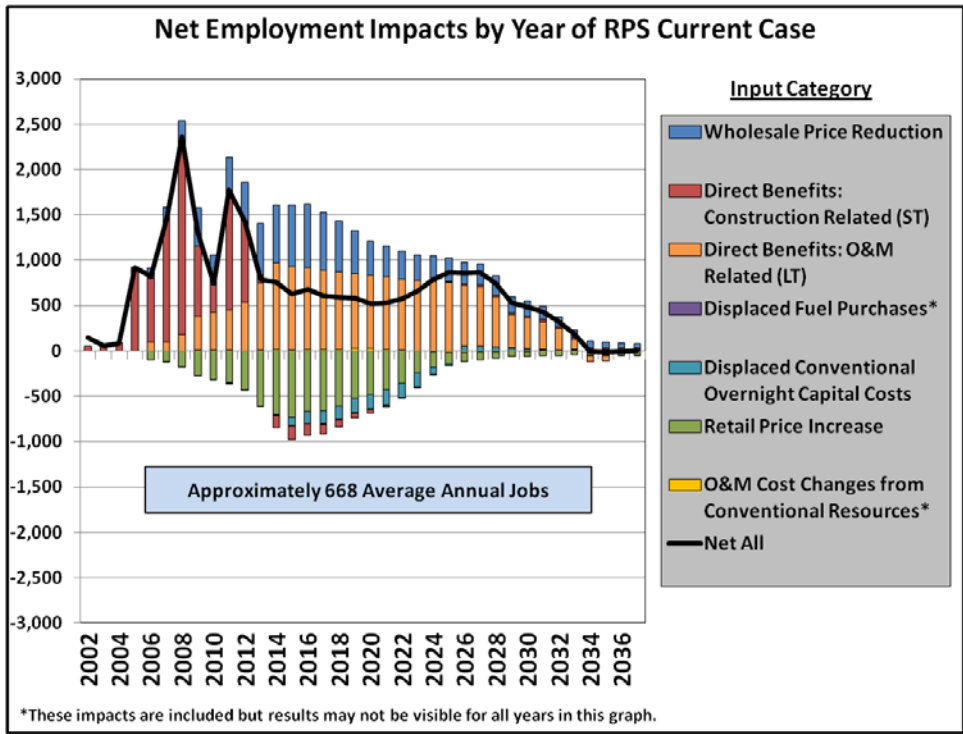
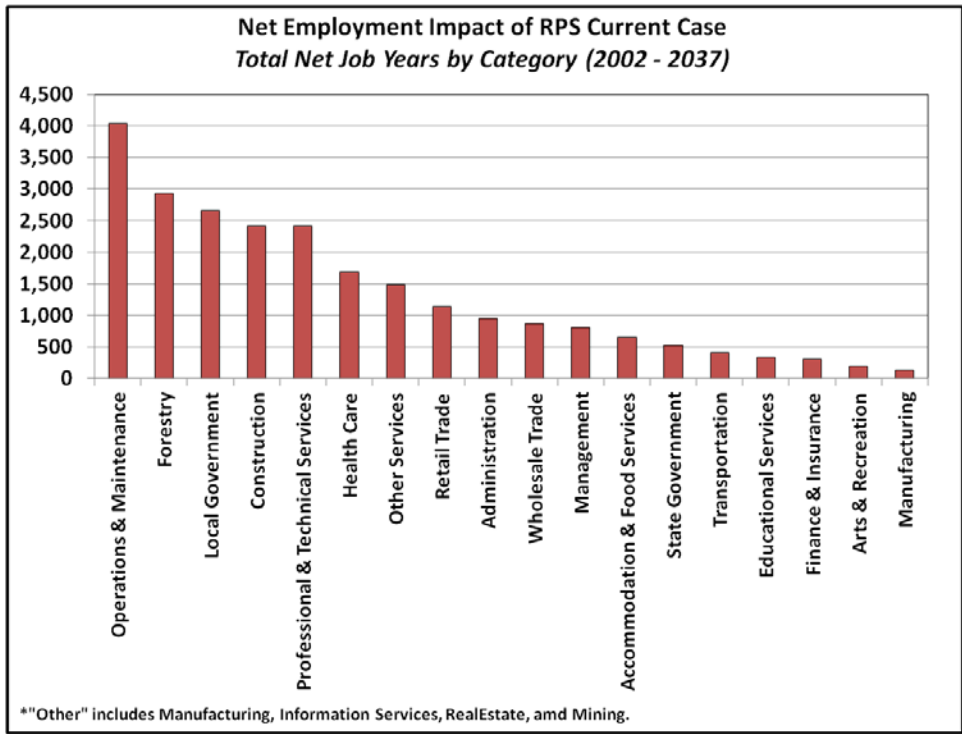


Figure 15. Net Job Year Impacts of RPS Current Portfolio by Industry



**Table 15. Employment Impacts of Direct Investment Analysis, Current Portfolio**

Total Employment (Annual Job Impacts)	2006	2012	2020	2030	2037	Average Annual Impact (2002-2037)
Spending by Renewable Developers	646	980	197	124	21	336
On-Site O&M Jobs	54	255	272	138	(6)	167
Payments to Landowners/Easements and Biomass Fuel Payments	20	64	210	94	(4)	110
Payments of Taxes and Fees to Local Governments	79	133	92	29	6	67
<b>Total</b>	<b>802</b>	<b>1,453</b>	<b>784</b>	<b>397</b>	<b>17</b>	<b>680</b>

**Figure 16. Employment Impacts of Direct Investment Analysis, Current Portfolio**

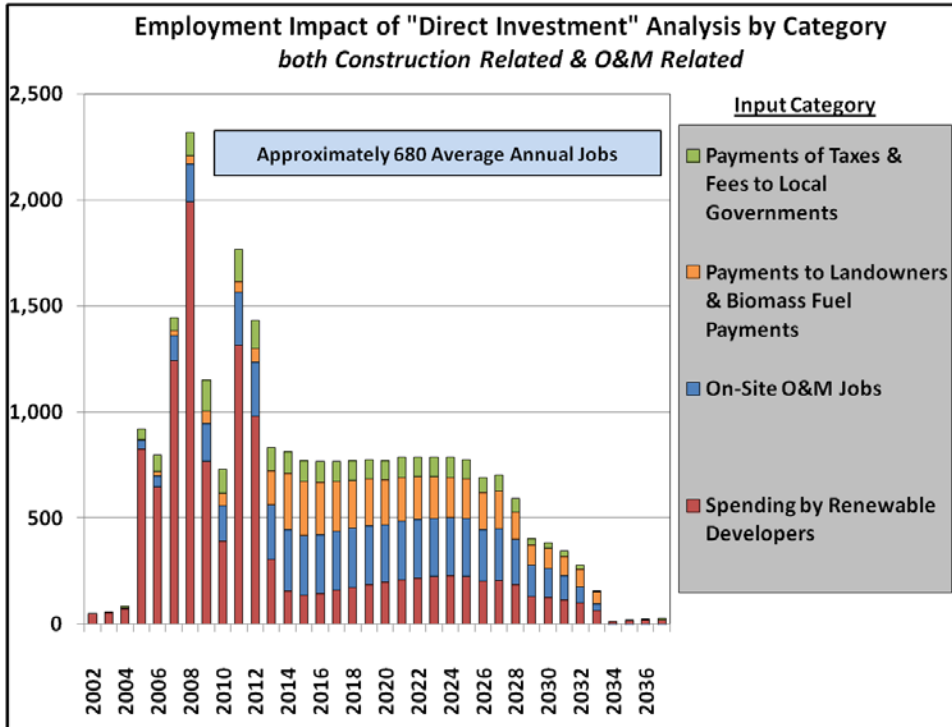
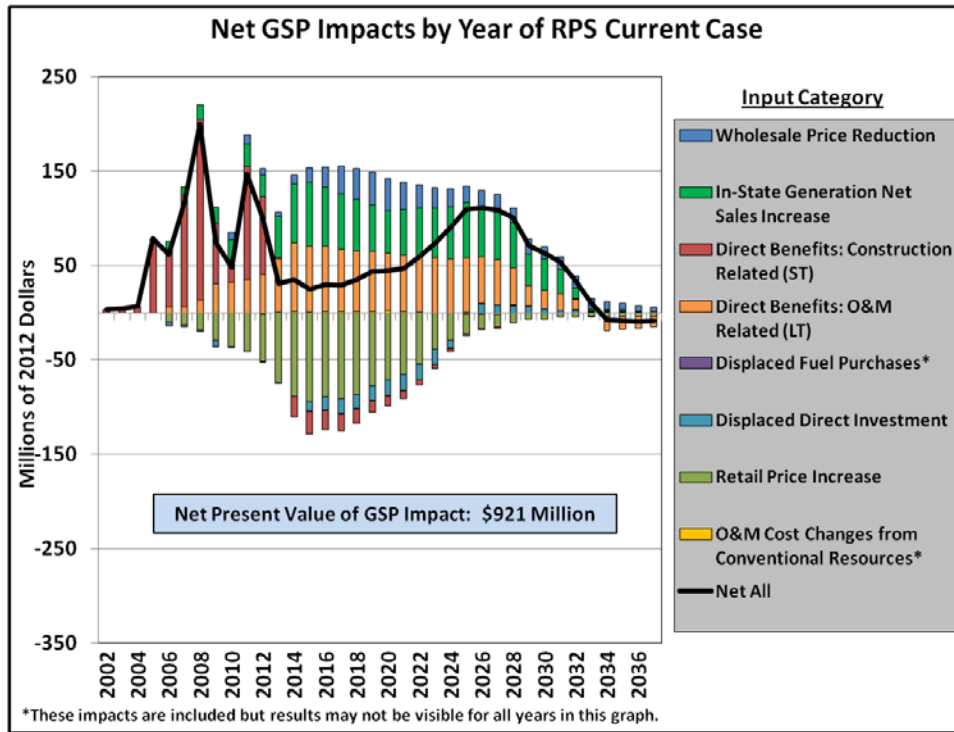


Figure 17. Net GSP Impacts of RPS Current Portfolio



Positive net macroeconomic results for the Current Portfolio can be attributed to three primary inputs:

- The net increase in generation sales by in-state generation resources.
- The direct hiring, investment spending, tax & fee payments, and landowner payments from renewable developers (Direct Investment).
- The Wholesale Price Reduction effect of the renewable resource additions.

Benefits from direct spending occur throughout the study period and are divided into a "construction related" (short term) period and an "O&M related" (long term) period, which vary by resource.

Though this analysis covers the period 2002 to 2037, note that renewable developers are estimated to invest more than 50 percent of total investments from 2005 through 2013. In fact, developers spent about \$79 million on construction related investments before ratepayers begin paying for program activity in 2006. This explains the front-loading of the positive estimated employment and GSP impacts seen in Figures 14 and 17.

IPM<sup>®</sup> electricity system model results show that after the Current Portfolio of RPS renewable resources are added, New York State becomes less reliant on imported electricity to meet its system needs. Over the study period, due to RPS implementation, New York State generators sell approximately 37.5 million additional megawatt-hours of

wholesale electricity valued at approximately \$2.0 billion (in 2012 dollars). This transfer of economic activity from out-of-state to in-state increases local employment and increases the size of the New York State economy.

Regarding direct impacts to electricity ratepayers, two significant macroeconomic effects start in 2006. First, ratepayers begin paying for program activity, resulting in lower spending by households on other goods and services, and increasing production costs for non-residential electricity customers. However, this effect of increasing retail rates is largely offset by the decreasing wholesale prices related to the price reduction effect of adding renewable resources to the grid. REMI model results show that, when considered over the entire analysis period, there is a small amount of net job creation when considering both effects together. The retail rate increase fades away in 2023 as all 10 year contracts for Current Portfolio projects expire, but a decreasing amount of price reduction effect remains after the retail rate increases erode. In other words, New York State electricity ratepayers benefit from the RPS Main Tier after program costs are paid.

IPM<sup>®</sup> model results show that approximately 320 MW of additional natural gas fired, combined-cycle capacity would have been needed absent of the RPS renewable additions. The displaced combined-cycle construction-related activity, or displaced direct investment, results in 127 fewer net jobs per year in the New York State economy from 2015 to 2025, most of which are direct construction jobs.

Conventional resources operated less because of RPS additions. This results in two additional effects that are considered in this analysis: (1) reduced fossil fuel purchases; and (2) changes to variable operating and maintenance (O&M) spending levels from conventional resources.

Reduced spending on fossil fuel by New York conventional generators impacts industries primarily located outside New York State, so the macroeconomic impacts on the State economy are small.

IPM<sup>®</sup> model results show that total O&M spending from conventional resources is not remarkably different in the RPS Current Portfolio case despite lower output from these resources. This difference is because some conventional resources see a modest increase in their O&M cost per unit of output due to increased "wear and tear" on equipment. IPM<sup>®</sup> model results show that these units are required to cycle equipment up and down more often in response to system needs. Although this phenomenon leads to minimal overall changes to O&M investment as conventional output drops, it likely mitigates some of the wholesale price reduction effect previously described as these units are forced to include this increased O&M cost in their energy bid.

## 7 Conclusions

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As of December 31, 2012, NYSERDA has conducted seven competitive Main Tier solicitations and is in the process of conducting an eighth solicitation in pursuit of the Main Tier target. Renewable energy production associated with the Main Tier projects are expected to produce 4.49 million RPS Attributes<sup>21</sup> in 2015, representing about 47% of the Main Tier target.<sup>22</sup> 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. Therefore, the RPS Main Tier results to date have been achieved more cost-effectively than originally projected.

The conclusion from this analysis of quantifiable benefits and costs is public investment in the current portfolio of Main Tier RPS renewable energy resources has a positive impact on the New York State's economy and the environment.

Key findings from the analysis include:

1. Direct Investment In New York
  - Approximately \$2.7 billion dollars of direct investments in New York State are expected over the projected life of the Current Portfolio, as measured in jobs, payments to public entities, in-state purchases and land leases.
  - For \$1 spent on the acquisition of RPS Attributes from Current Portfolio projects under contract with NYSERDA, on a Net Present Value (NPV) basis, New York is expected to capture on average almost \$3 in direct investments associated with project spending over project lifetime.
  - Overall, approximately \$27 in direct investments are produced as a result of project expenditures in New York State for every 1 MWh of renewable energy that is generated under the Main Tier program.
2. Electricity System Modeling
  - Generation output from Main Tier resources primarily displaces generation from in-State natural gas resources and imported electricity. Coal has been displaced, but is displaced less and less over time.
  - Net electricity imports decline by an estimated 4.7%, from 2006 through 2037, or an average of 1.17 million MWh per year.
  - Main Tier additions displace about 320 MW of cumulative combined-cycle capacity additions through 2037.

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<sup>21</sup> One RPS Attribute is generated by the production of one megawatt-hour (MWh) of energy production from an eligible renewable generator.

<sup>22</sup> NYSERDA counts toward the MWh program targets only the portion of a project's output or potential output that is under contract. Under the RPS rules, the maximum amount eligible for bid is 95% of output; some facilities have bid and are under contract for less than 95%.

- On average, from 2006 through 2037, wholesale electricity prices are, or are expected to be, less than 1% lower due to Main Tier additions. These lower prices are a benefit to ratepayers.
- From 2006 through 2037, it is projected that Main Tier RPS facilities will displace a total of more than 50 million tons of CO<sub>2</sub> and about 15 million tons each of NO<sub>x</sub> and SO<sub>2</sub>.

### 3. Environmental Benefits

- Over the study period (2002 – 2037) Current Portfolio Main Tier RPS facilities reduce fossil fuel usage by New York electrical generators by 133 trillion BTUs (or TBTUs), which represents a 1% reduction over this time period. This figure includes reductions from both coal and natural gas.
- Over the study period (2002 – 2037) Current Portfolio Main Tier RPS facilities lower North American CO<sub>2</sub> emissions by more than 50 million tons. This reduction corresponds to 2.6 million tons per year during the 2014-2025 peak RPS generation period, equivalent to removing 510,000 cars off the road.
- The amount of CO<sub>2</sub> reductions remains small compared to the total reductions that were identified for the power generation sector in the New York Climate Action Plan Interim Report. Over the peak RPS generation period (2014-2025), RPS facilities will reduce CO<sub>2</sub> emissions in New York State by 1.2 million tons per year (equivalent to removal of 230,000 cars), or 3% of the average annual emissions from the electric generation sector.
- SO<sub>2</sub>, NO<sub>x</sub>, and mercury all show decreases over the study period based on the areas examined.

### 4. Benefit-Cost Analysis

- Program costs are expected to comprise 0.17% of total retail electricity expenditures over the study period on an NPV basis with a maximum annual impact of 0.62%.
- The program's cumulative (NPV basis) net rate impact is essentially zero over the study period taking into account wholesale electricity price reductions. The maximum annual net rate impact is 0.12%. On an NPV basis, rates are expected to decrease by about \$23 million over the entire study period (2002-2037) compared to a total retail expenditure level of \$256 billion (for affected New York State ratepayers).
- The monetized emission reductions total \$312 million under base CO<sub>2</sub> value assumption and \$2.2 billion under high CO<sub>2</sub> value assumption.
- The primary benefits of the RPS under the statewide benefit-cost perspective include: (1) price reductions in wholesale energy and capacity markets, (2) renewable investment and expenditures, and (3) monetized CO<sub>2</sub> values and health benefits from avoided emissions.
- The primary costs under the statewide benefit-cost perspective include: (1) the actual payments to RPS program facilities for RPS Attributes under NYSERDA Main Tier RPS contracts plus associated program administration cost, and (2) non-renewable investment and expenditures that are not made as a result of renewable deployment.
- Over the study period, the statewide benefit-cost analysis shows a net benefit of approximately \$1.57 billion, with a benefit-cost ratio of 4.6, under base CO<sub>2</sub> value assumption, and \$3.45 billion in net benefits, with a benefit-cost ratio of 9.0, under high CO<sub>2</sub> value assumption.

5. Macroeconomic Economy Wide Analysis

- On average, there are expected to be approximately 668 more net jobs in the New York State economy (inclusive of multiplier effects) in each year during the study period, representing approximately 24,000 job-years. Total net jobs reflect all job impacts as a result of the Current Portfolio, including jobs added, saved, and lost. The cumulative GSP impact is expected to be approximately \$2.0 billion, with a net present value (NPV) of \$921 million.
- The three primary drivers of the positive impacts are: (1) the investments, tax and fee payments, and land use payments made by RPS Main Tier developers (or "Direct Investments"); (2) the net increase in generation sales by in-State generation resources (also known as import substitution); and (3) the wholesale electricity price reduction.
- As a result of the Direct Investments in New York for the RPS, there is on average an estimated 680 additional total jobs per year in the study period, of which 430 represent "direct" jobs.
- Estimated direct job additions from the Direct Investments analysis are most prominent in the following areas: (1) renewable generator operation and maintenance; (2) forestry (biomass fuel feedstock); (3) construction; and (4) professional and technical services (primarily engineers, lawyers, and architects).
- The addition of the RPS renewable resources in the Current Portfolio results in an increased reliance on in-state generation resources to meet New York's electricity needs. From 2006 to 2037, IPM® electricity modeling results show that New York generators produce approximately 37.5 million more megawatt-hours of electricity in-state in the Current Portfolio. This results in a cumulative GSP impact of approximately \$1.09 billion, with a net present value (NPV) of \$414 million.

Appendix A:  
Renewable Portfolio Standard Main Tier 2013 Program  
Review, Direct Investments in New York State Final Report

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New York State Energy Research and Development Authority

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# NYSERDA Renewable Portfolio Standard Main Tier 2013 Program Review

Direct Investments in New York State

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**  
**Direct Investments in New York State**

*Final Report*

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## Notice

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## Summary

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One of the key objectives of New York State’s Renewable Portfolio Standard (RPS) is to stimulate and capture the direct investments associated with expanding the role of renewable energy in the State’s electricity supply mix. Specifically, the Public Service Commission (Commission) in its September 2004 Order<sup>1</sup> specified program objectives that were used to guide the development of the RPS program. One such objective, Economic Benefits, was defined as developing “renewable resources and advance renewable resource technologies in and attract renewable resource generators, manufacturers and installers to New York State.”

As a result, NYSERDA has designed most RPS Main Tier procurements to quantify verifiable direct investments in New York State as part of the evaluation criteria. Winning bids are determined based on a weighted combined score with RPS Attribute price comprising 70% and direct investments in New York State at 30% of the weight. After a Main Tier RPS contract has been in operation for three years, NYSERDA receives data about related direct investments in New York State. The data is verified by NYSERDA and available for use in producing a reliable assessment of the direct investments in the New York State economy associated with the RPS program.

This analysis focuses on the direct investment impacts associated with RPS program activity, in terms of the scale and type of New York State spending previously incurred and expected to be incurred by Main Tier RPS-contracted projects in the Current Portfolio<sup>2</sup> in their development and for their ongoing operations. These data are further used as inputs for the overall Benefit-Cost and Macroeconomic analysis conducted for the 2013 RPS Main Tier Program Evaluation.

The focus of this study is on direct investments in New York State, which is a subset of the total amount spent by project developers, as this provides an estimate of the direct economic development benefit realized in New York State. Some studies simply provide the total cost of project development, including imported hardware and services, so comparison to other economic development reports should be made with care.

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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> “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.

Key findings of this analysis include:

- Approximately \$2.7 billion dollars of direct investments in New York State are expected over the projected life of the Current Portfolio of Main Tier RPS facilities, as measured in jobs, payments to public entities, in-state purchases and land leases.
- For every \$1 spent on the acquisition of RPS Attributes for the Current Portfolio of Main Tier RPS projects under contract with NYSERDA, New York State is expected to capture on average approximately \$3 in direct investments associated with project spending over project lifetime on a Net Present Value (NPV) basis.
- Overall, approximately \$27 in direct investment results from project expenditures in New York State for every 1 megawatt hour (MWh) of renewable energy that is generated under the RPS.

## Scope

The objective of this study is to analyze verified direct investments in New York State associated with a subset of Main Tier and Maintenance resource<sup>3</sup> RPS contracts, and to estimate those investments associated with the remaining projects with current Main Tier contracts as of December 31, 2012. This analysis evaluates verified in-state direct spending data from 18 projects with NYSERDA Main Tier RPS contracts and extrapolates these investments through the life of each project. The resulting data is then used to project New York State-specific direct investments attributable to all current RPS projects.

This analysis only considers the direct impacts of the Current Portfolio of Main Tier RPS contracts, without consideration of multiplier or induced effects, or net impacts. These investments are then compared with the value or cost of RPS contracts for a direct benefit-cost analysis of current projects in the Main Tier RPS program, which is referred to in this report as an investment ratio. Direct investments include all in-state spending by projects, in the form of purchases or salary payments, over their development, construction, and operating life. Direct investment data verified through internal NYSERDA reviews was subject to additional analysis by NYSERDA's consultants in an effort to better understand the scope and scale of the direct investments resulting from incentivizing renewable energy development within the State.

The analysis of the benefits associated with direct project investment is comprised of two parts:

- To provide an assessment of the direct investments in New York State that were associated with the projects that had submitted verified data, The first part was focused on the subset of verified projects, including a Maintenance resource project, and includes all verified and anticipated direct benefits (referred to as "Group 1" in this report).
- To provide an analysis of the portfolio of Main Tier projects under contract as of December 31, 2012 ("Current Portfolio") for use in the 2013 RPS Main Tier Program Evaluation. This second part includes all Main Tier RPS projects in the Current Portfolio, but excludes Maintenance resource projects, and reflects some modeled inputs and adjustments necessary to support conducting Net Macroeconomic and Benefit-Cost analyses for the 2013 RPS Main Tier Program Evaluation.

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<sup>3</sup> This effort includes stand-alone analyses of 17 Main Tier projects and one Maintenance Resource project with verified benefits.

NYSERDA collected the direct investment data used as the basis for this study as part of its administration of the RPS Program. NYSERDA's RPS Main Tier 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 have actually accrued to the State. Failure to make that demonstration results in a proportionate reduction in the contract bid price for the remaining seven years of the contract term.<sup>4</sup>

The direct investments in New York State were calculated and analyzed for short and long-term economic impacts. Short-term impacts included:

- Jobs lasting three years or less, such as construction, planning, engineering and legal jobs.
- Initial equipment or one-time capital expenditures for the development and construction of the project.

Long-term impacts included:

- Project ongoing operations and maintenance payroll (including salaries and benefits).
- Taxes or Payments in Lieu of Taxes to the State, municipalities, and schools (payments to public entities).
- Fuel purchases.
- Landowner payments.
- Other Operations and Maintenance in-state spending on equipment, supplies and services.

## Results

### Verified Direct Investments in New York State Analysis

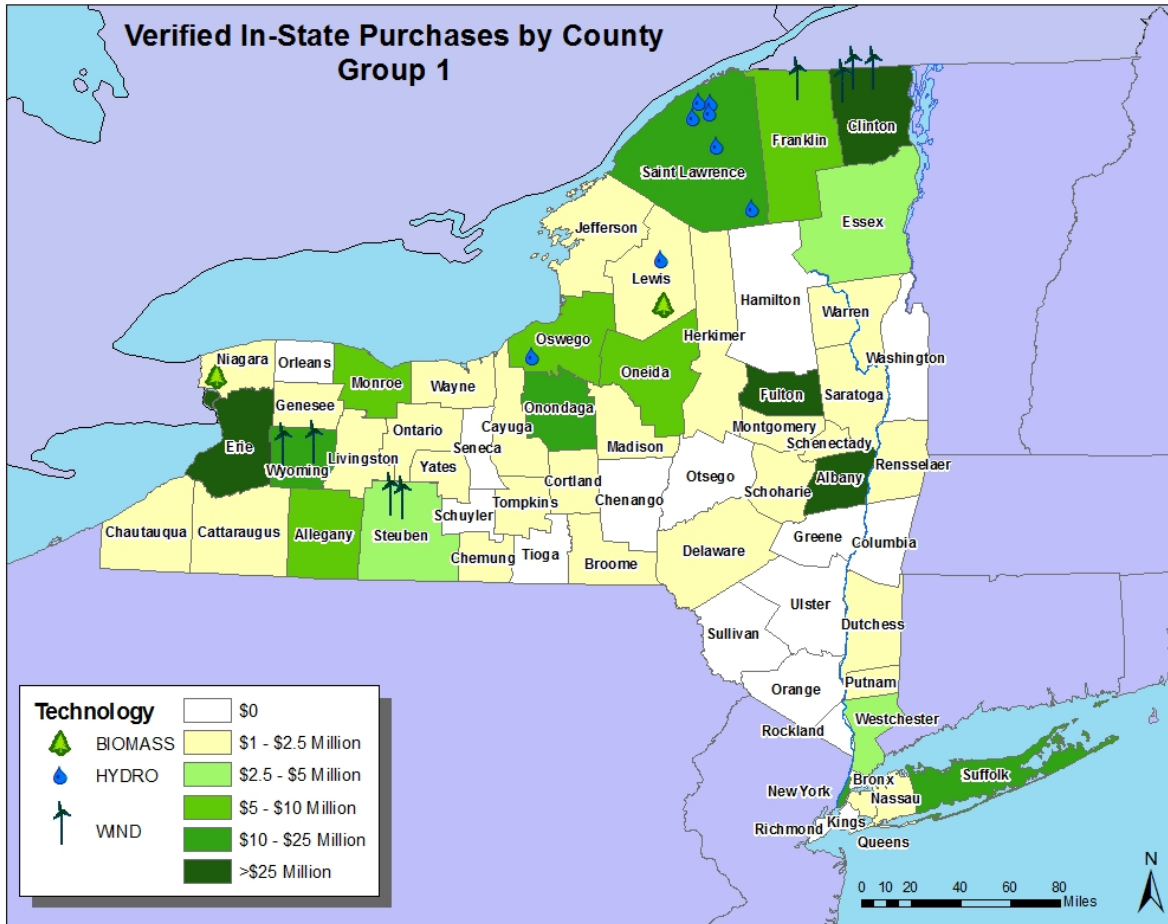
Key findings of the verification effort included corroboration of over \$450 million already spent in New York State over the first three years of commercial operation for the 18 Group 1 facilities.<sup>5</sup> The verified data confirm that over 1,000 in-state businesses benefited through the development, construction and operation of the referenced Group 1 facilities through three years of operation. The geographic impacts of these projects are often concentrated around, but also extend beyond, the host counties where the projects are located. Figure 1 shows a map of spending by county, as reported in the verified 3-year dataset.

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<sup>4</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>5</sup> The total expenditures in this paragraph are expressed in nominal dollars added across calendar years.

Figure 1. Verified In-State Purchases by County



Projection of anticipated long-term expenditures through the estimated life of the projects with verified investments adds over \$700 million in expenditures. In total, these projects are anticipated to add over \$1.1 billion to the New York State economy through their respective operating lives.<sup>6</sup>

Table 1 shows the anticipated direct investments in New York State for Group 1 projects in total and as a function of the nameplate capacity and anticipated generation of these facilities. Group 1 projects have a projected total of \$1.1 Billion in direct investments over the expected lifetime of all projects. This averages to approximately \$1.3 Million/MW of nameplate capacity and \$28 per MWh of production (2012 Dollars).

<sup>6</sup> The total expenditures in this paragraph are expressed in nominal dollars added across calendar years.

**Table 1. Total Verified and Anticipated Direct Investments in New York State for Group 1 Projects**

Technology	2012 Dollars			Nominal Dollars		
	Total \$ (Millions)	\$/MWh	\$/MW (Nameplate)	Total \$ (Millions)	\$/MWh	\$/MW (Nameplate)
Wind	\$ 800	\$25	\$1,079,000	\$ 823	\$26	\$1,110,000
Hydroelectric	\$ 12	\$11	\$ 319,000	\$ 11	\$10	\$ 281,000
Biomass	\$ 286	\$47	\$3,915,000	\$ 313	\$51	\$4,291,000
<b>Total</b>	<b>\$1,098</b>	<b>\$28</b>	<b>\$1,288,000</b>	<b>\$1,147</b>	<b>\$29</b>	<b>\$1,346,000</b>

### Total Current Portfolio Analysis

To align the verified dataset with conventions used for Benefit-Cost and Macroeconomic modeling completed for the 2013 Main Tier RPS Program Evaluation, only Main Tier projects with contracts as of December 31, 2012 were included in the Current Portfolio analyses. The data was also adjusted to include a de-rated estimate of investments that were not expressly verified as in-state expenditures (demand), and all investments in the trade sectors—verified and estimated—were further de-rated to represent only the applicable margin. Therefore, analyses associated with the Current Portfolio will not exactly align with Group 1 analyses above.

The results in Table 2 show the total direct investments in New York State for the Current Portfolio of projects in both real (2012 Dollars) and nominal dollars as compared to the projects' capacity and generation.

**Table 2. Summary of Total, \$/MW and \$/MWh Direct Investments in New York State – Current Portfolio**

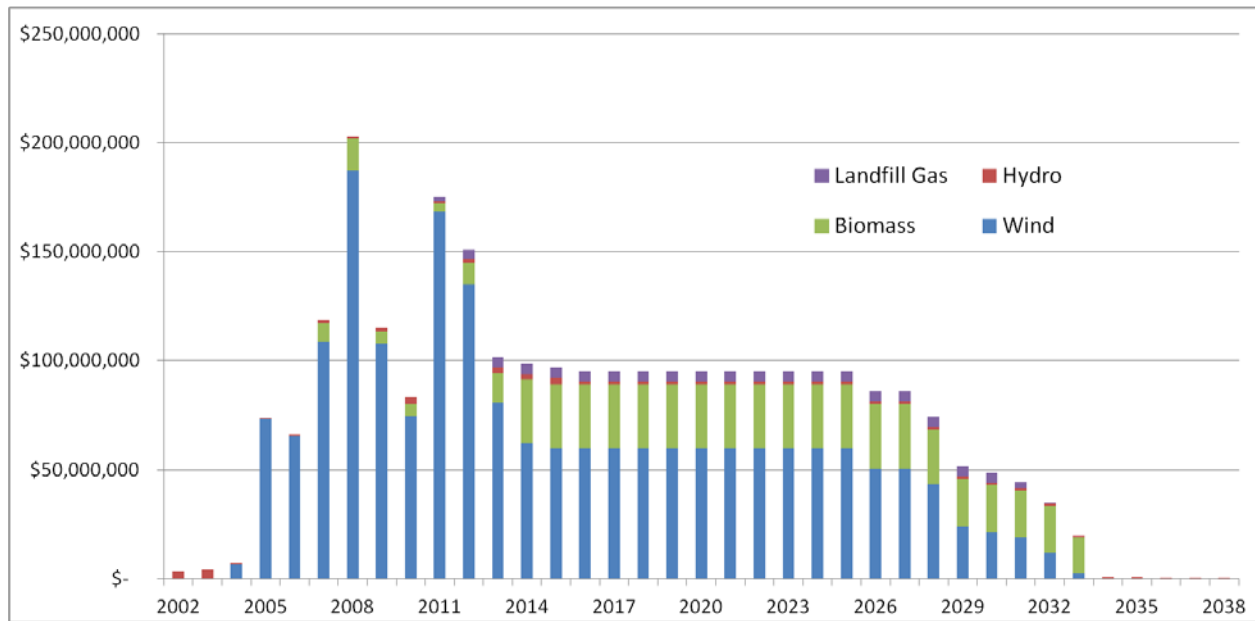
Technology	2012 Dollars			Nominal Dollars		
	Total (Millions)	\$/MWh	\$/MW (Nameplate)	Total (Millions)	\$/MWh	\$/MW (Nameplate)
Wind	\$1,951	\$24	\$1,199,000	\$2,065	\$26	\$1,269,000
Hydroelectric	\$ 51	\$11	\$ 298,000	\$ 55	\$12	\$ 323,000
Biomass	\$ 603	\$59	\$2,765,000	\$ 709	\$69	\$3,252,000
Landfill Gas	\$ 95	\$18	\$1,623,000	\$ 111	\$21	\$1,894,000
<b>Total</b>	<b>\$2,699</b>	<b>\$27</b>	<b>\$1,301,000</b>	<b>\$2,940</b>	<b>\$29</b>	<b>\$1,417,000</b>

Direct investments in New York State for the Current Portfolio of Main Tier projects totaled approximately \$2.7 billion, with the majority of investments occurring as long-term project expenditures for operating and maintaining the projects over their useful life. Due to extensive ongoing payments for fuel, biomass projects have the highest \$/MWh direct spending over the life of the projects. Overall, approximately \$27 in direct investment is produced as a result of project expenditures in New York State for every MWh that is generated under the RPS.

### Direct Investments in New York State as Inputs to 2013 RPS Main Tier Program Evaluation

As reviewed above, the results from this study were used as inputs for the Benefit-Cost and Macroeconomic analyses for the 2013 RPS Main Tier Program Evaluation. Both analyses required year by year spending summaries by technology, as well as some detail on the type of spending incurred in different categories and sectors. The previous figures and tables show summaries of spending by category and sector. Figure 2 depicts the direct investments in New York State by year, broken down by technology. Direct spending fluctuates in the early years as projects are being developed and installed, and then stabilizes as the portfolio of projects complete installation and commence stable long-term operations.

**Figure 2. Direct Investments in New York State by Year and Technology (2012 Dollars)**



## Direct Investments in New York State versus RPS Program Investment

In this analysis, an investment ratio was calculated that compares the Current Portfolio of project’s direct investments in New York State with the RPS investments in Main Tier and Maintenance Resource projects. The direct investments in New York State are calculated as all direct in-state spending over the project’s useful life, which extends beyond the 10-year RPS contract. The RPS investment portion of this comparison is the total RPS-related cost premium borne by ratepayers for procuring RPS Attributes over what is typically a 10 year term. The premise of this assumption is that the RPS program is responsible for stimulating construction and operation, whether or not NYSERDA contracts for the whole project output over a project’s entire useful life. Table 3 summarizes the Direct Investments in New York State and RPS Program Investment in nominal dollars for Group 1 and Group 2.

**Table 3. Total Direct Investments in New York State and RPS Program Investment (Nominal Dollars)**

Technology	Total Direct Investments in New York State (Millions)		Total RPS Program Investment (Millions) <sup>a</sup>	
	Group 1	Group 2	Group 1	Group 2
Wind	\$ 987	\$1,078	\$220	\$455
Hydroelectric	\$ 17	\$ 38	\$ 4	\$ 22
Biomass	\$ 178	\$ 531	\$ 30	\$133
Landfill Gas	n/a	\$ 111	n/a	\$ 58
<b>Total</b>	<b>\$1,182</b>	<b>\$1,758</b>	<b>\$254</b>	<b>\$668</b>

<sup>a</sup> For this calculation, RPS Program Investment included the actual historical payments and future contracted payments for RPS Attributes in addition to the historical and projected Administration costs for the Current Portfolio of Main Tier and Maintenance Resource projects.

Table 4 shows the Direct Investments in New York State and RPS Program Investments in 2012 Dollars on a Net Present Value (NPV) basis, which is used to calculate an investment ratio for each technology. An investment ratio in excess of 1 reflects greater direct investment realized than what was spent to implement and execute RPS contracts. An investment ratio in excess of 1 was realized, or is expected, across technologies. In total, the Current Portfolio studied yielded much more benefit than cost, on average, by approximately a 3:1 ratio.

**Table 4. Current Portfolio Investment Ratios (2012 Dollars)**

<b>Technology</b>	<b>NPV<sup>a</sup> Total Direct Investments in New York State (Millions)</b>	<b>NPV Total RPS Program Investment (Millions)</b>	<b>Investment Ratio</b>
<b>Wind</b>	\$ 979	\$324	3.0
<b>Hydroelectric</b>	\$ 25	\$ 12	2.0
<b>Biomass</b>	\$ 214	\$ 71	3.0
<b>Landfill Gas</b>	\$ 34	\$ 24	1.4
<b>Total</b>	\$1,252	\$431	2.9

<sup>a</sup> NPV was calculated using 2002 as the base year, which matches the first year in which benefits accrue.

## Key Findings and Conclusions

Through December 31, 2012, the RPS Main Tier has provided substantial revenue to support new generation from wind, biomass, hydroelectric and landfill gas systems. Through a comprehensive verification process on 18 Main Tier facilities, NYSERDA has confirmed that the currently contracted resources have yielded and will continue to yield significant direct investments to the State which far exceed the RPS funds committed to these projects.

The verification of New York State spending through three years of operation from 18 Main Tier facilities has shown that over 1,000 in-state businesses spread over 44 counties benefited through the development, construction and operation of these facilities. The geographic and economic impacts of these projects are often concentrated around the project location but also extend beyond the host counties where the projects are located. While fuel resource access and tax/local permit payments typically remain within the host county, purchases of goods and services for these projects were sourced throughout New York State.

Approximately \$2.7 billion dollars of direct investments in New York State are expected over the projected life of the Current Portfolio of Main Tier RPS facilities, as measured in jobs, taxes and local payments, in-state purchases and land leases. In the short-term, the greatest impacts come from spending on construction materials and services. In the long-term, PILOT payments, payroll expenses, fuel and landowner payments trigger the largest economic impacts. Overall, approximately \$27 in direct investments are produced as a result of project expenditures in New York for every 1 MWh of renewable energy that is generated under the Main Tier program.

The analysis indicates that for every \$1 spent on the acquisition of RPS Attributes for the Current Portfolio of RPS projects under contract with NYSERDA, the State will capture on average approximately \$3 in direct investments associated with project spending over project lifetime. Clearly the RPS Main Tier has brought and will continue to bring significant investments to many sectors of the state's economy.

# 1 Introduction

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## 1.1 Objective

The objective of this study was to analyze verified direct investments in New York State which are associated with a subset of New York State Main Tier and Maintenance resource RPS<sup>7</sup> contracts, and to estimate these investments associated with the remaining projects with current Main Tier contracts as of December 31, 2012. This analysis was accomplished by evaluating verified in-state direct investment data from 18 projects with NYSERDA Main Tier and Maintenance resource RPS contracts, and extrapolating these investments through the life of each project. The resulting data was then used to project the direct investments in New York State that are attributable to all current RPS projects.

This analysis only considers the direct impacts of the Current Portfolio of Main Tier RPS contracts, without consideration of multiplier or induced effects, or net impacts. These investments are then compared with the value or cost of RPS contracts for a direct benefit-cost analysis of current projects in the Main Tier RPS program, referred to in this report as an investment ratio. Direct investments include all in-state spending by projects, in the form of purchases or salary payments, over their development, construction, and operating life. NYSERDA's consultants verified data that were submitted in an effort to better understand the scope and scale of the direct investments resulting from incentivizing renewable energy development within the State.

The focus of this study is on direct investments in New York State, which is a subset of the total amount spent by project developers, as this provides an estimate of the direct economic development benefit realized in New York State. Some studies simply provide the total cost of project development, including imported hardware and services, so comparison to other economic development reports should be made with care.

The analysis of the benefits associated with direct project investment is comprised of two parts:

- To provide an assessment of the direct investments in New York State that were associated with the projects that had submitted verified data, The first part was focused on the subset of verified projects, including a Maintenance resource project, and includes all verified and anticipated direct benefits.
- To provide an analysis of the portfolio of Main Tier projects under contract as of December 31, 2012 ("Current Portfolio") for use in the 2013 RPS Main Tier Program Evaluation. This second part includes all Main Tier RPS projects in the Current Portfolio, but excludes Maintenance resource projects, and reflects some modeled inputs and adjustments necessary to support conducting Net Macroeconomic and Benefit-Cost analyses for the 2013 RPS Main Tier Program Evaluation.

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<sup>7</sup> This effort includes stand-alone analyses of 17 Main Tier projects and one Maintenance Resource project with verified benefits.

## 1.2 Background

Five categories of direct investments in New York State were used as the basis for this study. Data was collected by NYSERDA from operating projects for the purpose of substantiating the direct investments in New York State which were included in project bid proposals.<sup>8</sup> (See Section 1.2.2 for a detailed explanation of this process). These data were then analyzed by NYSERDA's consultants – Sustainable Energy Advantage, LLC and Economic Development Research Group, Inc. – in an effort to better understand the nature of the direct investments realized as a result of incentivizing renewable energy development within the State. These benefits as described in the following section include in-state expenditures by each project through development, construction, and operating (including maintenance) phases, have significant direct impacts on the New York State economy.

### 1.2.1 Benefits Categories

NYSERDA verifies actual direct investments in New York State created by an RPS project through the first three years of the NYSERDA contract in the following categories:

1. Long-Term New York State Jobs: The degree to which the operation of the project directly created long-term jobs (jobs lasting more than three years) in New York State. Examples of such jobs include, but are not limited to, those associated with operations and maintenance, plant management, or similar.
2. Payments to New York State and/or its Municipalities (Payments to Public Entities): The degree to which the operation of the project provided new or increased local property tax revenues to school districts, cities, towns or other taxing jurisdictions in New York State, or alternatively, Payments in Lieu of Taxes (PILOT) or other alternative taxing mechanisms and forms of compensation.
3. Payments for Fuels and Resource Access: The degree to which the operation of the project provided royalties, production-based payments, land lease or land use payments or other forms of compensation, associated with securing rights to or directly acquiring fuel or access to wind resources for the project. Examples include payments for leases of land in New York State, payments associated with the production of electricity, fuel purchases of biomass sourced or harvested in New York State, and purchases for landfill gas produced in New York State.
4. In-State Purchases or Consumption of Goods: The degree to which local and state economic activity increased as a result of:
  - The purchase and consumption of local goods and services by non-New York State-resident workers, such as, but not limited to, food, lodging, vehicles, equipment, fuel.
  - The purchase of materials sourced from within New York State such as, but not limited to, gravel, steel, concrete and similar materials and/or the purchase and use of equipment and products manufactured or assembled within New York State and/or the use of rental equipment or similar supplies sourced from within New York State.

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<sup>8</sup> RPS Contract terms require the facilities to demonstrate actual investment of no less than 85% of the bid-based amount, or face a penalty through a lowering of contract prices.

- Ongoing operations and maintenance expenses occurring through the first three years of the NYSERDA contract.
5. Short-Term Employment: The degree to which New York State workers were employed on a short-term basis. Illustrative examples include direct employment of New York State construction, rail and port workers, contractors and laborers, engineering or environmental service providers, consultants, financial service advisors, and legal service providers associated with the development and construction/modification of the project.

## 1.2.2 Benefits Verification Process

NYSERDA's RPS Main Tier contracts require each of NYSERDA's contractors, after the first three years of project operations under contract, to demonstrate that at least 85% of the direct investments in New York State that were claimed in the contractor's Bid Proposal have actually accrued to New York State. Failure to make that demonstration results in a proportionate reduction in the contract bid price for the remaining seven years of the contract term.<sup>9</sup> This requirement is based on the Commission Order that authorized economic benefits evaluation criteria to constitute 30% of the weight in bid evaluation, 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 State."<sup>10</sup> NYSERDA recognizes the importance of the accurate, verifiable quantification of the direct investments of projects receiving RPS Main Tier funding to the integrity of the 30% weighting. The comprehensive process developed by NYSERDA to verify the accrual of direct investments in New York State reflects this priority.

NYSERDA program staff is responsible for reviewing the documentation provided by contractors after the third year of operation, and, in consultation with NYSERDA legal staff, determining whether the actual direct investments were consistent with those claimed in the bid proposals. Records provided as demonstration of benefits differ by project, type of direct investment claimed, and contractor, but to be acceptable all records must be third-party verifiable. Examples of records provided for this purpose include: W-2 (Wage and Tax Statement), 1099 (Non-Employee Compensation), invoices and accompanying records of payment, Payment-in-lieu of taxes (PILOT) or Host Community Agreements with accompanying records of payment, and subcontracts with supplier breakdown and associated documentation.

Regardless of the form of documentation, NYSERDA considers overarching factors throughout this process such as the reasonableness of the claimed expenses, the presence of satisfactory demonstration that an expense was actually incurred, and assurance that expenses were not double counted.

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<sup>9</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>10</sup> Case 03-E-0188; 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.

Procedurally, the process for verifying direct investments in New York State consists of five primary steps:

1. RPS program staff engages each contractor in advance of the report due date to discuss the obligation to demonstrate the actual accrual of economic benefits through the submission of verifiable, defensible documentation confirming the bid proposal claims. Eligible data sources are also reviewed with the contractor.
2. RPS program staff reviews the initial submission.
3. RPS program staff engages the contractor to review additional data needs; follow up ensues to ensure that NYSERDA is collecting the best and most complete data set available to substantiate economic benefit claims. Should the need arise RPS program staff engages RPS legal staff for support. RPS program staff may also engage outside support from subcontractors, other State agencies, local taxing jurisdictions, etc. to assist with the independent verification of direct investments in New York State.
4. Once a file is complete and thoroughly evaluated, a letter recommendation and summary report are prepared and circulated internally along with all supporting documentation for approval by NYSERDA legal and senior RPS program staff.
5. Contractors are notified of their compliance status in writing.

### **1.2.3 Direct Investments in New York State Verification Status**

As of December 31, 2012, 18 facilities with claimed direct investments in New York State had passed their three-year anniversary of operations under contract. These facilities include 8 wind farms, 2 biomass facilities (including one Maintenance resource project) and 8 hydroelectric facility upgrades, which are all located in New York State. For purposes of this study, these projects are referred to as Group 1 facilities. RPS staff completed a thorough review of the documentation provided to substantiate the claims made for each of these facilities. Through the process described above, more than 30,000 documents were received and examined by RPS staff.<sup>11</sup> All 18 facilities were determined to be at or above their contract compliance obligation.

### **1.2.4 In-State Purchases versus Short-Term Employment**

Through the direct investment verification process, significant short term employment benefits were verified by NYSERDA. However, a preponderance of short term employment was verified as falling under the In-State Purchases category. The reason is that vast majority of short term workers were not paid as independent contractors, where the individual employee's salary and length of work could be verified by NYSERDA as defined through the categories above. Rather, this labor was largely obtained through contracts with construction or other service firms, and the associated invoices included fees for both materials and labor. Therefore, much of the short-term employment was actually verified in the In-State Purchases category, a factor that is considered and addressed through this analysis.

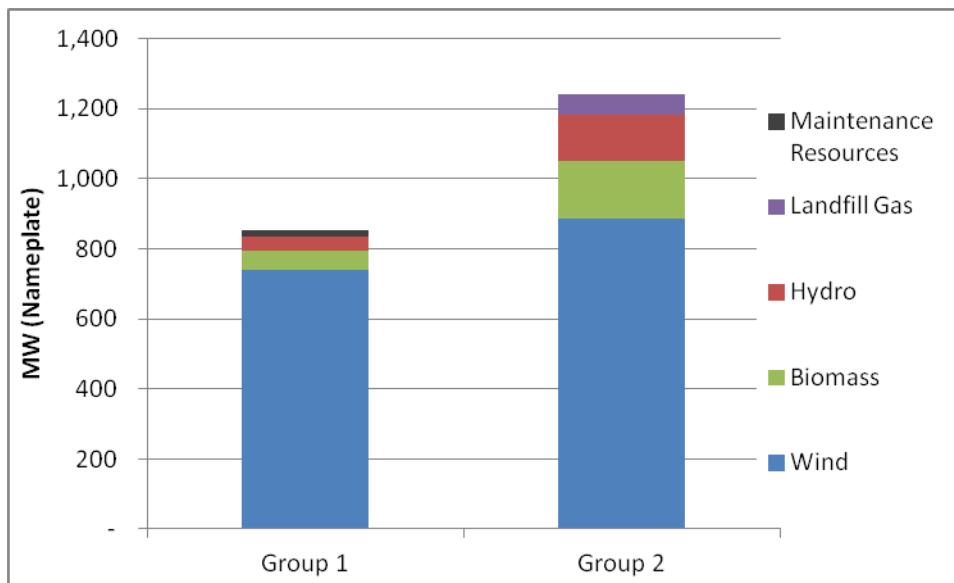
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<sup>11</sup> Most of the referenced documents were submitted to NYSERDA under a claim of confidentiality under Public Officers' Law § 87(2)(d), as records submitted to an agency by a commercial enterprise.

### 1.3 Project Data

The RPS projects were analyzed in two groups. Group 1 projects submitted, and NYSERDA has verified, three years worth of spending data, which was used as the basis for this direct investment analysis. Group 2 projects consist of the remaining projects under contract with NYSERDA. Many of these projects submitted bid data on expected direct investments but have not operated under the NYSERDA contract for three years, the period after which reporting is required. Group 1 (834 MW) has fewer megawatts than Group 2 (1,241 MW) as shown in Figure 3. The Group 1 total includes one 19 MW Maintenance resource project which was used for the verified data analysis but not included in the Main Tier Current Portfolio Analysis which followed.

**Figure 3. Nameplate MW by Technology and Group**



The direct investment data that have been verified for the 18 Group 1 facilities shown in Figure 4 and listed in Table 5 form the basis for projecting the direct investments that are anticipated to accrue to New York State from the operation of 30 additional projects (referred to hereafter as Group 2 facilities). Group 2 facilities have been approved for an RPS contract with NYSERDA, but either

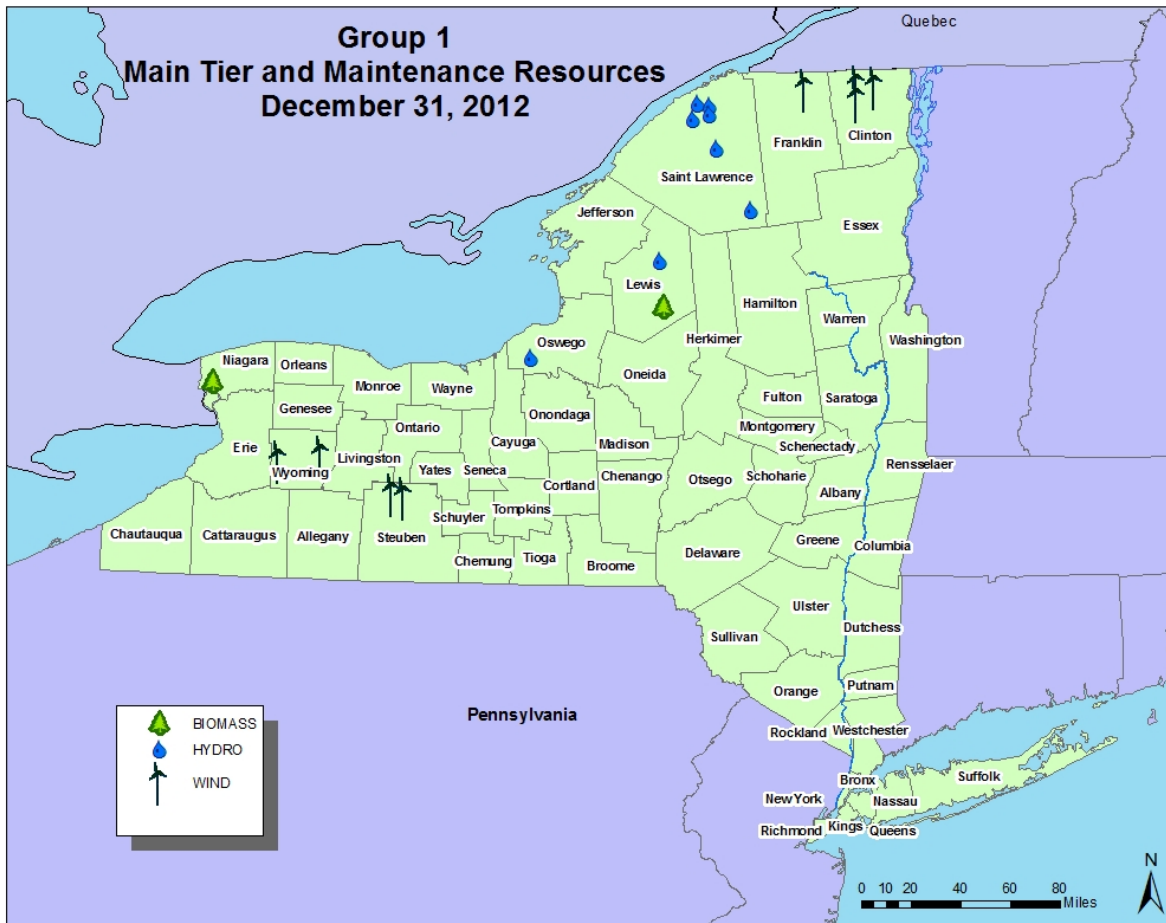
- Have not been reached their three-year contract year anniversary and a verified data set of spending is not yet available.
- Anticipated in-state benefits were not eligible for NYSERDA’s consideration pursuant to specific requirements of the RPS solicitation under which the project received an award.<sup>12</sup>

<sup>12</sup> RFP 916 awards were based only on the price bid for RPS Attributes. RFP 1851 included a requirement based on Commission Orders which restricted economic benefits eligibility to those projects entering commercial operation after January 8, 2010.

There were an additional 10 projects for which direct investments were not projected because New York State investments were not claimed in their RPS bid despite the eligibility of such claims. Though no direct investments were attributed to those projects in this analysis, the budgeted costs to be paid by NYSERDA for RPS Attributes were included in later benefit-cost analyses.<sup>13</sup>

Group 2 facilities are listed in Table 6 and shown on a map in Figure 5.

**Figure 4. Map of Projects with Verified Direct Investments in New York State (Group 1)**



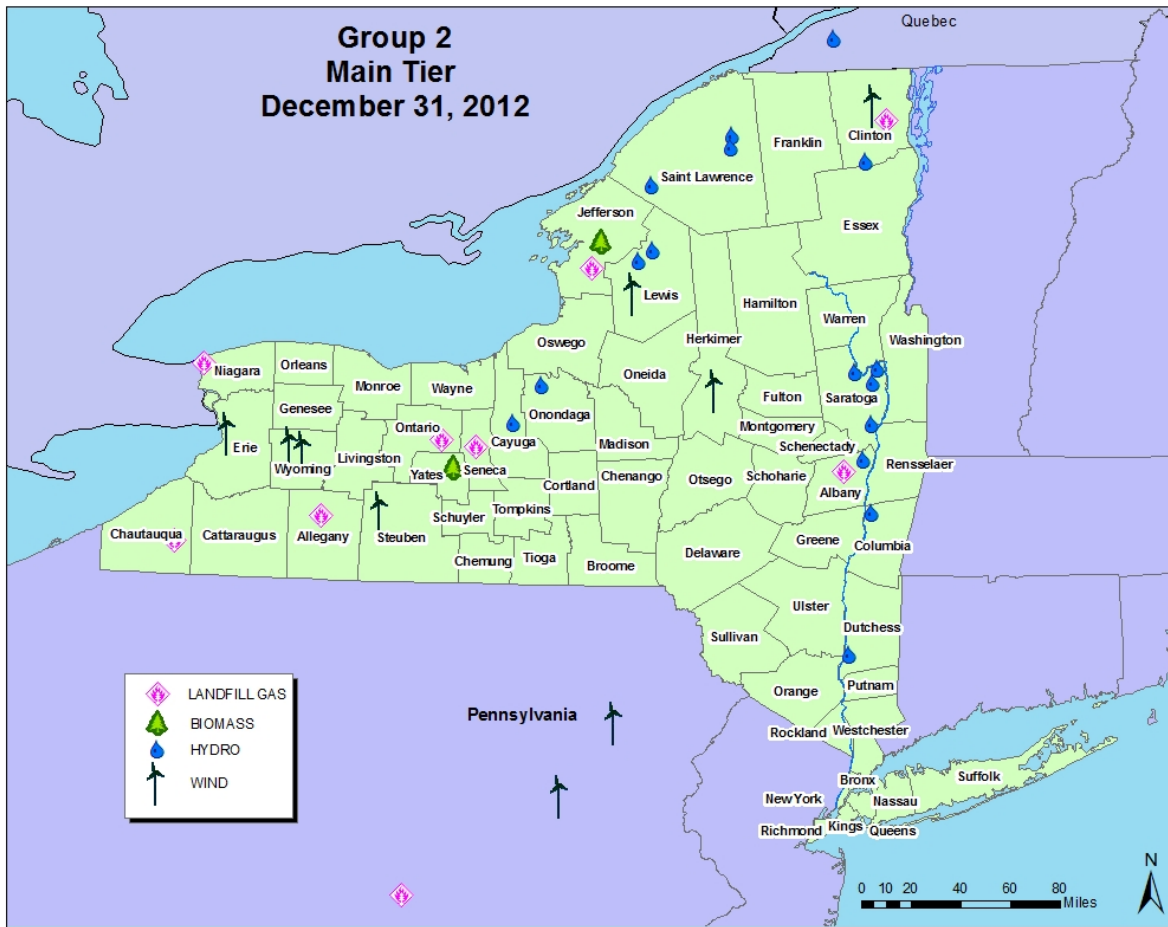
<sup>13</sup> RFP 916 awards were based only on the price bid for RPS Attributes. RFP 1851 included a requirement based on Commission Orders which restricted economic benefits eligibility to those projects entering commercial operation after January 8, 2010.

**Table 5. Projects with Verified Direct Investments in New York State (Group 1)**

<b>Technology</b>	<b>Project Name</b>	<b>Nameplate Capacity (MW)<sup>14</sup></b>	<b>Delivery Start Date</b>
Wind	Altona Windpark	102.00	February 2009
Wind	Bliss Windpark	100.50	June 2008
Wind	Chateaugay Windpark	106.50	February 2009
Wind	Clinton Windpark	100.50	June 2008
Wind	Dutch Hill Farm/Cohocton Wind Farm	125.00	February 2009
Wind	Ellenburg Windpark	81.00	June 2008
Wind	Wethersfield Windpark	126.00	February 2009
Biomass	Lyonsdale Biomass (Maintenance Resource)	19.00	January 2008
Biomass	Niagara Generation Facility	54.00	May 2008
Hydroelectric	Eagle	6.57	January 2008
Hydroelectric	East Norfolk	4.05	January 2008
Hydroelectric	Higley Falls	6.20	January 2008
Hydroelectric	Norfolk	5.75	January 2008
Hydroelectric	Norwood	2.67	November 2008
Hydroelectric	Oswego Falls	7.47	November 2008
Hydroelectric	Piercefield	2.70	January 2009
Hydroelectric	Raymondville	2.70	November 2008

<sup>14</sup> Nameplate Capacity refers to the Bid Facility's full capacity whereas Bid Capacity refers to the portion of the Bid Facility's capacity associated with production which is under an RPS contract.

Figure 5. Map of Projects with Calculated Direct Investments in New York State (Group 2)



**Table 6. Projects with Calculated Direct Investments in New York State (Group 2)**

<b>Technology</b>	<b>Project Name</b>	<b>Nameplate Capacity (MW)</b>	<b>Delivery Start Date</b>
Wind	Hardscrabble Wind Farm	74.00	March 2011
Wind	High Sheldon Wind Farm	112.50	March 2012
Wind	Howard Wind Farm	51.25	January 2012
Wind	Howard Wind Farm Expansion	4.10	January 2013
Wind	Maple Ridge Wind Farm	321.00	January 2006
Wind	Marble River Wind Farm	215.25	December 2012
Wind	Steel Winds II Wind Farm	15.00	February 2012
Wind	Orangeville Wind Farm	92.80	October 2013
Biomass	AES Greenidge, LLC	104.00	August 2009
Biomass	Black River Facility	60.00	October 2013
Hydroelectric	Black Brook Hydro	0.64	June 2011
Hydroelectric	Brown Falls	15.90	January 2008
Hydroelectric	Mechanicville Hydroelectric	4.50	June 2011
Hydroelectric	Mill Street Dam	0.60	October 2013
Hydroelectric	School Street Hydroelectric	38.80	January 2011
Hydroelectric	Spier Falls	56.60	January 2006
Hydroelectric	Stewarts Bridge Hydroelectric	2.60	July 2013
Hydroelectric	Stuyvesant Falls Hydroelectric	6.00	January 2013
Hydroelectric	Taylorville Hydroelectric Project	4.60	January 2011
Hydroelectric	Wappingers Falls Hydroelectric	2.10	July 2011
Hydroelectric	Wave Hydro LLC	0.42	July 2011
Landfill Gas	Albany 1	0.90	January 2011
Landfill Gas	Albany 2	3.20	July 2012
Landfill Gas	Chautauqua LFGE	8.00	July 2011
Landfill Gas	Clinton County Landfill	6.40	May 2012
Landfill Gas	DANC LFGE	4.80	July 2011
Landfill Gas	Hyland LFGE	4.80	July 2011
Landfill Gas	Modern LFGE	6.40	July 2011
Landfill Gas	Ontario LFGE	6.40	July 2011
Landfill Gas	Seneca Energy	17.60	July 2011

## 2 Methodology

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### 2.1 Overview

The direct investments in New York State assessment was based on the verified data set. Data on Group 1 projects included verified spending data through three years of operation, which was then extrapolated by technology for expected long-term expenditures over a project's useful life. For every technology, a dollars-per-megawatt (\$/MW) factor was calculated by expenditure category, which was used to calculate expected short-term and long-term direct investments in New York State for projects with no verified data.

### 2.2 Data Source

The main data source for this evaluation comes from the 18 Group 1 projects with NYSERDA RPS contracts that have reported three years of project data verified by NYSERDA staff according to the process referenced in Section 1.2.2.<sup>15</sup> Detailed results and analysis of the verified investments in New York State are included in Section 3.1 of this report.

Group 1 projects were sorted by technology, and each project's verified expenditures were summed up by year and by the categories detailed in Section 1.2.1. This three-year data set comprised a mix of short-term spending - characterized as initial investments for project upgrades or development - and long-term spending for operations and maintenance. Group 2 projects did not have verified data reported, so their direct investments in New York State were calculated by applying metrics developed from the Group 1 data set or by using bid data in the absence of a correlating Group 1 data set. Because all Group 1 facilities with verified investments met or exceeded the threshold for contractual adjustment, it is reasonable to assume that the RPS contractual repercussions are an effective deterrent to overstating benefits, and thus bid proposal data was considered to be an acceptable proxy for verified data.

### 2.3 General Assumptions

Despite having a robust data set of verified investments from Group 1 projects, the study still required developing a number of educated assumptions to complete the data set. These assumptions included the split between short-term versus long-term spending within these data sets, anticipated project life, fuel cost, and the magnitude of unreported long-term spending for capital replacements. These assumptions were largely based on inputs to be used for NYSERDA's 2013 Main Tier RPS Program Evaluation. Section 2.4.2.3 provides more detail about how these assumptions were used to extrapolate Operations and Maintenance expenditures (O&M) over the project's expected life. The analysis was conducted in 2012 dollars, and all verified data, which were reported in nominal dollars, were

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<sup>15</sup> The verification process yielded documentation which required the inclusion of short-term jobs in the in-state purchases category. See Section 1.2.4 for additional discussion on this topic.

converted using the GDP Inflation Index from U.S. Energy Information Administration (EIA)'s Annual Energy Outlook 2013.<sup>16</sup> Results are shown in both real and nominal dollars.

## 2.4 Group 1 Investment Calculations

Direct investments in New York State were calculated for each project over the expected project life, including expected operating years that extend beyond the end of the RPS contract. Direct investments are defined as total New York State spending from the project, which includes short-term expenditures for project upgrades or development, as well as long-term expenditures for ongoing O&M.

The direct investments in New York State were calculated and analyzed for short and long-term economic impacts. Short-term impacts included:

- Jobs lasting three years or less, such as construction, planning, engineering and legal jobs.
- Initial equipment or one-time capital expenditures for the development and construction of the project.

Long-term impacts included:

- Project ongoing operations and maintenance payroll (including salaries and benefits).
- Taxes or Payments in Lieu of Taxes to the State, municipalities, and schools (payments to public entities).
- Fuel purchases.
- Landowner payments.
- Other O&M in-state spending on equipment, supplies and services.

For Group 1, each project's direct investments comprised both verified and modeled expenditures, with heavy emphasis on verified investments wherever available. The verified direct investments in New York State during the first three years of operating life include neither capital replacement costs nor higher O&M spending one would expect as projects age. Therefore, a small incremental O&M expenditure was added into the In-state Purchases category to account for these expected but unverified expenditures, to paint a full picture of each project's realistic O&M spending over its useful life. All verified and modeled data were converted to 2012 dollars for consistency. The complete modeling process is described in Section 2.4.2.3. As described earlier, Group 1 benefit per-unit ratios were used as the primary basis for calculating projected investments for Group 2 projects. This approach is explained more fully in Section 2.5.

Figure 6 illustrates the direct investments in New York State calculation process for all categories except for In-state Purchases. Verified data was split up into short-term expenditures (construction-related) and long-term expenditures (O&M related) for the first three years. The long-term spending was then extrapolated over the rest of the project's projected useful life to calculate the project's total direct investment.

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<sup>16</sup> EIA's Annual Energy Outlook <http://www.eia.gov/forecasts/aeo/>.

**Figure 6. Direct Investment in New York State Calculation for Jobs, Payments to Public Entities, and Fuel Resource Access Categories**

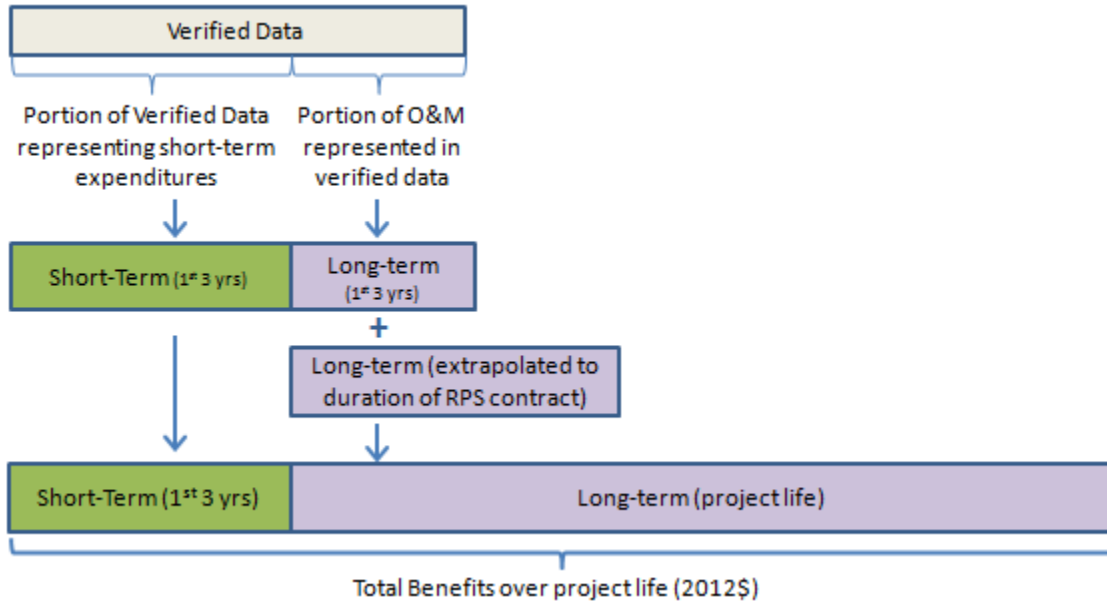
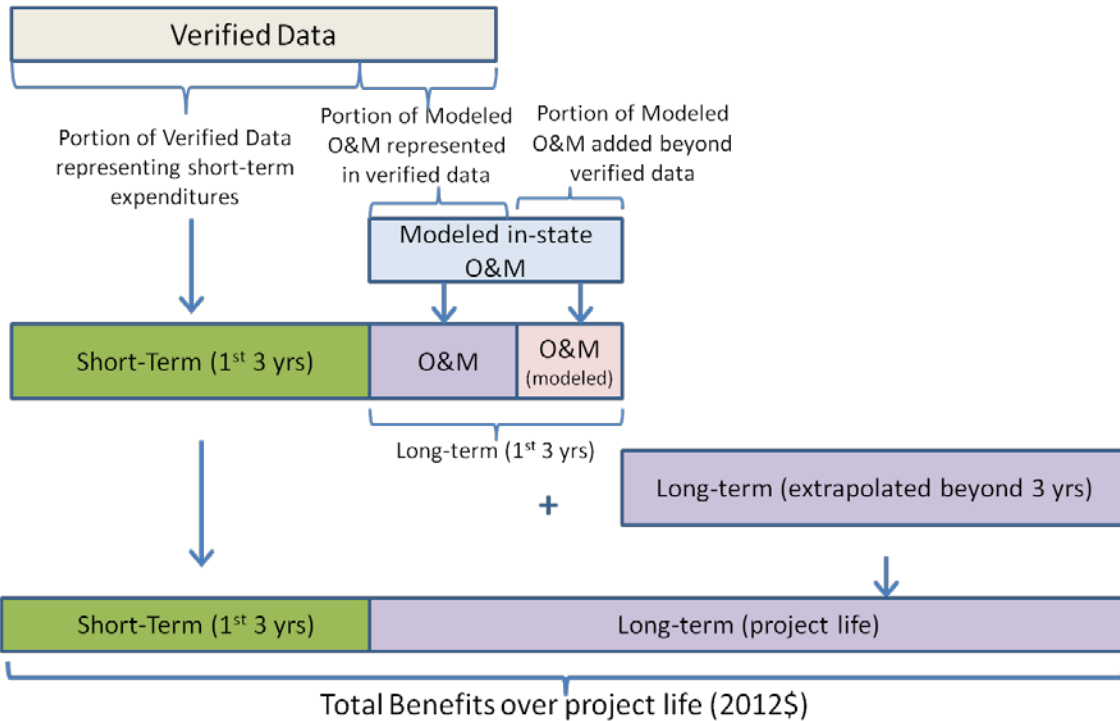


Figure 7 shows the process for calculating In-state Purchases. It is similar to the process used for other spending categories, but also includes modeled O&M. As with the other categories, verified direct investments in New York State were split into short-term expenditures and long-term expenditures representing O&M spending for the first three years. Because projects are expected to increase O&M spending on parts and maintenance over their operating life, a small portion of modeled O&M was added to the long-term expenditures for each operating year. Direct investments are extrapolated for all projects through expected operating life, which extends past the end of the RPS contract. In-state Purchases are broken down into a number of sectors, such as construction, utilities, or legal services. For the direct investment calculations developed for the 2013 Main Tier Program Evaluation, a further adjustment was made to all project-related spending modeled as transactions through the New York State wholesale or retail trade sectors. Only the “mark-up” dollars or “margin” reflects the New York State for these sectors. The mark-up percent for Wholesale trade business is 20% and 28% for Retail trade businesses; this percentage was applied to all purchases in the these categories.<sup>17</sup>

<sup>17</sup> 2010 NYS IMPLAN Model industry database. <http://implan.com/V4/Index.php>.

**Figure 7. Direct Investment in New York State Calculation for In-State Purchases Category**



### 2.4.1 Short-term Expenditures

Short-term expenditures were defined as all direct investments in New York State not associated with O&M or capital replacement costs. For Group 1 projects, short-term expenditures were calculated by taking all verified investments and subtracting out long-term O&M expenditures for each operating year, assuming no capital replacement costs were included in the verified investments data set.

### 2.4.2 Long-term Expenditures

Long-term expenditures represent all of the ongoing O&M direct investments in New York State over a project’s life, including payments to public entities and landowners, fuel costs, labor, and materials. For this analysis, Group 1 projects reported the first three years of in-state expenditures, which were divided between short-term and long-term costs. Group 1 long-term expenditures, by expenditure category and by technology, were converted to a dollars per unit of capacity or \$/MW per year measure that was then extrapolated for the project life.

Details on the specific modeling approach used for Group 1 projects for each category of long-term expenditures are presented in the following sections.

**2.4.2.1 Long-term Fuel Payments – Biomass**

Biomass projects incur significant fuel payments over the life of the project that varies by expected production. For projects that are operating and have been producing at expected output, historic fuel cost was extrapolated in a similar method as other categories, with the expectation that production<sup>18</sup> and thus fuel use would remain the same.<sup>19</sup> For projects that had under-produced relative to their Bid Quantities during the period of data verification, a \$/MWh fuel cost was calculated from historic data and applied to future expected production based on contracted production over the project life.

**2.4.2.2 Long-term Labor, Payments to Public Entities, Landowner Payments**

Long-term costs for labor as well as payments to public entities and landowners were extracted from the rest of the verified direct investments in New York State for each project by using the last full year directly following commercial operation from the reported and verified data. For example, if a project began operating on July 1, 2008 and submitted spending data through mid 2011, costs in 2010 are assumed to represent a full year of likely ongoing long-term costs in these categories.

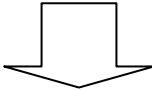
The remaining long-term costs for in-state purchases related to O&M were estimated using verified and modeled quantities and applied over the expected project life as described in Section 2.4.3.3.

**2.4.2.3 Remaining Operations & Maintenance Expenditures Calculation**

**O&M from Verified Data**

All verified expenditures in the In-state Purchases category that were not considered as O&M expenses remained under short-term spending. Table 7 shows an illustration of separating and projecting O&M from the verified data.

**Table 7. Illustrative O&M Allocation from Verified Project (2012 Dollars)**

	2008	2009	2010	2011-2027
<b>Total verified expenditures</b>	\$2M	\$1.5M	\$1M	(extrapolated)
				
<b>Short-term portion</b>	\$1M	\$0.5M	\$0	n/a
<b>Long-term portion (O&amp;M)</b>	\$1M	\$1M	\$1M	\$17M

<sup>18</sup> This study assumed no production degradation over the projected life of the projects.

<sup>19</sup> Verified fuel purchases showed that biomass plants’ fuel costs averaged approximately \$30/MWh.

As discussed in Section 2.4.2.2, the full final year of verified data for the compliance period was assumed to be representative of a typical year of long-term O&M costs. In this example, 2010 is the final year with verified data, and the project reported \$1M of expenditures during that year. This sample project began operating in 2008, so \$1M of each year’s reported expenditures were categorized as ongoing O&M and the remainder was categorized as short-term expenditures. This \$1M/year was extrapolated for the remainder of expected project life (17 years), totaling \$20M in long-term O&M expenses over the project’s useful life. The project also had \$1.5M in remaining short-term expenditures incurred in 2008 and 2009.

The exception to this methodology is hydroelectric facilities, which reported only short-term expenditures. Long-term expenditures for hydroelectric facilities were all modeled according to the methodology described as follows.

**Modeled O&M**

Table 8 presents key metrics used to extrapolate O&M direct investments in New York State, consistent with those investments used in the 2013 RPS Main Tier Program Evaluation. Assumed project life was used to determine the number of years for extrapolating direct investments and production. These O&M costs were used to estimate each project’s total O&M expenditures, a portion of which are assumed to be spent in New York State.

**Table 8. Modeling Metrics for Extrapolation (2012 Dollars)**

Technology	Project Life	Fixed O&M (\$/kW-yr)	Variable O&M (\$/MWh) <sup>a</sup>
Wind	20	67.1	0.58
Hydroelectric	25	60.0	6.1
Biomass	20 <sup>b</sup>	84.5	11.2
Landfill Gas	20	112.0	13.2

<sup>a</sup> kW and MWh were based on the project’s bid capacity to match requirements for what projects could report as verified in-state spending.

<sup>b</sup>Biomass co-firing is often modeled with a shorter project life because many are converted coal plants near the end of their useful life. The two co-firing plants in Group 1 and Group 2 were both newer coal plants which included significant investments, consequently both are expected to operate for 20+ years.

The verified data set only accounts for typical and verified O&M in-state expenses incurred within the three-year period during which projects reported verified expenses, and does not capture whether capital replacements or any O&M increase occurs over time as projects age. Models and reports in the electric power sector typically estimate O&M over a plant's life using escalation at a rate higher than inflation to account for higher maintenance costs universally experienced to keep aging equipment operating on a regular basis. To account for that portion of cost, the analysis compares the reported O&M with a modeled O&M projection by technology, and makes an assumption of what portion of the difference over time should be included as long term direct investments in New York State. This modeled O&M number estimates one year of O&M cost that accounts for future capital replacements and increases over time. This figure is higher than a project's initial O&M, but should plateau over the project's operating life. The remaining portion of modeled O&M that was not considered direct in-state spending was summed by sector and treated as demand that may or may not yield benefits to the State. Using the regional price coefficients (RPC) from Regional Economic Models Inc. (REMI), these demand benefits were de-rated to estimate their in-state benefits, and added to each project's total direct investments in New York State.

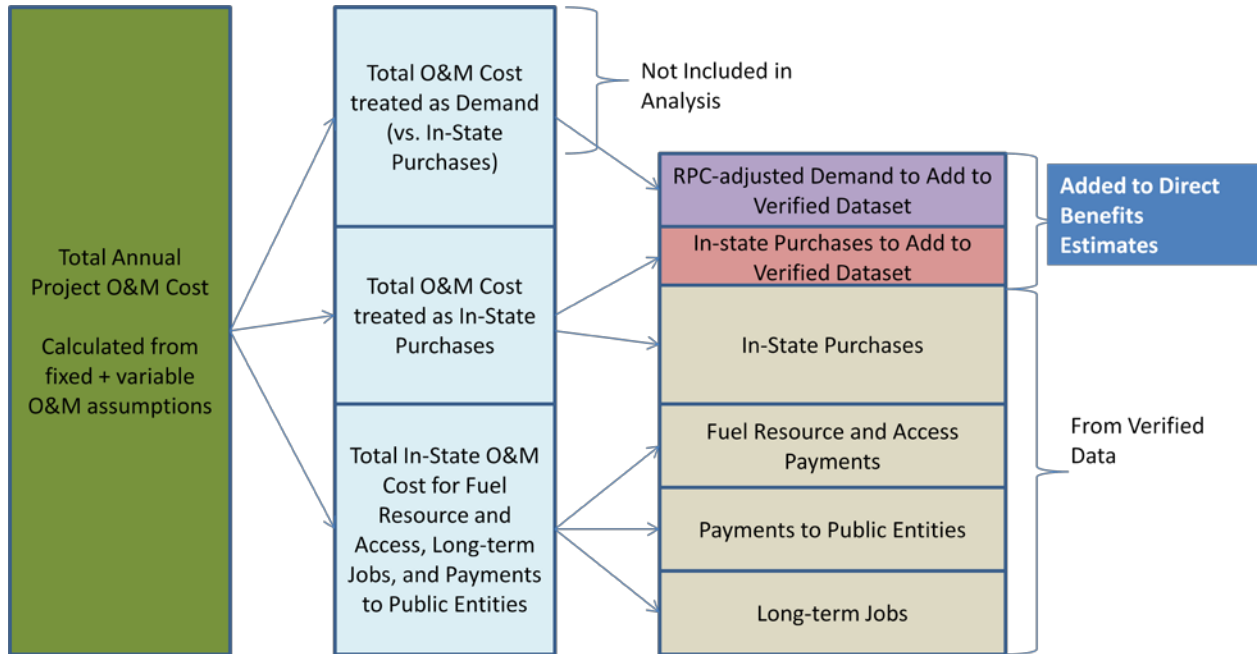
Each project's annual expected O&M expenditure was calculated based on its bid capacity and bid quantity. The calculated O&M expenditure includes all ongoing expenditures except for fuel costs. Although some O&M expenditures may have been directed out-of-state, this analysis assumed that long-term jobs, fuel resource access, and payments to public entities were all spent in-state, included in the verified data set and did not require any modeling considerations. Purchases are the only category<sup>20</sup> where the project's verified bid data do not represent a complete picture of their total direct investments in New York State. Therefore, a conservative assumption was made that only in-state purchases would see an expected increase in O&M costs as projects age.

Figure 8 depicts the breakdown of a project's annual O&M cost, including the de-rated Demand benefits that were included in the analyses for the 2013 Main Tier Program Evaluation. The green bar on the left represents one project's total O&M expenses, which include all costs except for fuel. The second bar shows the breakdown of that O&M expense into the demand portion, part of which is included in this analysis, and the in-state portions. The in-state portions are divided into Purchases and Other O&M. The third bar shows how these two in-state portions were compared with the verified data set to determine the O&M cost to be added to the in-state purchases category to account for higher ongoing costs over time. The rose-colored box near the top of the third stack represents direct investments in New York State that are added to the verified data set, and the purple box shows demand de-rated by RPC values to, both of which are added to the verified data to arrive at the total estimate for ongoing direct investments in New York State.

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<sup>20</sup> These categories were divided into subcategories such as types of jobs or sectors for in-state purchases. The modeling process of estimating in-state purchases was done on each sub-category based on default data from existing macroeconomic models that estimated the percentage of O&M cost by sector, as well as the percentage of spending in New York State.

**Figure 8. Diagram of O&M Cost Breakdown**



## 2.5 Applying Group 1 Verified Investments to Group 2 Projects

Once the Group 1 project expenditures were adequately characterized and extrapolated through the project life, much of the resulting data could be applied to estimate projected investments for Group 2 projects of the same resource types throughout their respective project lives. Due to the greater level of accuracy and reliability of verified data compared to project bid data, Group 1 verified expenditure data were selected for this purpose over bid-based/proposed data whenever possible.

### 2.5.1 Short-term Expenditures

To calculate Group 2 investments from Group 1 data for Wind and Hydroelectric projects, the total amount of short-term expenditures for Group 1 projects were calculated on a \$/MW basis by technology. Because short-term expenditures for most projects occurred over a span of years prior to the verification date, extrapolating to Group 2 projects required the development of a temporal profile of expenditures for short-term spending. This schedule was based on the typical temporal profile of expenditures for Group 1 projects by technology, and does not reflect additional research on the typical timeline of short-term expenditures for project development. This approach only applies to wind and hydroelectric projects, and Table 9 shows the temporal profile used for each technology starting three years prior to commercial operation (Op Yr – 3). Group 2 Biomass short-term expenditures were projected using bid data, as the technology- and site-specific nature of biomass plants suggests that data from Group 1 projects is unlikely to be representative of specific Group 2 projects. Landfill gas projects were not assigned short-term expenditures because these projects were already operating prior to the commencement of the RPS contract, or

short-term expenditures were not included in the bid proposal provided for these projects. There were also no Group 1 Landfill Gas projects, so verified data were not available to estimate typical short-term expenditures in the absence of bid data.

**Table 9. Short-Term Expenditure Schedule for Group 2 Calculation**

Expenditure Category	Timeline (all numbers are percents)						
	Op Yr -3	Op Yr -2	Op Yr-1	Op Yr <sup>a</sup>	Op Yr+1	Op Yr+2	Op Yr+3
<b>Wind</b>							
<b>Long-term Jobs</b>	0	5	60	30	5	0	0
<b>Payments to Public Entities</b>	0	10	60	25	5	0	0
<b>In-State Purchases</b>	0	5	60	30	5	0	0
<b>Fuel Resource Access Payments</b>	10	20	40	25	5	0	0
<b>Hydroelectric<sup>b</sup></b>							
<b>In-State Purchases</b>	10	30	60	0	0	0	0

<sup>a</sup> First year of commercial operation

<sup>b</sup> Group 1 Hydroelectric projects only reported in-state purchases

## 2.5.2 Long-Term Expenditures

Long-term in-state expenditures represent all of the ongoing O&M costs over a project’s life, including payments to public entities and landowners, fuel costs, labor, and materials. Group 2 long-term expenditures were projected by applying the average Group 1 in-state \$/MW per year unit measure of expenditures by technology and expenditure category to each Group 2 project’s capacity.

Details on the specific modeling approach used for Group 2 projects for each technology category of long-term expenditures are presented below.

### 2.5.2.1 Wind and Hydroelectric Projects

Group 2 investments for wind and hydroelectric projects were calculated entirely based on Group 1 summary results on a \$/MW basis across the main in-state expenditure categories and their subcategories. The standard metrics for projecting investments were calculated by totaling all Group 1 short-term verified spending and dividing by the total bid capacity (MW) in Group 1, yielding \$/MW factors for every subcategory within long-term jobs (such as

operations and administrative), payments to public entities, in-state purchases, and fuel resource access.<sup>21</sup> For short-term expenditures, the \$/MW reflects total short-term spending for the project over a number of years. For any given Group 2 project, the \$/MW was multiplied by that project's bid capacity and then spread out over time by the allocations presented in Table 9.

Long-term expenditures were based on the annual average \$/MW for each technology and category. These expenditures were assumed to remain the same (in 2012 Dollars) over time, so the \$/MW annual average was multiplied by the project's bid capacity and project life. The full set of data associated with Group 1 wind projects was included in the summary used to calculate Group 2 wind investments, but data from one hydroelectric project were removed as an outlier prior to developing extrapolation parameters.

### **2.5.2.2 Biomass Projects**

Biomass projects differed in technology, size and fuel resource availability, and could not be accurately projected by applying total investments from Group 1 on a \$/MW or \$/MWh factor basis to estimate Group 2 investments. There were also fewer biomass projects than other technologies, some of which had low production or a short project life. Each biomass project's investments were estimated separately based on either their verified data (Group 1), or their bid data (Group 2). Bid data generally gave adequate information to calculate likely jobs by subcategory, other labor payments, fuel resource and access cost, as well as payments to public entities, especially as all Group 1 projects met or exceeded their bid proposal claims for benefits. Most bid proposals included in-state purchases in broader categories than required for this analysis, so the in-state purchase totals were allocated into sub-categories by using the relative percentages from Group 1 projects as a proxy.

Group 2 biomass fuel costs were not projected based on Group 1 project fuel costs, because each project could have different fuel requirements, fuel source mix (e.g., from waste wood and land clearing to forest biomass and silviculture, each with very different costs) and resource availability. Instead, Group 2 fuel costs were based on each project's bid data, which were compared to and generally consistent with the expected range verified for Group 1 projects. None of these estimates included assumptions for fuel cost increasing at higher-than-inflation rates over each project's operating life.

### **2.5.2.3 Landfill Gas Projects**

Landfill Gas projects were not represented in Group 1, so there was no verified data available for extrapolation. Therefore, investments were estimated using bid proposals. As with Group 2 biomass projects, most of the Landfill Gas bid proposals included enough detail to estimate jobs, payments to public entities by category, and in-state purchases by category.

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<sup>21</sup> Hydroelectric and Wind projects make ongoing payments for access to resources such as landowner payments to entities hosting wind turbines, but the associated Group 2 facility payments were estimated on a per MW basis rather than as a function of production, as landowner payments are generally more consistent over time.

Landfill Gas fuel payments were calculated based on reported resource access costs, which are paid to the landfill owner for fuel access or to the entity that owns the gas collection system. These costs ranged from \$2-15/MWh. Because there were no verified data, and because none of the bid proposals specified fuel resource access costs, the landfill gas fuel costs were estimated by the project operator using their total resource access charges divided by production. One of the project operators provided fuel resource cost on a \$/MWh basis for a majority of the Group 2 Landfill Gas projects, along with some general capital replacement estimates on a \$/MW/yr basis. These fuel access costs were averaged and applied to projects with no cost data. The capital replacement estimates from projects making such estimates were applied to all remaining Landfill Gas projects as a proxy, and added to in-state purchases claimed in each project's bid proposal to reflect a "reported" total. This total was then adjusted to account for additional O&M costs over time as each project ages, using the same methodology as described in Section 2.4.2.3 on Modeled O&M. Group 2 Landfill Gas projects had no expected short-term costs because they were already operating prior to the start of the NYSERDA contract. However, direct investments were modeled over a 20-year expected life, beginning with the RPS contract start date. This approach represents a simplifying assumption that does not account for fuel resource degradation over time.<sup>22</sup>

## 2.6 Production Calculation

Through Main Tier RPS contracts, NYSERDA pays a production incentive to renewable electricity generators selected through competitive solicitations for the portion of electricity they deliver for end use in New York State covered under the contract. In exchange for receiving the production incentive, the renewable generator transfers to NYSERDA all rights and/or claims to the RPS Attributes associated with a specified percentage of the megawatt-hours (MWhs) of renewable electricity generated, and guarantees delivery of the associated electricity to the New York State ratepayers.<sup>23</sup> NYSERDA Main Tier RPS contracts includes provisions limiting NYSERDA's obligation to pay for up to a certain number of RPS Attributes per year, as well as over the typical 10-year contract term. The purchase quantity corresponds to the percentage of expected output of the project (or the output of the RPS-eligible upgrade) specified in the bid. This percentage may not exceed 95% of a project's expected output.<sup>24</sup>

Although the RPS contracts only obligate NYSERDA to pay for these RPS Attributes for the contract term – typically a 10-year period, with the exception of a few shorter contracts - this analysis incorporates direct investments in New York State and production for the entire project life based on the assumption that the initial RPS contract enabled the project to be built and the State will continue to experience the benefits of the associated in-

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<sup>22</sup> We note that some landfill gas generators may experience declining production well before 20 years, as the methane production from capped landfill cells degrades, while others may be able to maintain a more level production profile over time as a landfill expands and additional gas is collected to replace depleting cells. There was insufficient data available in bidder submissions to distinguish the situation specific to each landfill gas project.

<sup>23</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.

<sup>24</sup> While many RPS Contracts are for 95% of the facility's output, a few bidders have exercised the ability to bid as low as 30% their output, as per the terms of the RPS Main Tier Solicitation.

state O&M spending through the life of the projects. The project's RPS contract start date was used as a proxy to model the project's operational date for the projection of associated investments.<sup>25</sup> Table 8 provides additional detail on the project life assumptions by technology type. This approach is explained in more detail in the benefit-cost analyses discussed in Section 3.4.

All projects were assumed to operate at maximum capacity for future years while historic production data and associated RPS payments were used for reported years. A number of Group 1 projects have underperformed to a degree such that contractual modifications were implemented by NYSERDA to decrease the maximum contractual production and payment obligations to these projects. These newer quantities and associated contract commitments are reflected in the analysis.<sup>26</sup>

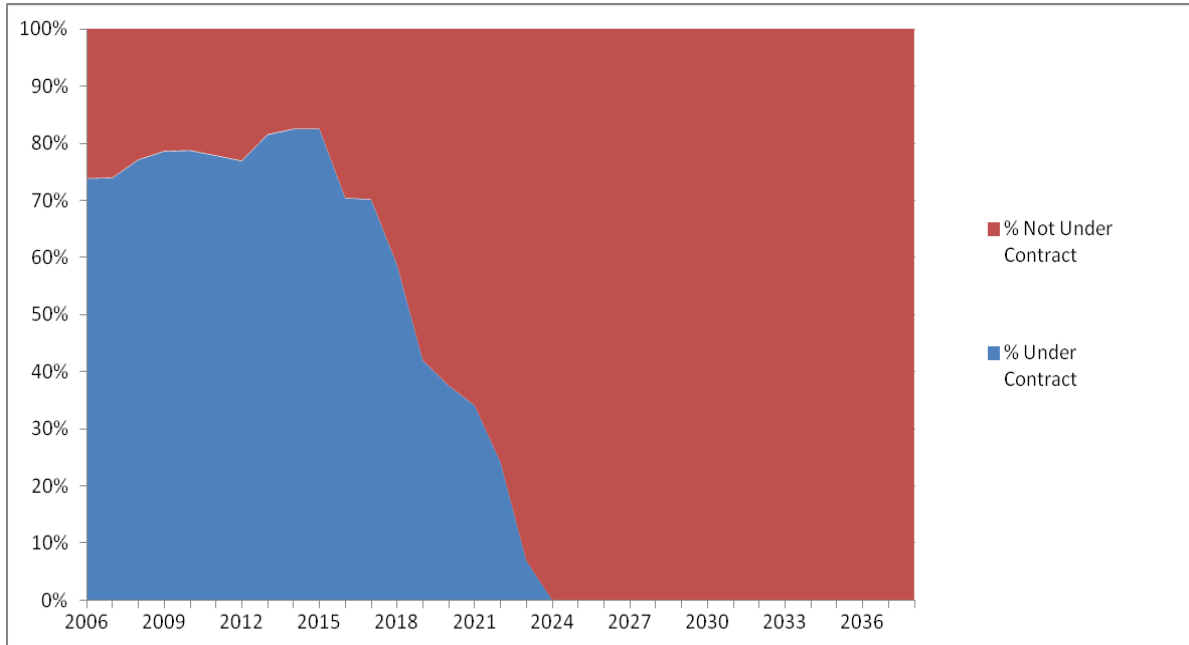
Although direct investments in New York State are calculated as total in-state expenditures over the project's operating life, less than half of total lifetime production is generated while under an RPS contract. The RPS contracts cover the first 10 years and include up to 95% of a project's expected output. The aggregate summary for Group 1 and Group 2 production under contract as a percentage of total projected production is shown in Figure 9. Some projects only have a portion of their nameplate capacity under contract, which is why the portion under contract peaks at less than 90% instead of at 95% of total production. The RPS contracted portion tapers off as projects end their contracts from 2016-2024, and totals around 40% of production.

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<sup>25</sup> A small number of projects began operating prior to the start of their RPS contract. By making this simplifying assumption, a small portion of production and benefits were likely offset in time by one or more years in this analysis.

<sup>26</sup> To ensure that the Main Tier target is met and other projects are afforded timely opportunities for funding, NYSERDA contractually requires 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.

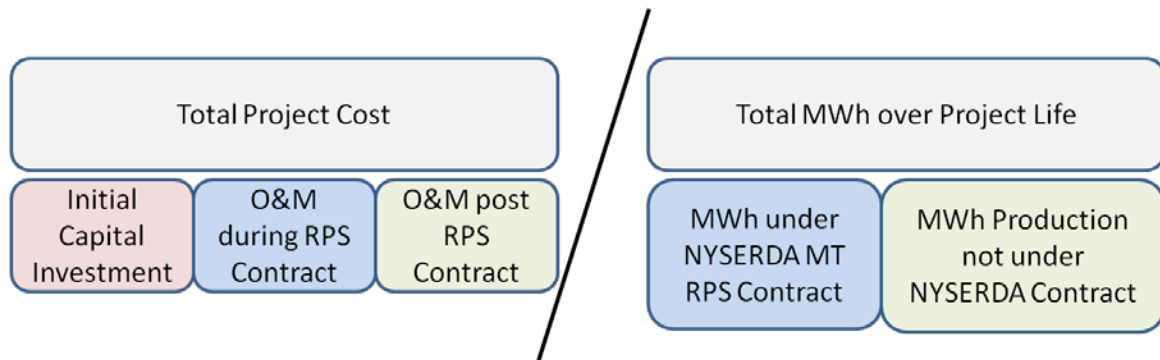
**Figure 9. Aggregate Group 1 and Group 2 Proportion of RPS Contracted Production as Percentage of Total Production, by Year over Project Life**



## 2.7 Direct Investments in New York State per MWh Produced

Using the methods described in previous sections, the total New York State short- and long-term spending for both Group 1 and Group 2 projects was then compared to the total production anticipated over the projects’ operating lives. Figure 10 shows the breakdown of project spending and production categories. In this analysis, a project’s total direct investments in New York State were compared with the cost of RPS contracts and total production over the project life. The calculation for \$/MWh is similar, except total spending is divided by the project’s Nameplate or bid capacity, depending on the calculation.

**Figure 10. Direct Investments in New York State and Production Components**



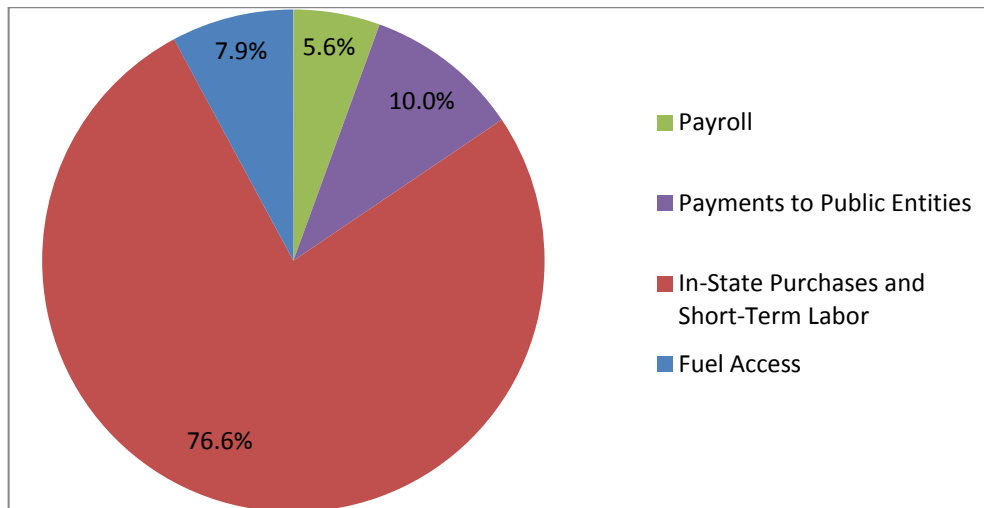
## 3 Results

### 3.1 Group 1 Verified Direct Investments in New York State Analysis

As previously discussed, the foundation for this analysis is a robust data set resulting from the verification of New York State spending spurred by the development, construction and operation of 18 Main Tier facilities listed in Table 5. Through this effort, more than 30,000 documents were examined by NYSERDA staff and extensive tracking tables were established for this subsequent analysis.

Key findings of the verification effort included corroboration of over \$450 million already spent in New York State over the first three years of commercial operation for the 18 Group 1 facilities.<sup>27</sup> Figure 11 shows the four primary categories of 3-year verified spending for Group 1 projects and the percentage of spending in each category. The greatest percentage of verified spending was in the In-state Purchases and Short-Term Labor category, as this spending is highly concentrated in the construction and development phase. The other categories persist throughout the life of the facility for many resource types.

**Figure 11. Verified Direct Investments in New York State by Category (Group 1)**<sup>a</sup>



<sup>a</sup> Percentages may not add up to exactly 100% because of rounding.

<sup>27</sup> The total expenditures in this paragraph are expressed in nominal dollars added across calendar years.



Figure 13. Number of Affected Businesses by County

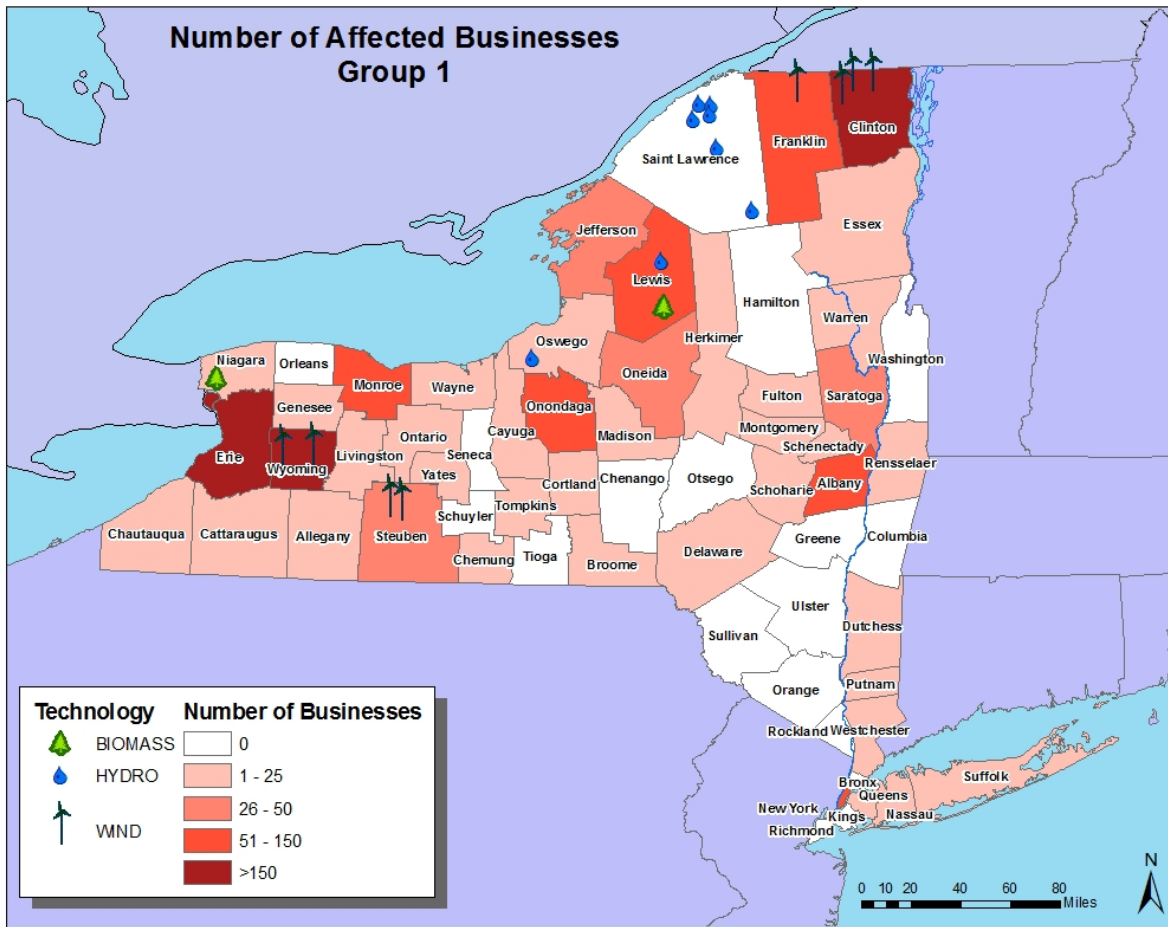


Table 10 highlights the 15 counties that received the largest share of verified In-State Purchases and Short-Term Jobs through the first three years of commercial operations. These numbers do not include payments for long-term jobs, payments to public entities, or fuel resource access payments. Most of these top counties host projects and received local direct investment benefits from purchases alone in addition to local tax payments land leases and jobs. New York State City also received a large portion of direct investments through the procurement of professional services.

**Table 10. Verified In-State Purchases and Short-Term Jobs by County (Top 15)**

<b>County</b>	<b>\$ Millions (nominal)</b>
Erie	71.9
Fulton	62.5
Clinton	31.7
Albany	30.4
New York State	22.5
Onondaga	22.4
Wyoming	20.5
Suffolk	16.0
St. Lawrence	10.1
Oswego	7.5
Allegany	6.9
Monroe	6.3
Oneida	5.7
Franklin	5.1
Steuben	4.2

### 3.1.2 Industry Impacts

All told, more than 1,000 in-state businesses benefited through the development, construction and operation of the referenced Group 1 facilities. These businesses provided materials, equipment and services required for the projects and the scope of their efforts ranged from supplying gravel and cranes to engineering and legal support. Of additional significance is the fact that many of these businesses provided goods or services for multiple projects.

Typical goods and services which were obtained through New York State contractors and suppliers are presented in Table 11.

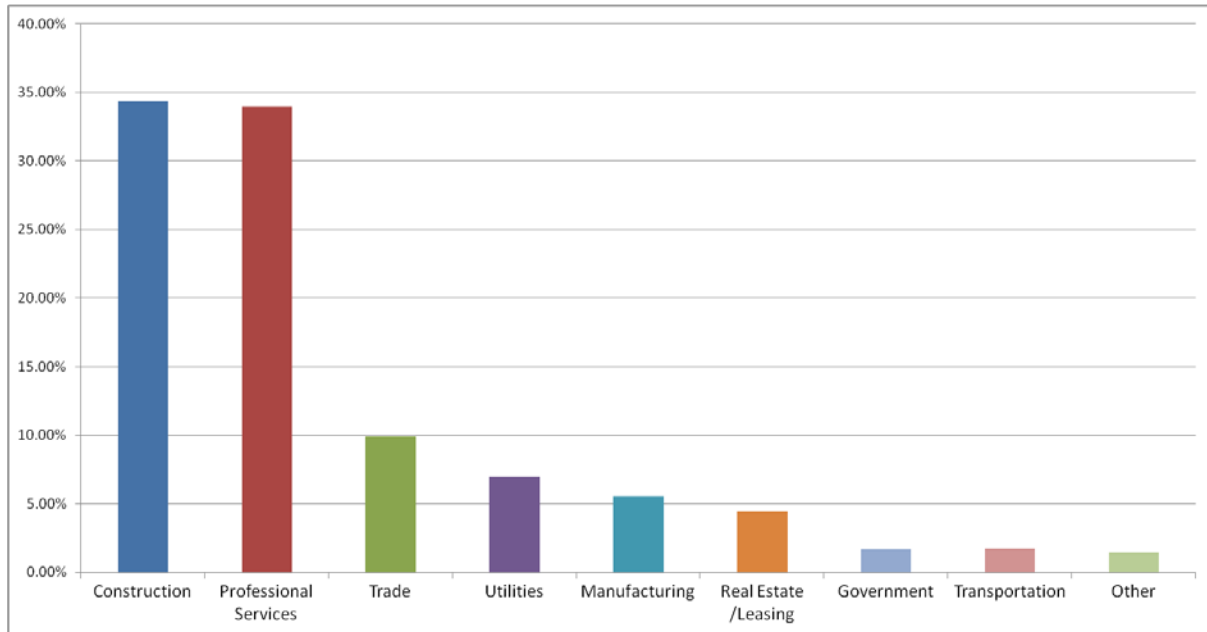
**Table 11. Typical Goods Sourced in New York State**

<b>Goods</b>	<b>Services</b>
Gravel	Construction
Electrical/Utility Equipment	Operations/Maintenance
Cranes	Loggers/Forestry
Wood Loads	Engineering
Foundations (Wind Projects)	Legal
Water	Marketing
Fuel (Gasoline/Diesel)	Accounting
Hardware	Environmental Permitting
Plumbing Supplies	Environmental Monitoring
	Public Relations
	Food Services
	Transportation/Trucking
	Real Estate/Leasing
	Utilities
	Trade
	Manufacturing

A significant portion of goods sourced in New York State include construction materials, from small items like hardware to crushed rock for building access roads or wind turbine foundations. Electrical/utility equipment comprises another significant portion of goods procured for these projects; typical expenditures range from meters to substations to high voltage lines.

In addition to material goods, millions of verified dollars went to procure services through New York State suppliers. Throughout the verification process, construction and engineering trades were most commonly represented, but Group 1 projects also required a significant number of different services in other areas. Environmental companies conducted site assessments and helped projects acquire permits or complete wetlands rehabilitation and site remediation. New York State City companies in the legal and finance sectors were hired by projects throughout the State. Figure 14 depicts the extent of the impacts on various sectors through the development, construction and operation of these projects.

**Figure 14. Group 1 Total Verified and Anticipated In-State Purchases by Sector (2012 Dollars)**



Sectors with the most significant direct investments are Construction and Professional Services (including Finance & Insurance, Architecture & Engineering). Trade, Utilities, Manufacturing and Real Estate contributed approximately 5-10% each, while Government, Transportation and Other expenditures were just a few percent of total direct investments. In total, Group 1 projects are expected to contribute approximately \$500 million of direct investments in New York State as in-state purchases.

### 3.1.3 Total Group 1 Direct Investments in New York State by Category

The direct investments from Group 1 were primarily verified in the In-State Purchases and Short-Term Jobs category, with the rest spread out among payroll, fuel, payments to public entities or payments for land access. Using the methods described in Section 2.4, the verified spending was then projected through the estimated life of each Group 1 project. Extrapolation of anticipated long-term expenditures - such as salaries, payment-in-lieu-of-taxes agreements and host community payments, operations and maintenance expenses and payments for land use or fuel – add significant expenditures over the projected lives of these projects. In total, these projects are anticipated to add more than \$1 billion (2012 Dollars) to the New York State economy through their respective operating lives.

Table 12 shows the total anticipated spending by category for these projects over the expected life of the projects.

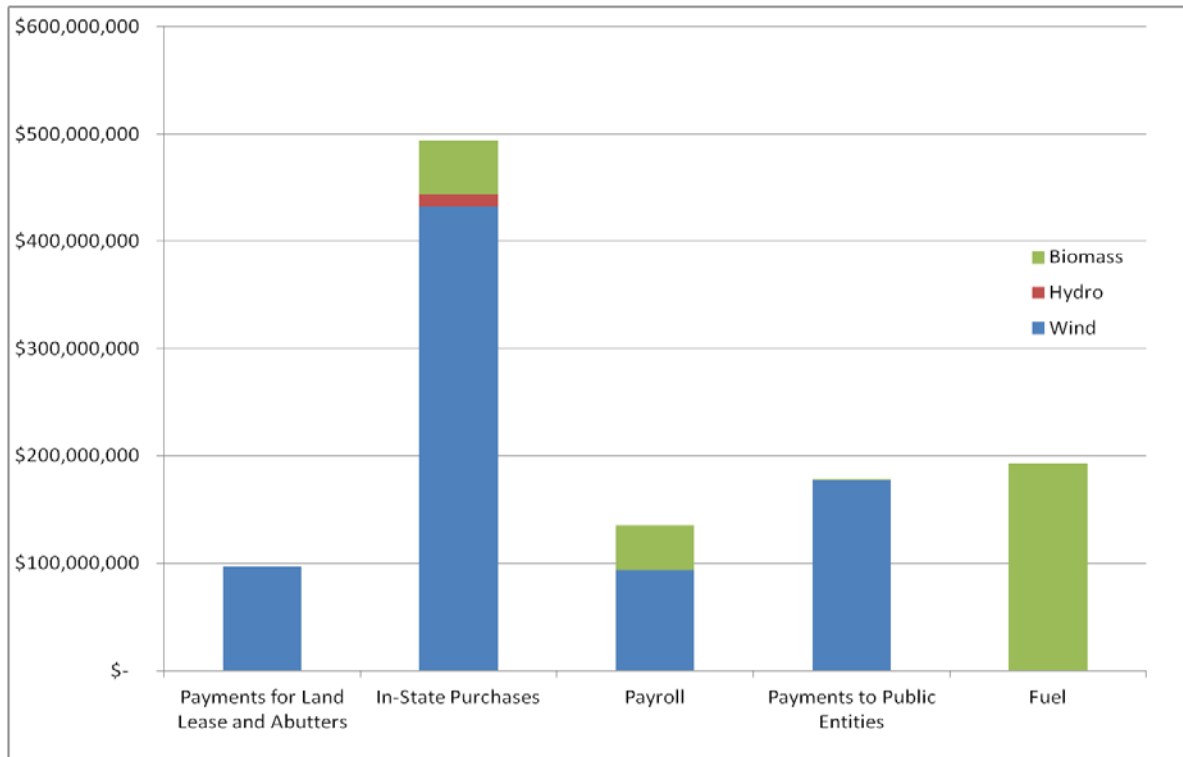
**Table 12. Total Verified and Anticipated Direct Investments in New York State for Group 1 by Resource and Category (Millions 2012 Dollars)<sup>a</sup>**

Technology	Short-term Spending				O&M Spending				Total
	Payroll	Payments to Public Entities	Fuel Resource Access	In-State Purchases	Payroll	Payments to Public Entities	Fuel and Resource Access	In-State Purchases	
Wind	8.8	26.1	6.0	331.9	85.0	151.3	90.9	100.1	800.1
Hydro	-	-	-	10.4	-	-	-	1.7	12.1
Biomass	1.0	0.0	2.3	21.7	40.4	1.2	190.7	28.5	285.8
<b>Total</b>	9.9	26.1	8.3	364.0	125.4	152.5	281.6	130.3	1,098.1

<sup>a</sup> Numbers may not add up due to rounding

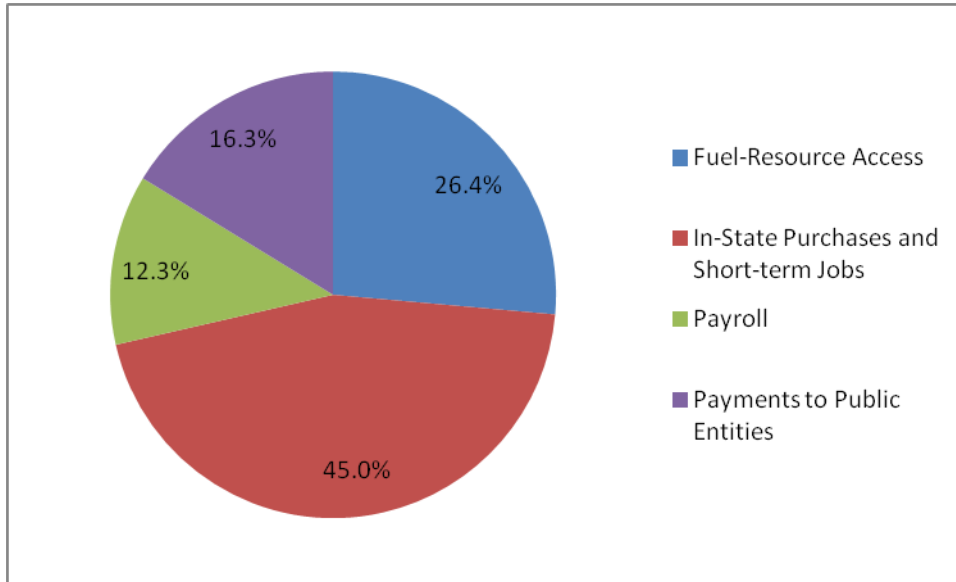
As seen in Figure 15, wind project expenditures contributed the most significant percentage of investments in all categories other than fuel. Biomass projects were responsible for all of the fuel expenditures and a significant portion of In-State Purchases and Payroll.

**Figure 15. Total Verified and Anticipated Direct Spending Categories for Group 1 Projects (2012 Dollars)**



For Group 1, including both short and long-term expenditures, In-State Purchases comprised the largest portion of direct investments in New York State, totaling about 45% of all investments from project expenditures. Ongoing payments such as those for Fuel Resource Access, Payments to Public Entities and Long-term Jobs comprised smaller percentages of the total expenditures over the life of the projects.

**Figure 16. Percentage of Total Verified and Anticipated Direct Investments in New York State by Category for Group 1 (2012 Dollars)**



### 3.1.4 Group 1 Capacity and Production

Table 13 shows the nameplate capacity, bid capacity, maximum annual production and total expected production for the Group 1 projects that are referenced in this report. These project-specific metrics were used for extrapolation throughout this analysis as well as specific benefit-cost analyses. Figure 17 shows the total annual production by technology for each year (historic and expected).

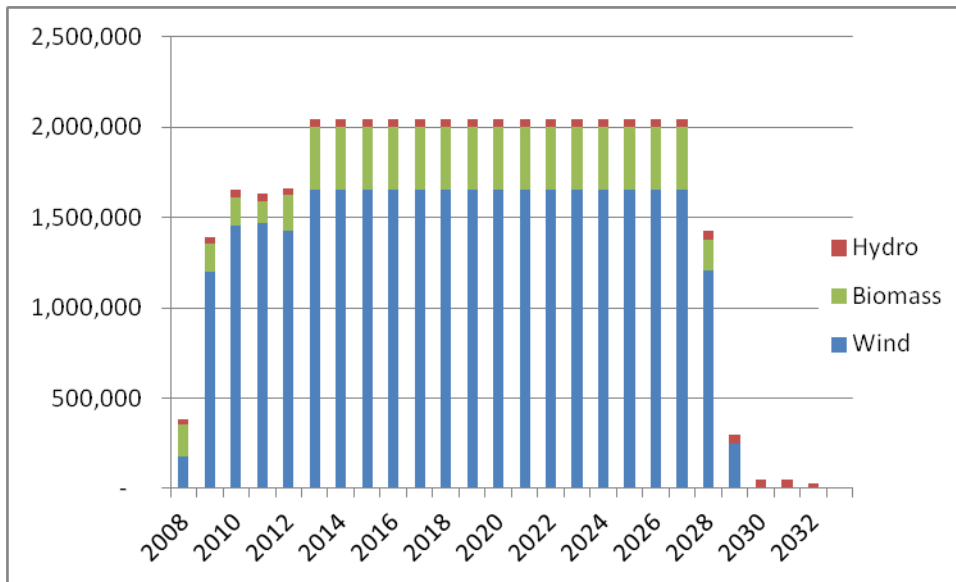
**Table 13. Group 1 Project Capacity and Production**

Technology	Nameplate Capacity (MW)	Bid Capacity (MW)	Max Annual Production (Approx MWh)	Total Expected Production over Project Life (GWh) <sup>a</sup>
Wind	742	636 <sup>b</sup>	1,650,000	32,000
Hydroelectric	38	7	50,000	1,000
Biomass	54	26	340,000	6,000
Total	834	669	2,040,000	39,000

<sup>a</sup> Based on historic generation for past years and maximum annual production for future years.

<sup>b</sup> Dutch Hill Farm/Cohocton’s contracted bid capacity was only on a portion of its 125 MW nameplate capacity. This calculation only includes 50.2 MW of contract bid capacity, but the direct benefits assessment assumed that the project had reported benefits associated with the total nameplate capacity.

**Figure 17. Historic and Expected Annual Production for Group 1 Projects (MWh)**



**3.1.5 Group 1 Direct Investments in New York State Summary**

Table 14 shows the anticipated direct investments in New York State for Group 1 projects in total and as a function of the nameplate capacity and anticipated generation of these facilities. Group 1 projects have a projected total of \$1.1 Billion in direct investments over the expected lifetime of all projects. This averages to approximately \$1.3 Million/MW of nameplate capacity and \$28 per MWh of production (2012 Dollars).

**Table 14. Direct Investments in New York State Summary for Verified Projects (Group 1)**

Technology	2012 Dollars			Nominal Dollars		
	Total \$ (millions)	\$/MWh	\$/MW (Nameplate)	Total \$ (millions)	\$/MWh	\$/MW (Nameplate)
Wind	\$ 800	\$25	\$1,079,000	\$ 823	\$26	\$1,110,000
Hydroelectric	\$ 12	\$11	\$ 319,000	\$ 11	\$10	\$ 281,000
Biomass	\$ 286	\$47	\$3,915,000	\$ 313	\$51	\$4,291,000
<b>Total</b>	<b>\$1,098</b>	<b>\$28</b>	<b>\$1,288,000</b>	<b>\$1,147</b>	<b>\$29</b>	<b>\$1,346,000</b>

As Table 14 shows, the direct investments from large-scale wind, repowered hydropower and biomass facilities differ materially. On a nominal dollar per-MWh basis, the verified data show that biomass projects stimulate greater direct investments than wind (\$51 versus \$26 per MWh). Not surprisingly, the hydropower projects receiving RPS awards, which typically involve project upgrades and/or repowering, have the lowest direct economic benefit per MWh.

### 3.2 Current Portfolio Direct Investments in New York State Results

As described in Section 1, the analyses presented in this report serve two purposes. The earlier section focused on an assessment of the verified economic benefits to New York State from direct investment by RPS projects. This section presents an assessment of the direct investments of the Current Portfolio of Main Tier RPS projects, excluding existing Maintenance resource projects, and reflects some modeled inputs and adjustments necessary to support the Net Macroeconomic and Benefit-Cost analyses in the 2013 RPS Main Tier Program Evaluation.

As discussed in Section 2.5, Group 1 expenditures were used where applicable to help estimate direct investments in New York State for Group 2 projects for the same resource types through their respective project lives. Where data corresponding to Group 2 resources wasn't present in the Group 1 data set, bid proposal data were used. The combined total actual and projected direct investments associated with Group 1 and Group 2 projects, which comprise the current RPS Main Tier project portfolio ("Current Portfolio"), approaches \$2.7 billion. This total, along with detailed analyses, were developed and used for the 2013 RPS Main Tier Program Evaluation by including only Main Tier projects and making the analytical adjustments discussed in Section 2.4 and 2.4.2.3 relating to demand benefits and the trade sectors. Because of this different approach for the Current Portfolio Analysis, Group 1 results in the following sections will not align with results from Section 2.1.

### 3.2.1 Group 2 Capacity and Production

There were significantly more projects and capacity installed as part of Group 2, totaling 1,241 MW of nameplate capacity versus the Group 1 total of 834 MW. Table 15 summarizes Group 2 capacity and production totals, showing approximately 64 million MWh of expected production over the useful life of all Group 2 projects.

**Table 15. Group 2 Project Capacity and Production**

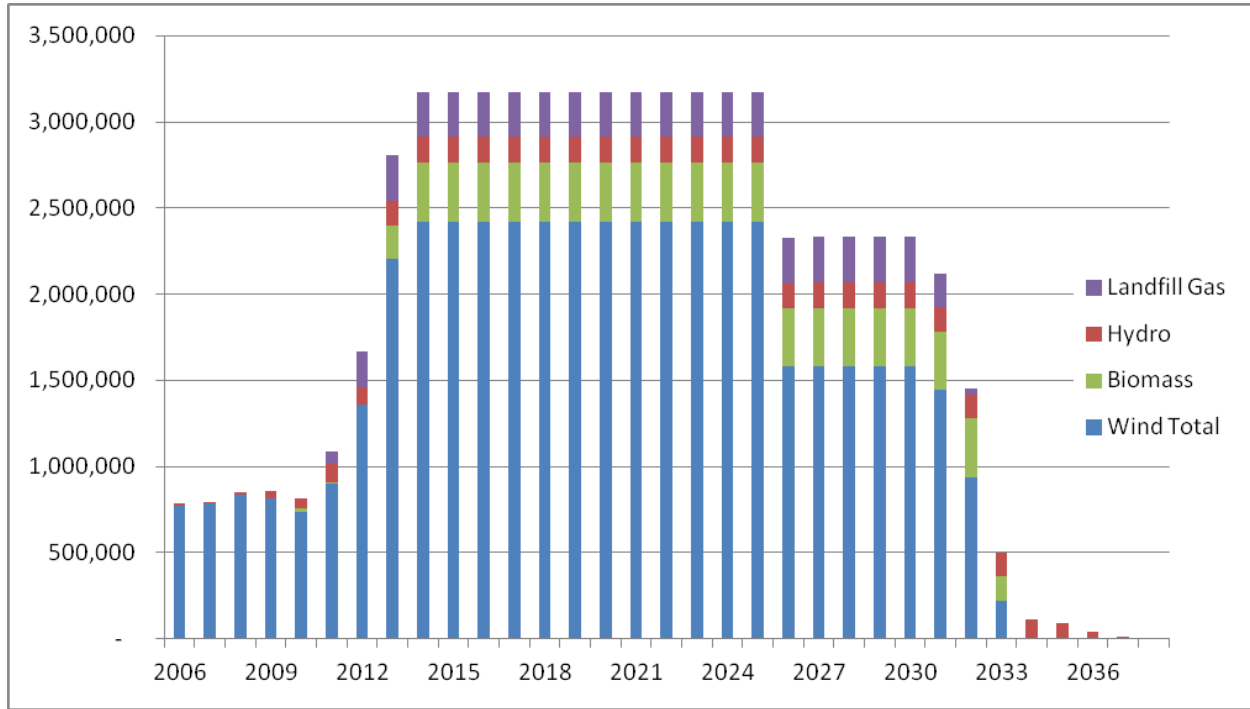
Technology	Nameplate Capacity (MW)	Bid Capacity (MW)	Max Annual Production (MWh)	Total Expected Production over Project Life (GWh) <sup>a</sup>
Wind	886	765 <sup>b</sup>	2,400,000	48,000
Hydroelectric	133	20	150,000	4,000
Biomass	164	45	340,000	7,000
Landfill Gas	59	25	260,000	5,000
<b>Total</b>	<b>1,241</b>	<b>855</b>	<b>3,170,000</b>	<b>64,000</b>

<sup>a</sup> Based on historic generation for past years and maximum annual production for future years.

<sup>b</sup> Maple Ridge offered a bid capacity of 231 MW of a 321 MW nameplate capacity. The bid capacity was used to estimate direct benefits, and is also included in this calculation.

The timeframe for Group 2 project construction and operation is generally a few years later than Group 1 projects, with the exception of two Group 2 projects that began operating under contract in 2006. As a result, the Group 2 production period extends from 2006 through 2038, compared with the shorter Group 1 period of 2008 through 2033. Figure 18 details the expected historic and expected production for Group 2 projects.

**Figure 18. Historic and Expected Production for Group 2 Projects (MWh)**



**3.2.2 Group 1 and 2 Comparative Analysis – Total Direct Investments in New York State**

The results in Table 16 show the anticipated direct investments in New York State from Group 1 and Group 2 Main Tier projects by category and time-phase of expenditure in 2012 Dollars.

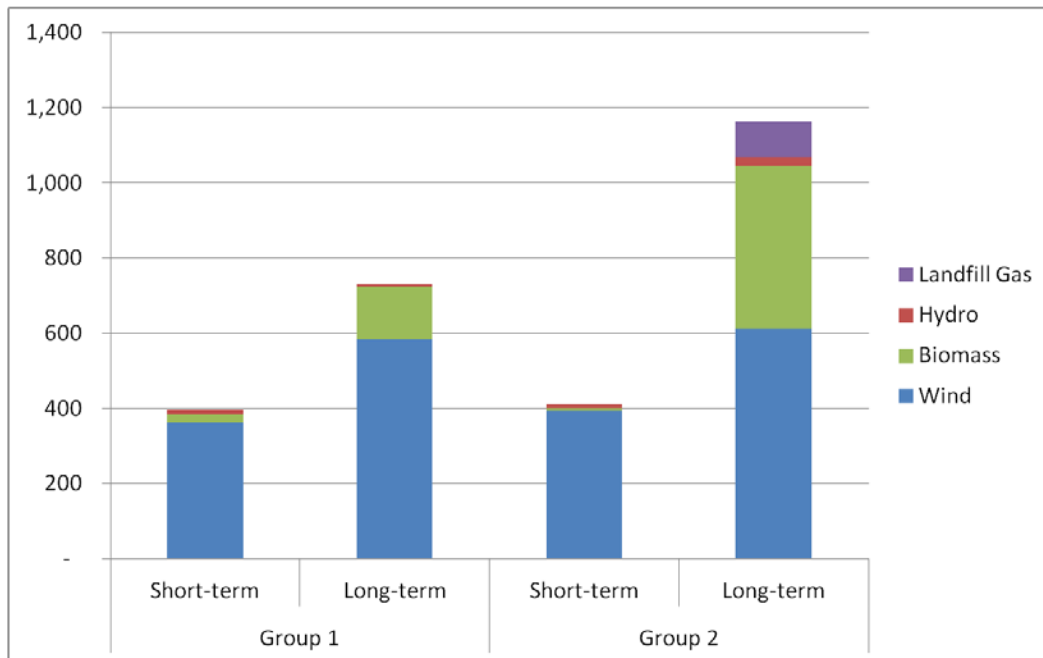
**Table 16. Total Direct Investments in New York State by Technology for Group 1 and Group 2 Projects (Millions 2012 Dollars)<sup>a</sup>**

Technology	Group 1		Group 2	
	Short-Term	Long-Term	Short-Term	Long-Term
Wind	\$ 362	\$583	\$ 394	\$ 612
Hydroelectric	\$ 10	\$ 8	\$ 10	\$ 23
Biomass	\$ 23	\$139	\$ 7	\$ 434
Landfill Gas	-	-	\$ 0	\$ 95
<b>Total</b>	<b>\$395</b>	<b>\$730</b>	<b>\$411</b>	<b>\$1,163</b>

<sup>a</sup> Numbers may not add up due to rounding

Figure 19 depicts this breakdown between Group 1 and Group 2 totals for short-term versus long-term direct investments in New York State. Short-term investments represent project expenses for project development, construction, upgrades, and other expenses that are not expected to recur annually over the course of the project’s operating life. Long-term investments are the project expenses necessary to keep the project operating, and represent an average of operations and maintenance expenses, ongoing payments, as well as capital replacement costs over each project’s expected useful life.

**Figure 19. Total Direct Investments in New York State by Technology for Group 1 and Group 2 Projects**



Due to the largely front-loaded cost of wind project development and construction, short-term investments are a significant portion of total investment in New York State for both groups but ongoing expenditures dominate as they persist for the project’s operating life. Hydroelectric projects also have significant short-term investments as a percentage of total investments, as these projects are typically upgrades to existing projects and have few eligible incremental maintenance costs. Therefore, little in-state spending for hydroelectric operations and maintenance could be attributed to the RPS capacity.

As expected, biomass facilities have significant long-term expenditures compared with short-term costs due to extensive ongoing fuel costs. Landfill gas was only represented in Group 2 and was modeled as only having long-term investments because the majority of the projects were operating prior to starting their RPS contract, and no construction-related expenditures were claimed in the RPS proposal. As with biomass projects, landfill gas projects also have large ongoing fuel costs for access to landfill gas in addition to ongoing costs for equipment maintenance and replacement.

### 3.2.3 Group 1 and 2 Comparative Analysis – Total Direct Investments in New York State per MW Installed and MWh Produced

Table 17 shows the components of the total direct investments in New York State associated with Group 1 and Group 2 facilities, as calculated for the 2013 RPS Main Tier Program Evaluation. As previously discussed, these results include adjustments for demand and the trade sectors, and do not include maintenance resource projects. The \$/MWh figures represent total direct investments per MWh of production, both calculated over each project's full expected operating life.

**Table 17. Direct Investments in New York State Summary for Group 1 and Group 2 (2012 Dollars)**

Technology	Group 1			Group 2		
	Total \$ (millions)	\$/MWh	\$/MW (Nameplate)	Total \$ (millions)	\$/MWh	\$/MW (Nameplate)
Wind	\$ 945	\$30	\$1,275,000	\$1,005	\$21	\$1,135,000
Hydroelectric	\$ 18	\$16	\$ 471,000	\$ 33	\$ 9	\$ 248,000
Biomass	\$ 162	\$47	\$2,995,000	\$ 441	\$64	\$2,690,000
Landfill Gas	n/a	n/a	n/a	\$ 95	\$18	\$1,623,000
<b>Total</b>	<b>\$1,125</b>	<b>\$31</b>	<b>\$1,349,000</b>	<b>\$1,574</b>	<b>\$25</b>	<b>\$1,268,000</b>

Comparing the results between Groups 1 and 2, both groups had very similar \$/MW direct investments in New York State, though the breakdown by technology differs and changes between groups. Between Group 1 and Group 2, the difference in \$/MWh results are attributable to cost differences between projects of the same technology and differences in anticipated generation for the same technology types.

For biomass, this difference is driven by project-specific differences for verified and expected expenditures. Biomass projects had the highest \$/MWh direct investment when compared with other technologies because of high up-front construction expenditures combined with high ongoing fuel and maintenance costs associated with these projects.

The large drop in \$/MW for hydroelectric projects is due to one outlier project within the Group 1 hydroelectric technology that had significantly higher expenditures (and thus investments) than all of the other hydroelectric projects. This outlier project was removed when calculating the \$/MW extrapolation factors, so Group 2 hydroelectric investments, which are calculated on the basis of lower Group 1 average expenditures, are much lower.

On the whole, Biomass and Landfill Gas projects have higher \$/MW investments due to their higher capacity factors and ongoing fuel or fuel access costs that persist for the life of the project. Biomass fuel costs are estimated from historic fuel costs, while Landfill Gas fuel costs are the access charges paid to the landfill or pipeline owner.

Table 18 summarizes Group 1 and Group 2 direct investment in New York State totals on a 2012 Dollars/MWh and Nominal Dollars/MWh basis.

**Table 18. Direct Investments in New York State/MWh by Technology for Group 1 and Group 2 Projects (2012 Dollars/MWh and Nominal Dollars/MWh)**

Technology	2012 Dollars/MWh		Nominal Dollars/MWh <sup>a</sup>	
	Group 1	Group 2	Group 1	Group 2
Wind	\$30	\$21	\$31	\$22
Hydroelectric	\$16	\$ 9	\$16	\$10
Biomass	\$47	\$64	\$52	\$78
Landfill Gas	n/a	\$18	n/a	\$21
<b>Total</b>	<b>\$31</b>	<b>\$25</b>	<b>\$32</b>	<b>\$28</b>

<sup>a</sup> Nominal dollars were added across years without applying a discount rate.

### 3.2.4 Current Portfolio Analysis

Table 19 summarizes the results combining Group 1 and Group 2 into a total Current Portfolio Analysis. The Current Portfolio includes more than 2,000 MW of nameplate capacity. Over their expected operating life, these projects are expected to generate approximately 100 million MWh and \$2.7 billion dollars of estimated direct investments in New York State. Overall, approximately \$27 in direct investment is produced as a result of project expenditures in New York State for every MWh that is generated under the RPS.

**Table 19. Summary of Current Portfolio and Direct Investments in New York State (2012 Dollars)**

Technology	MW (Nameplate)	Total Investments (Millions)	\$/MWh	\$/MW (Nameplate)	Total Production (GWh)
Wind	1,627	1,951	\$24	\$1,199,000	80,000
Hydroelectric	171	51	\$11	\$ 298,000	5,000
Biomass	218	603	\$59	\$2,765,000	10,000
Landfill Gas	59	95	\$18	\$1,623,000	5,000
<b>Total</b>	<b>2,075</b>	<b>2,699</b>	<b>\$27</b>	<b>\$1,301,000</b>	<b>100,000</b>

On average, hydroelectric upgrade projects, the smallest group, have the lowest \$/MWh and \$/MW direct investments due to their relative low upgrade and operating costs. Wind, which comprises the bulk of production and direct investments, averages \$24/MWh and approximately \$1 million/MW installed. As described above, Biomass and Landfill Gas projects have the highest direct investments per MW and MWh due to their high ongoing operating costs.

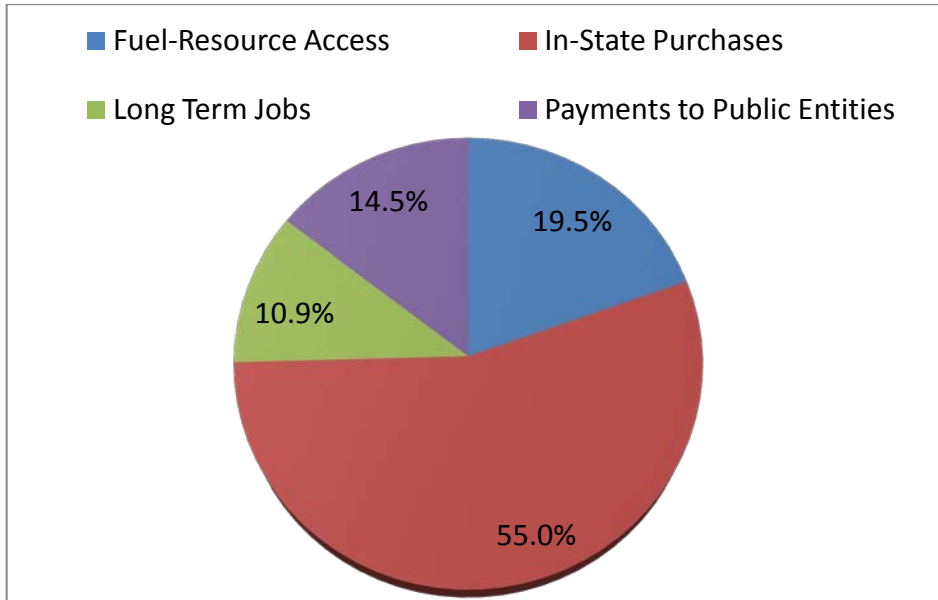
The results in Table 20 show the total direct investments in New York State for the Current Portfolio of projects in both real (2012 Dollars) and nominal dollars as compared to the projects’ capacity and generation.

**Table 20. Summary of Total, \$/MW and \$/MWh Direct Investments in New York State 2012 Dollars and Nominal Dollars – Current Portfolio**

Technology	2012 Dollars			Nominal Dollars		
	Total (Millions)	\$/MWh	\$/MW (Nameplate)	Total (Millions)	\$/MWh	\$/MW (Nameplate)
Wind	\$1,951	\$24	\$1,199,000	\$2,065	\$26	\$1,269,000
Hydroelectric	\$ 51	\$11	\$ 298,000	\$ 55	\$12	\$ 323,000
Biomass	\$ 603	\$59	\$2,765,000	\$ 709	\$69	\$3,252,000
Landfill Gas	\$ 95	\$18	\$1,623,000	\$ 111	\$21	\$1,894,000
<b>Total</b>	<b>\$2,699</b>	<b>\$27</b>	<b>\$1,301,000</b>	<b>\$2,940</b>	<b>\$29</b>	<b>\$1,417,000</b>

As shown in Figure 20, for the entire program, including both short and long-term expenditures, In-State Purchases comprised the largest portion of direct investments in New York State, totaling about 55% of all investments from project expenditures. Fuel Resource and Access made up almost 20% of direct investments, while ongoing payments for Long-term Jobs and Payments to Public Entities comprised smaller percentages of the total expenditures over the life of the projects.

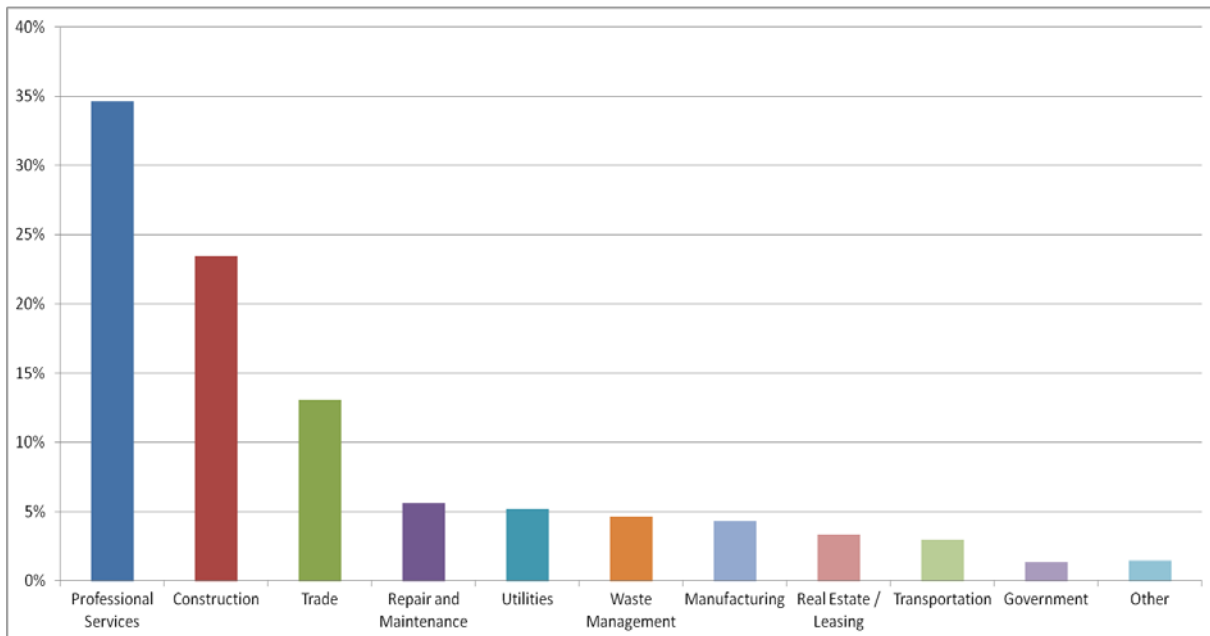
**Figure 20. Percentage of Total Direct Investments in New York State by Category for the Current Portfolio (2012 Dollars)<sup>a</sup>**



<sup>a</sup> Percentages may not add to exactly 100% because of rounding.

These direct investments in New York State have a greater impact on some sectors of the economy than on others. Figure 21 shows the breakdown for in-state purchases by industry sector. The sectors with the greatest portion of benefits include Professional Services (including Finance and Insurance, Legal, and Architectural & Engineering Services), Construction, and Trade.

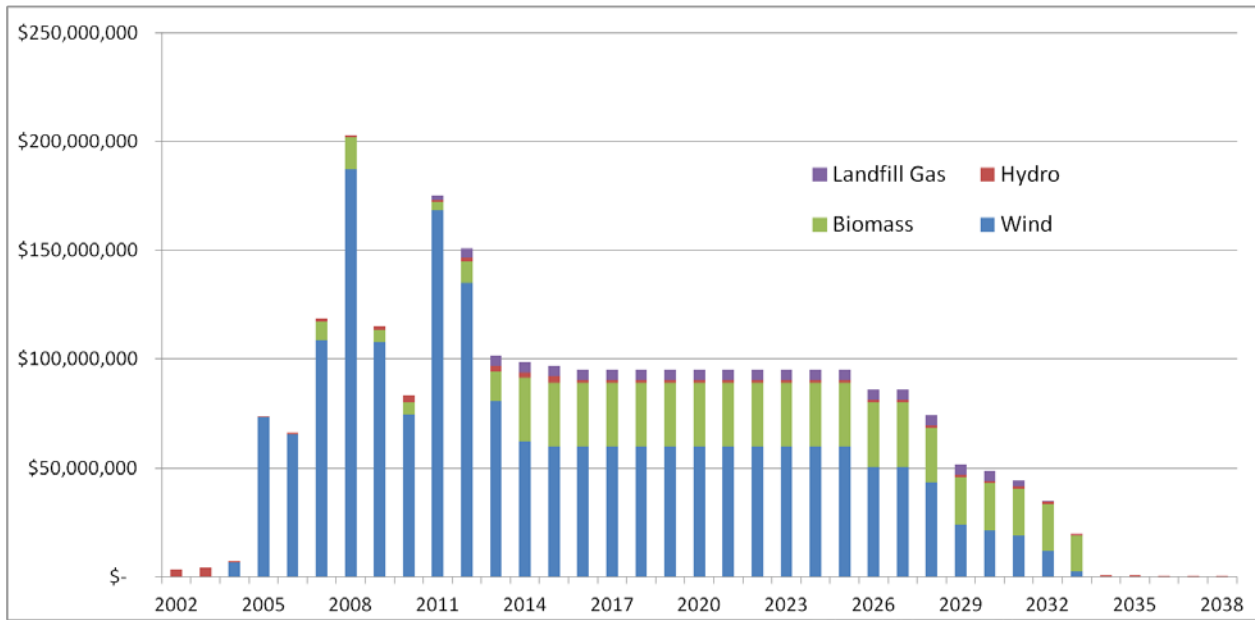
**Figure 21. Total In-State Purchases by Sector (2012 Dollars)**



### 3.3 Direct Investments in New York State as Inputs to 2013 RPS Main Tier Program Evaluation

As previously reviewed, the results from part two of this study were used as inputs for the Benefit-Cost and Macroeconomic analyses for the 2013 RPS Main Tier Program Evaluation. Both analyses required year-by-year spending summaries by technology, as well as some detail on the type of spending incurred in different categories and sectors. The previous figures and tables show summaries of spending by category and sector. Figure 22 depicts the amount of New York State direct spending by year, broken down by technology. Direct spending fluctuates in the early years as projects are being developed and installed, and then stabilizes as the portfolio of projects complete installation and commence stable long-term operations. Wind projects made considerable short-term investments in the construction phase of these projects, which resulted in comparatively high totals in 2008, 2011, and 2012.

**Figure 22. Direct Investment by Year and Technology (2012 Dollars)**



### 3.4 Direct Investments in New York State Versus RPS Program Investment

Using the components of the Current Portfolio Analysis discussed above in Section 3 with results summarized in Section 3.2, an investment ratio was calculated which compares the Current Portfolio of project's direct investments in New York State with the RPS investments in Main Tier and Maintenance Resource projects.. The direct investments in New York State are calculated as all direct in-state spending over the project's useful life, which goes beyond the 10-year RPS contract. The RPS investment portion of this comparison is the total RPS-related cost premium borne by ratepayers for procuring RPS Attributes over what is typically a 10-year term. The premise of this assumption is that the RPS program is responsible for stimulating construction and operation, whether or not NYSERDA contracts for the whole project output over a project's entire useful life.

#### 3.4.1 RPS Program Investment Description

RPS program investment comprises the actual funds disbursed or anticipated to be disbursed by NYSERDA for RPS Attributes associated with the Current Portfolio, as well as overhead costs associated with administrative staffing necessary for program implementation and management. Actual administrative costs were used for years prior to 2013 and projected costs were used for future years, as program administration will persist for the life of these projects. For this analysis, these costs were prorated among the technology categories.

#### 3.4.2 Investment Ratio Results

There are a number of ways to look at the RPS program's investment ratio. Table 21 shows the total Direct Investments in New York State compared with RPS Program Investment by technology in 2012 dollars, Table 22 shows the same results in nominal dollars.

**Table 21. Total Direct Investments in New York State and RPS Program Investment (2012 Dollars)**

Technology	Total Direct Investments in New York State (Millions)		Total RPS Program Investment (Millions) <sup>a</sup>	
	Group 1	Group 2	Group 1	Group 2
Wind	\$ 945	\$1,005	\$215	\$434
Hydroelectric	\$ 18	\$ 33	\$ 4	\$ 21
Biomass	\$ 162	\$ 441	\$ 30	\$ 123
Landfill Gas	n/a	\$ 95	n/a	\$ 54
<b>Total</b>	<b>\$1,125</b>	<b>\$1,574</b>	<b>\$249</b>	<b>\$633</b>

<sup>a</sup> For this calculation, RPS Program Investment included the actual historical payments and future contracted payments for RPS Attributes in addition to the historical and projected Administration costs for the Current Portfolio of Main Tier and Maintenance Resource projects.

**Table 22. Total Direct Investments in New York State and RPS Program Investment (Nominal Dollars)**

Technology	Total Direct Investments in New York State (Millions)		Total RPS Program Investment (Millions) <sup>a</sup>	
	Group 1	Group 2	Group 1	Group 2
Wind	\$ 987	\$1,078	\$220	\$455
Hydroelectric	\$ 17	\$ 38	\$ 4	\$ 22
Biomass	\$ 178	\$ 531	\$ 30	\$133
Landfill Gas	n/a	\$ 111	n/a	\$ 58
<b>Total</b>	<b>\$1,182</b>	<b>\$1,758</b>	<b>\$254</b>	<b>\$668</b>

<sup>a</sup> For this calculation, RPS Program Investment included the actual historical payments and future contracted payments for RPS Attributes in addition to the historical and projected Administration costs for the Current Portfolio of Main Tier and Maintenance Resource projects.

Table 23 shows the Direct Investments in New York State and RPS Program Investment in 2012 Dollars by group on a Net Present Value (NPV) basis, which is used to calculate an investment ratio for each technology.

Table 24 aggregates this investment ratio across the entire Current Portfolio of Main Tier projects. An investment ratio in excess of 1 reflects greater direct investments in New York State realized than what was spent to implement and execute RPS contracts. An investment ratio in excess of 1 was realized, or is expected, across technologies and both group averages. In total, the Current Portfolio of projects (including all technologies) studied yielded much more benefit than cost, on average, by approximately a 3:1 ratio.

To explain these results, several factors can be considered. The RPS contracts for Group 1 cost in aggregate less than half of Group 2 contracts, but the total Group 1 investments were similar to Group 2, yielding higher investment ratios for Group 1 than Group 2. Biomass and wind have the highest investment ratios of all technologies. Also, several large Group 1 projects have incurred production-based contract adjustments due to underperformance which have reduced the contract commitment on the part of NYSERDA but have not affected the in-state spending attributed to the project. This results in a higher investment ratio for these projects. Also, as is referenced in the most recent RPS annual performance report,<sup>28</sup> RPS Attribute prices have generally risen over time, and Group 2 projects often received awards in later procurements, which increases the associated costs of these contracts. The lower investment ratio for landfill gas projects is due to the lack of short-term investments for the landfill gas projects included in this analysis. The Group 1 average for hydroelectric is high due to the outlier project described in Section 3.2, but the Group 2 hydroelectric average reflects much lower expected direct investments with no such outliers.

<sup>28</sup> The New York State Renewable Portfolio Standard Performance Report, Through December 31, 2012  
<http://www.nyseda.ny.gov/Energy-Data-and-Prices-Planning-and-Policy/Program-Planning/Renewable-Portfolio-Standard/Main-Tier/-/media/Files/Publications/PPSER/NYSERDA/2013-rps-report.pdf>

**Table 23. NPV of Total Direct Investments in New York State, RPS Program Investment and Investment Ratios (2012 Dollars)**

Technology	NPV <sup>a</sup> Total Direct Investments in New York State (Millions)		NPV Total RPS Program Investment (Millions)		Investment Ratio		
	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2	Total
<b>Wind</b>	\$493	\$486	\$111	\$213	4.4	2.3	3.0
<b>Hydroelectric</b>	\$ 12	\$ 13	\$ 2	\$ 10	5.5	1.3	2.0
<b>Biomass</b>	\$ 70	\$144	\$ 16	\$ 54	4.3	2.6	3.0
<b>Landfill Gas</b>	n/a	\$ 34	n/a	\$ 24	n/a	1.4	1.4
<b>Total</b>	\$575	\$677	\$130	\$302	4.4	2.2	2.9

<sup>a</sup> NPV was calculated using 2002 as the base year, which matches the first year in which benefits accrue.

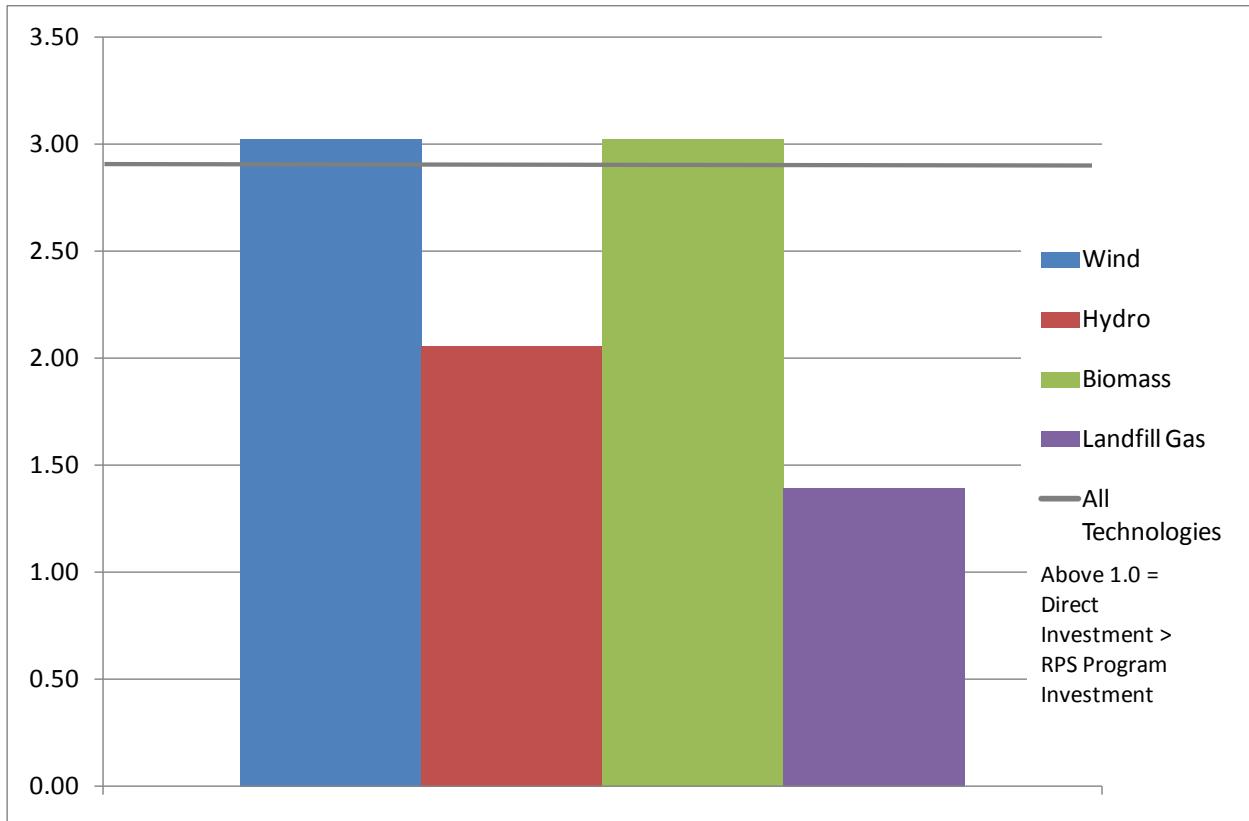
**Table 24. Current Portfolio Investment Ratios (2012 Dollars)**

Technology	NPV <sup>a</sup> Total Direct Investments in New York State (Millions)	NPV Total RPS Program Investment (Millions)	Investment Ratio
<b>Wind</b>	\$ 979	\$324	3.0
<b>Hydroelectric</b>	\$ 25	\$ 12	2.0
<b>Biomass</b>	\$ 214	\$ 71	3.0
<b>Landfill Gas</b>	\$ 34	\$ 24	1.4
<b>Total</b>	\$1,252	\$431	2.9

<sup>a</sup> NPV was calculated using 2002 as the base year, which matches the first year in which benefits accrue.

Figure 23 depicts the same Investment Ratio results including the program average by technology for the Current Portfolio of projects.

Figure 23. Current Portfolio Investment Ratios by Technology



## 4 Conclusions

---

Through December 31, 2012, the RPS Main Tier has provided substantial revenue to support new generation from wind, biomass, hydroelectric and landfill gas systems. Through a comprehensive verification process on 18 Main Tier facilities, NYSERDA has confirmed that the currently contracted resources have yielded and will continue to yield significant direct investments to the State which far exceeds the RPS funds committed to these projects.

The verification of New York State spending through three years of operation from 18 Main Tier facilities has shown that more than 1,000 in-state businesses spread over 44 counties benefited through the development, construction and operation of these facilities. The geographic and economic impacts of these projects are often concentrated around the project location but also extend beyond the host counties where the projects are located. Although fuel resource access and tax/local permit payments typically remain within the host county, purchases of goods and services for these projects were sourced throughout New York State.

Approximately \$2.7 billion dollars of direct investments in New York State are expected over the projected life of the Current Portfolio of Main Tier RPS facilities, as measured in jobs, taxes and local payments, in-state purchases and land leases. In the short term, the greatest impacts come from spending on construction materials and services. In the long term, PILOT payments, payroll expenses, fuel and landowner payments trigger the largest economic impacts. Overall, approximately \$27 in direct investments are produced as a result of project expenditures in New York for every 1 MWh of renewable energy that is generated under the Main Tier program.

The analysis indicates that for every \$1 spent on the acquisition of RPS Attributes for the Current Portfolio of RPS projects under contract with NYSERDA, the State will capture on average approximately \$3 in direct investments associated with project spending over project lifetime. These direct in-state investments have a greater impact on some sectors of the economy than on others. The sectors with the greatest portion of benefits include Professional Services (including Finance & Insurance, Legal, and Architectural & Engineering Services), Construction, and Trade.

Clearly the RPS Main Tier has brought and will continue to bring significant investments to many sectors of the State's economy.

NYSERDA, a public benefit corporation, offers objective information and analysis, innovative programs, technical expertise and funding to help New Yorkers increase energy efficiency, save money, use renewable energy, and reduce their reliance on fossil fuels. NYSERDA professionals work to protect our environment and create clean-energy jobs. NYSERDA has been developing partnerships to advance innovative energy solutions in New York since 1975.

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**State of New York**  
Andrew M. Cuomo, Governor

# NYSERDA

## Renewable Portfolio Standard Main Tier 2013 Program Review

### Direct Investments In New York State

Final Report  
September 5, 2013

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

## Appendix B: REMI Inputs, Current Portfolio, Select Years and Cumulative Through 2037

**Table B-1 Net Change as a result of RPS Additions (Millions of 2012 Dollars)**

<b>1. Wholesale Price Reduction</b>								
<b>Input Effect</b>	<b>2006</b>	<b>2012</b>	<b>2020</b>	<b>2030</b>	<b>2037</b>	<b>Cumulative (2002 - 2037)</b>	<b>Stimulative or Depressive</b>	<b>REMI Lever(s) Assignment</b>
Ratepayer Savings	\$19.4	\$51.1	\$25.2	\$13.0	\$0.1	\$991.5	Stimulative	<ul style="list-style-type: none"> <li>• Consumer Reallocation</li> <li>• Production Cost (across all NYS industry)</li> </ul>
Lower Generator Net Income	\$17.1	\$45.0	\$22.2	\$11.4	\$0.1	\$872.5	Depressive	<ul style="list-style-type: none"> <li>• Value Added with No Effect to Sales or Employment (Utilities)</li> </ul>
Reduced NYS Investment Income	\$1.1	\$3.1	\$1.5	\$0.8	\$0.01	\$59.5	Depressive	<ul style="list-style-type: none"> <li>• Dividend, Interest, and Rent Income</li> </ul>

<b>2. Direct Spending from RPS Developer Activity (both Construction and O&amp;M Related)</b>								
<b>Input Effect</b>	<b>2006</b>	<b>2012</b>	<b>2020</b>	<b>2030</b>	<b>2037</b>	<b>Cumulative (2002 - 2037)</b>	<b>Stimulative or Depressive</b>	<b>REMI Lever(s) Assignment</b>
Increase in Compensation for On-Site Employees	\$2.3	\$11.4	\$13.7	\$7.4	\$0.0	\$294.7	Stimulative	<ul style="list-style-type: none"> <li>• Compensation (&amp; direct employee additions)</li> </ul>
Increase in Construction-related or O&M Spending	\$53.8	\$117.9	\$48.4	\$24.2	\$0.5	\$1,687.4	Stimulative	<ul style="list-style-type: none"> <li>• Industry Sales (by industry)</li> <li>• Exogenous Final Demand (by industry)</li> </ul>
Payments of Various Taxes & Fees to Local Governments	\$9.7	\$20.2	\$17.1	\$6.8	\$0.0	\$407.7	Stimulative	<ul style="list-style-type: none"> <li>• Local Government Spending</li> </ul>
Payments to Landowners / Easements	\$3.2	\$11.1	\$26.8	\$15.1	\$0.0	\$527.7	Stimulative	<ul style="list-style-type: none"> <li>• Dividend, Interest, and Rent Income</li> <li>• Local Government Spending</li> <li>• Industry Sales (Forestry)</li> </ul>

<b>3. Increase in New York State Wholesale Electricity Sales</b>								
<b>Input Effect</b>	<b>2006</b>	<b>2012</b>	<b>2020</b>	<b>2030</b>	<b>2037</b>	<b>Cumulative (2002 - 2037)</b>	<b>Stimulative or Depressive</b>	<b>REMI Lever(s) Assignment</b>
Generation Import Substitution	\$8.7	\$23.4	\$45.0	\$33.4	\$0.3	\$1,092	Stimulative	Value Added with No Effect to Sales or Employment (Utilities)

4. Retail Rate Increase Necessary to Fund RPS Main Tier Program Spending								
Input Effect	2006	2012	2020	2030	2037	Cumulative (2002 - 2037)	Stimulative or Depressive	REMI Lever(s) Assignment
Program Cost Charged to NYS Electricity Ratepayers (including Administrative Costs)	\$18.1	\$55.0	\$44.0	\$0.0	\$0.0	\$882.1	Depressive	<ul style="list-style-type: none"> <li>• Consumer Reallocation</li> <li>• Production Cost (across all NYS industry)</li> </ul>
Administrative Spending	\$2.0	\$4.7	\$2.7	\$0.0	\$0.0	\$60.8	Stimulative	<ul style="list-style-type: none"> <li>• State Government Spending</li> </ul>

5. Displaced Direct Investment from Conventional Generation Resources								
Input Effect	2006	2012	2020	2030	2037	Cumulative (2002 - 2037)	Stimulative or Depressive	REMI Lever(s) Assignment
Investment Level Change (negative sign denotes less investment in Current Case)	\$0.0	\$0.0	-\$46.2	\$1.8	\$0.0	-\$392.2	Depressive	<ul style="list-style-type: none"> <li>• Industry Sales (across the applicable industries)</li> <li>• Exogenous Final Demand (across the applicable industries)</li> </ul>

6. Reduced Purchases of Fossil Fuels by Conventional Resources								
Input Effect	2006	2012	2020	2030	2037	Cumulative (2002 - 2037)	Stimulative or Depressive	REMI Lever(s) Assignment
Reduced Purchase Levels	\$12.7	\$62.5	\$130.6	\$70.0	\$1.6	\$2,197.3	Depressive	<ul style="list-style-type: none"> <li>• Exogenous Final Demand (across applicable industries)</li> </ul>

7. Change to Conventional Resource Spending on Variable O&M								
Input Effect	2006	2012	2020	2030	2037	Cumulative (2002 - 2037)	Stimulative or Depressive	REMI Lever(s) Assignment
Investment Level Change (negative sign denotes less investment in Current Case)	\$0.1	-\$0.9	\$4.1	-\$1.7	-\$0.03	\$6.3	Mixed	<ul style="list-style-type: none"> <li>• Intermediate Demand (across applicable industries)</li> <li>• Compensation (&amp; direct employee changes)</li> </ul>

New York State Energy Research and Development Authority

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# NYSERDA

## Renewable Portfolio Standard Main Tier 2013 Program Review

Volume 3 — Projected Impacts from Using  
Available Uncommitted Funds

Final Report  
September 5, 2013



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

**Volume 3**  
**Projected Impacts from Using**  
**Available Uncommitted Funds**

*Final Report*

Prepared by:

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

September 5, 2013

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# Executive Summary

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## Introduction

Volume 3 presents an assessment of the benefits and costs of the Renewable Portfolio Summary (RPS) program as required by the Public Service Commission's January 2010 Order.<sup>1</sup> NYSERDA conducted an analysis of new renewable resources that could be procured under future Main Tier RPS solicitations through 2015 by expending the remaining \$1.316 billion of authorized but uncommitted funds, referred to as the Reference Case portfolio. Depending on the underlying assumptions, there may be different Reference Case results for cost, quantities procured, resource mix and timing. The analysis described in this volume therefore describes a Base Case analysis of the Reference Case and various sensitivity analyses.

## Focus and Approach

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 has been used in previous analyses of RPS program compliance costs, but key modeling assumptions have been updated for this effort.<sup>2</sup>

The Reference Case cost study was conducted in the manner described by the methodology and assumptions in Volume 1, Section 6.7. A forecast of electricity prices (necessary to estimate additional RPS attribute incentive payments required to attract financing) relied on the same assumptions as the draft State Energy Plan (SEP) reference case that was developed in 2012, and are based on continued operation of Indian Point. While various input assumptions were updated in 2007 and again in 2009 to reflect changing market conditions and model inputs, the cost study methodology used here remains essentially unchanged from when it was first developed and applied by NYSERDA and the Commission to establish procurement processes, funding levels and predict program outcomes in 2004.<sup>3</sup>

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<sup>1</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, p.26.

<sup>2</sup> The supply curve model was initially developed by Sustainable Energy Advantage, LLC and La Capra Associates for New York renewable energy policy cost study analysis, and has been maintained and updated by La Capra Associates.

<sup>3</sup> See New York Renewable Portfolio Standard Cost Study Report, Appendix A.

## **Structure of the Report**

Volume 3 is a companion piece to Volume 1 and Volume 2 of the overall RPS Main Tier Program Review. This volume presents an analysis of new renewable resources that could be procured under future Main Tier RPS solicitations by expending the remaining authorized but uncommitted funds through 2015, referred to as the Reference Case portfolio. Because the cost, quantities procured, resource mix and timing are highly depending on the underlying assumptions, in addition to an analysis of a Base Case Reference Case, various sensitivity analyses are presented.

# 1 Introduction and Approach

---

NYSERDA continues to implement the Main Tier RPS procurements under current authorizations which are the cumulative result of orders described in Volume 1, Section 2. This volume describes the projection of the procurement results based on spending uncommitted funds dedicated to the Main Tier RPS. The incremental portfolio of renewable energy contracts expected to result from expending remaining uncommitted funds is referred to herein as the Reference Case portfolio. This represents continuation along the Commission's currently authorized RPS design path with currently-authorized but unencumbered funding. The Reference Case is considered herein under different potential exogenous future conditions.

## 1.1 Budget

The Reference Case budget reflects the projected full utilization of the remaining (as of December 31, 2013) Commission-approved Main Tier budget of \$1.316 billion. This available budget anticipates a re-allocation of \$108 million from Main Tier budgets to support the NY-Sun Initiative in 2014 and 2015.

## 1.2 Procurement Status/Timing

### 1.2.1 Current Main Tier Progress

The Commission established static NYSERDA Main Tier and Customer-Sited Tier program targets for supporting the production of approximately 10.4 million megawatt hours (MWh) of renewable energy annually by 2015. Including recent changes in the allocations of these targets based on the 2012 Customer-Sited Tier Program Operating Plan, this consists of approximately 9.52 million MWh from the Main Tier. As the end of 2012 and after conducting seven Main Tier solicitations, NYSERDA has existing contract commitments valued at \$872 million that support the production of 4,487 GWh annually from 54 large-scale electricity generation projects. These contracts represent 47% of the Main Tier program goal of 9,520 GWh. (See Volume 1; Current Portfolio).

### 1.2.2 Eighth Main Tier Procurement

A portion of the budget is dedicated to NYSERDA's eighth Main Tier solicitation. Approximately \$250 million has been dedicated to this procurement under Request for Proposals (RFP) 2554, which was originally released on December 20, 2012, and reissued on January 4, 2013 after the federal production tax credit extension was announced. Proposals have been received and evaluated, and contracting with respect to the selected proposals is currently underway.

Modeling analysis for the 2013 Review has proceeded in parallel to this open procurement. In this context, it is important to point out that the results of RFP 2554 with respect to contracts executed and funding committed, when finalized and made available, will post-date this analysis, and will likely differ from the modeled results discussed herein (see Volume 1, Section 6, and Section 1.2.6 below for Methodology discussion).

### **1.2.3 Subsequent Procurements**

The Commission has authorized NYSERDA to conduct future Main Tier solicitations, without Commission approval, after consultation with DPS Staff and approval by the Director of the Office of Energy Efficiency and the Environment prior to each solicitation.<sup>4</sup> However, pending the closure of RFP 2554, the resolution of other issues and the progress of the 2013 Program Review, the schedule for remaining procurements has yet to be established. To proceed with the analysis required for this review, NYSERDA has assumed a proxy timeline for these future Main Tier procurements.

### **1.2.4 Timing Assumptions**

Solicitations to expend the uncommitted Main Tier RPS funding and fulfill procurement of the Reference Case portfolio are assumed to take place during three consecutive years: 2013, 2014 and 2015.<sup>5</sup> It is assumed that contracts valued at a total of \$316 million, \$500 million and \$500 million will be procured during calendar years 2013, 2014 and 2015, respectively. Resources procured in a given year are assumed to come online on January 1 of the second year following the year of procurement. For example, resources procured in 2013 would come online in January 2015.

### **1.2.5 The Reference Case**

The Reference Case portfolio represents the resources that can be procured under Main Tier RPS solicitations by expending the remaining \$1.316 billion in uncommitted funds. Depending on the underlying assumptions, there may be different Reference Case results for cost, quantities procured, resource mix and timing. The analysis described in this volume therefore describes a Base Case analysis of the Reference Case, as well as various sensitivity analyses.

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<sup>4</sup> *Proceeding on Motion of the Commission Regarding a Retail Renewable Portfolio Standard* “Order Authorizing Additional Main Tier Solicitation and Setting Future Solicitation Guidelines,” issued and effective December 3, 2010.

<sup>5</sup> The timing assumption is consistent with the Commission’s January 2010 Order, which extended the target date to 2015. See note 1, p 14.

### 1.2.6 Approach to Reference Case Analysis

The Reference Case cost study analysis was conducted consistent with the methodology described in Volume 1, Section 6 (Methodology). 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 the associated market clearing price. This market clearing price, in dollars per megawatt hour, represents the projected cost of all RPS Attributes<sup>6</sup> to be procured under a given spending level. In practice, the Main Tier RPS solicitations have been applied on an as-bid rather than clearing price auction, where NYSERDA commits funding based on the prices that are bid from each generator in the solicitation, from the lowest bid to highest bid, and as limited by the funding available. The cost model approach used in this analysis assumes that over time, bid prices may converge toward the clearing price with increased market experience, liquidity and transparency. Thus, the cost model will likely project slightly higher costs per renewable attribute generated, resulting in less projected progress toward the program goals given fixed program funding.

Sensitivity analyses were conducted to provide the Commission insight into the potential impacts of exogenous issues that might materially change the results of the resource selection and cost projection process such as changes in federal financial incentives or onshore wind costs as described further in Section 2.

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<sup>6</sup> The following terms should be read as synonymous with RPS Attributes: renewable attributes and renewable energy certificates or credits.

## 2 Reference Case Cost Study Results

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### 2.1 Projected Impacts of Using Available Uncommitted Funds

The initial step in estimating the costs and benefits of the Main Tier Reference Case involves projecting the results of incremental Main Tier contract solicitations resulting from expending the remaining approved budget. The key results consist of the type of generation projected to be procured, the quantity of RPS Attributes procured, the timing of production and payment, and the cost of RPS Attributes procured.

Key findings of this analysis include:

- Under a Base Reference Case assuming extension of the federal production tax credit in its current form and no future onshore wind technological-advance-driven cost improvements, expenditure of the uncommitted \$1.316 billion by the end of 2015 is expected to procure an additional 3,700 GWh per year of renewable energy. After accounting for current NYSERDA commitments, total program progress would approach 8,200 GWh per year, equal to 86% of the Main Tier target.
- Under the primary Reference Case sensitivity, labeled Sensitivity 1, the PTC is assumed to be phased out by 2019 (the PTC Phase-out Sensitivity). In this case, available funding would be sufficient to procure a reduced total of 3,000 GWh of additional renewable generation per year, resulting in total program progress of 7,500 GWh per year, equal to 79% of the Main Tier program target.
- Although the PTC phase-out has a material impact on NYSERDA's buying power, this impact is partially offset by a correspondingly lower onshore wind project financing cost (described in Volume 1). This decrease in project financing costs may be feasible in a post-PTC world in which equity investment is not limited to those few with the tax appetite to fully monetize federal tax credits. The impact is also partially offset by anticipated technology improvements.
- The outlook for meeting RPS Main Tier program goals in 2015 appears more challenging than a few years ago. Market conditions in 2013 continue to evolve from conditions in 2004 when the RPS Program was designed and in 2009 during the mid-course review. Various factors will influence the premium required to support project development, and thus the ultimate achievements of the program. Some of these factors are outside the control of the program, whereas others factors such as the chosen pace of procurements and program contracting mechanisms can be altered to compensate for shifting market conditions as necessary to support policy objectives.

This section is organized as follows:

- Section 2.2 reviews key input assumptions used in the Reference Case analysis, with further details included in Appendix A.
- Section 2.3 described the Base Reference Case and several sensitivity analyses, which vary with federal production tax credit and onshore wind cost trajectories.
- Section 2.4 describes the results of the Reference Case cost study.
- Section 2.5 discusses key findings.
- Section 2.6 presents a discussion of factors that have impacted program progress.
- Section 2.7 describes considerations for future program implementation.

## 2.2 Review of Reference Case Input Assumptions

The Reference Case Cost Study analysis presents an estimate of the incremental future portfolio of renewable energy generation that becomes possible when spending the remaining approved Main Tier budget of \$1.316 billion. Solicitations to expend the uncommitted Main Tier RPS funding and fulfill procurement of the Reference Case portfolio are assumed to take place during three consecutive years: 2013, 2014 and 2015. It is assumed that contracts valued at a total of \$316 million, \$500 million and \$500 million will be procured during calendar years 2013, 2014 and 2015, respectively. Resources procured in a given year are assumed to come online on January 1 of the second year following the year of procurement. For example, resources procured in 2013 would come online in January 2015.

The Reference Case Cost Study was conducted consistent with the methodology and assumptions described in Volume 1, Section 6.7. A forecast of electricity prices (necessary to estimate additional RPS Attribute incentive payments required to attract financing) relied on the same assumptions as the draft State Energy Plan (SEP) Reference case that was developed in 2012, and are based on continued operation of Indian Point. Although various input assumptions have been updated in 2007 and again in 2009 to reflect changing market conditions and model inputs, the cost study methodology used here remains essentially unchanged from when it was first developed and applied by NYSERDA and the Commission to establish procurement processes, funding levels and predict program outcomes in 2004.<sup>7</sup> Key input assumptions for the Reference Case analysis and related sensitivities are summarized in Appendix A. Two sets of assumptions which define the Base Reference Case and key sensitivities are discussed further in the following section.

## 2.3 Analysis Cases: Base and Sensitivities

Of the various input assumptions, two primary exogenous drivers shape the Base Case and key sensitivities considered in this section: the future availability of the Federal Production Tax Credit (PTC), and the future trajectory of the cost and performance of wind power.

The PTC is currently slated to expire for projects not reaching an “under construction” milestone by December 31, 2013. Although the PTC has expired and been reauthorized a number of times in the past, further extension is uncertain. Two PTC cases were developed. The “Full PTC” case is defined as the PTC in its current form and level assumed to be extended and continue in effect for the entire study period. The “PTC Phase-Out” sensitivity case is defined as the PTC is reduced beginning in 2015, phased down to 60% of its current value by 2018 (as shown in

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<sup>7</sup> New York State Department of Public Service, NYSERDA, Sustainable Energy Advantage, LLC, and La Capra Associates. *Proceeding on Motion of the Commission Regarding a Retail Renewable Portfolio Standard*, New York Renewable Portfolio Standard Cost Study Report, Appendix A, dated March 9, 2004

Volume 1, Table 6), and eventually eliminated in 2019. In both the Full PTC 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. The PTC cases are described more fully in Volume 1.<sup>8</sup>

The Review also includes analysis of different future forecasted levelized costs of energy for onshore wind, described in more detail in Volume 1. The analysis explores two cases. The first case assumes that continued technology (and associated cost and performance) improvements will reduce levelized costs over time. The second case is more conservative, incorporating technology improvements to date, but assuming that the levelized cost of energy remains constant in real terms over the study horizon.

The Base Reference Case analysis assumes Full PTC coupled with no further wind cost improvements. The three other combinations of PTC and wind cost improvements were run as sensitivities. These sensitivities couple PTC assumptions and onshore wind cost assumptions as follows. Sensitivity 1 is the primary PTC Phase-Out sensitivity. It is coupled with continued future improvements in onshore wind technology and cost improvements reducing the levelized cost of energy over time. Sensitivity 2 couples Full PTC with onshore wind improvements, while Sensitivity 3 couples PTC Phase-Out with no wind improvements.

The Base Reference Case (Full PTC without wind technology improvements) and Sensitivity 1 (PTC phase-out with wind technology improvements) are considered to bound the most likely range of future conditions, and are therefore considered more likely than the other sensitivities. The rationale for this is that technology improvements would bring wind costs down sufficient to enable a viable wind industry in the future without PTC support; conversely, if there are no further wind improvements, the PTC would still be necessary to maintain a growing wind industry. Sensitivity 2 and Sensitivity 3 were analyzed for completeness, but are considered to be less likely than the Base or Sensitivity 1 variations of the Reference Case portfolio analysis. Sensitivity 2 would be likely to provide support in excess of what the onshore wind industry would require in the presence of substantial cost of energy improvements, while Sensitivity 3 couples withdrawal of federal policy support with the absence of cost advances likely to drive broad acceptance of the phase-out of federal support.

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<sup>8</sup> We note that the current PTC allows for qualifying generators to take a 30% Investment Tax Credit in lieu of the PTC. For generators in particular with high installed cost and relatively low production (capacity factor), the ITC will be preferable. The availability of ITC in lieu of PTC has not been a long-term component of federal renewable energy support, but was included first in the American Recovery and Reinvestment Act of 2009 (ARRA) and again in the American Taxpayer Relief Act of 2012 (H.R. 6, Sec. 407) in January 2013. If PTC is extended again, inclusion of the ITC in lieu of PTC is uncertain. Due to this uncertainty, availability of ITC in lieu of PTC has not been considered in this analysis. If however ITC in lieu of PTC is included in any extension of the PTC, and ITC is elected by generators, projected costs may be reduced. This assumption is therefore a source of conservatism in this analysis.

## 2.4 Results

Tables 1 through 5 summarize the key findings for the projected Reference Case portfolio including RPS Attribute price, energy procured and total renewable capacity for each case. Table 1 shows the amount of energy procured in the Reference Case portfolio each year for the Base and each sensitivity case. Resources are shown by the year in which they are procured.

**Table 1. Reference Case Energy Procured Each Year (GWh)**

<b>Sensitivity</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>Total</b>
Base (Full PTC/No Wind Improvements)	900	1,400	1,400	3,700
Sensitivity 1 (PTC Phase Out/With Wind Improvements)	800	1,100	1,100	3,000
Sensitivity 2 (Full PTC/ With Wind Improvements)	1,000	1,700	1,900	4,700
Sensitivity 3 (PTC Phase Out/ No Wind Improvements)	700	1,000	900	2,600

Note: Summation may not equal due to rounding.

Table 2 shows the projected Reference Case portfolio RPS Attribute prices for each year and each sensitivity case. Resources are assumed to come online on average two years after the procurement date, commencing operation on January 1 of the applicable year. Revenue and cost assumptions for the year the resource is projected to be online are used to determine RPS Attribute prices. The RPS Attribute prices reflect the price in the year that the resource is procured.

**Table 2. Reference Case RPS Attribute Prices by Procurement Year (nominal \$/MWh)**

<b>Sensitivity</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>
Base (Full PTC/No Wind Improvements)	\$35	\$36	\$35
Sensitivity 1 (PTC Phase Out/With Wind Improvements)	\$41	\$44	\$45
Sensitivity 2 (Full PTC/ With Wind Improvements)	\$32	\$29	\$26
Sensitivity 3 (PTC Phase Out/ No Wind Improvements)	\$44	\$51	\$55

The weighted average RPS Attribute price over the study period for the Base case and each sensitivity case is shown in Table 3.

**Table 3. Reference Case Weighted Average RPS Attribute Prices by Scenario (nominal \$/MWh)**

Scenario	REC Price
Base (Full PTC/No Wind Improvements)	\$35
Sensitivity 1 (PTC Phase Out/With Wind Improvements)	\$44
Sensitivity 2 (Full PTC/ With Wind Improvements)	\$28
Sensitivity 3 (PTC Phase Out/ No Wind Improvements)	\$50

Note: Value expressed as weighted average of nominal RPS Attribute Price over the different years funding is committed.

Tables 4 and 5 show the annual capacity and energy additions comprising the Reference Case portfolio under the Base case and each sensitivity case respectively.

**Table 4. Reference Case Incremental Capacity Additions by Type, Base and Sensitivity Cases (MW)**

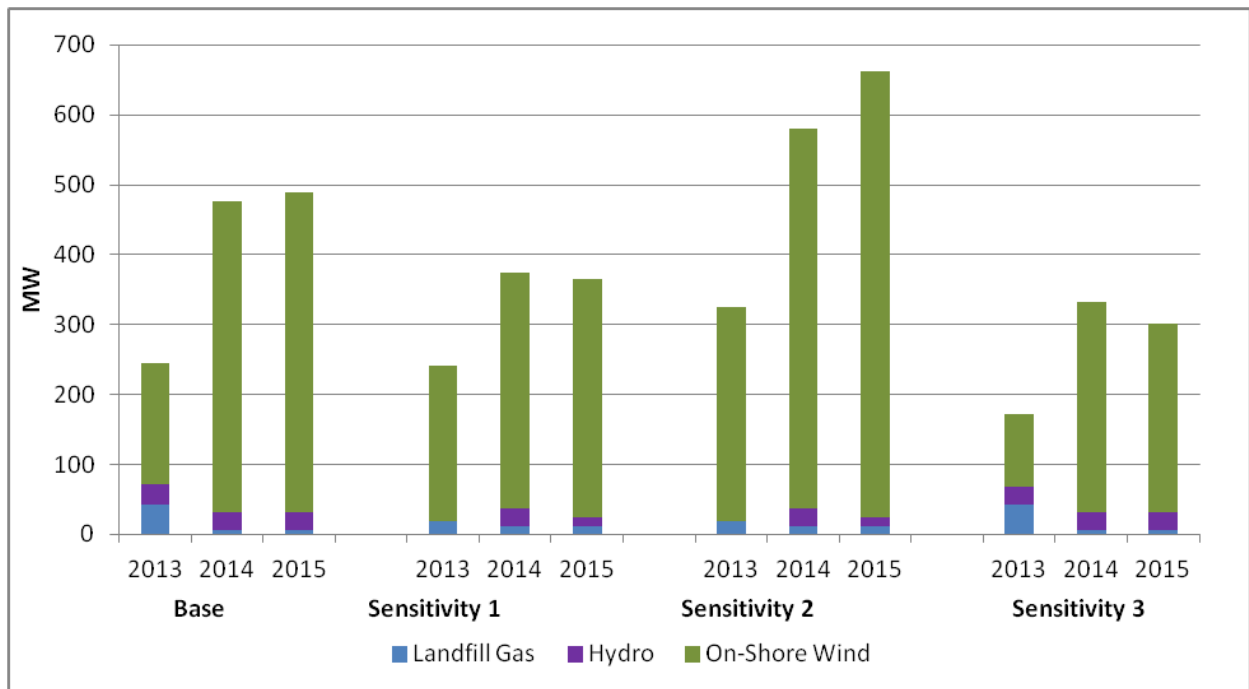
	Base Full PTC No Improvements			Sensitivity 1 PTC Phase-Out With Improvements			Sensitivity 2 Full PTC With Improvements			Sensitivity 3 PTC Phase-Out No Improvements		
	2013	2014	2015	2013	2014	2015	2013	2014	2015	2013	2014	2015
Landfill Gas	42	6	6	18	12	12	18	12	12	42	6	6
Hydro	26	26	26	0	26	13	0	26	13	26	26	26
On-Shore Wind	173	444	457	223	337	340	308	543	638	104	301	270
Total	241	476	489	241	375	365	326	581	663	172	333	302

**Table 5. Reference Case Incremental Renewable Energy Generation by Type, Base and Sensitivity Cases (GWh/yr)**

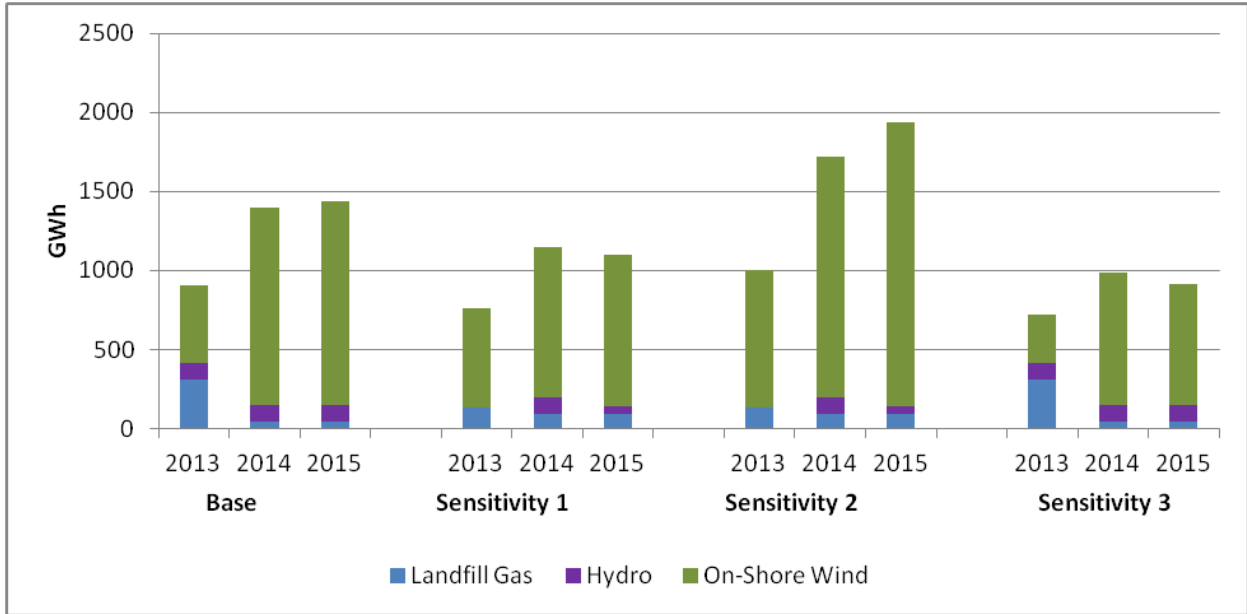
	Base Full PTC No Improvements			Sensitivity 1 PTC Phase-Out With Improvements			Sensitivity 2 Full PTC With Improvements			Sensitivity 3 PTC Phase-Out No Improvements		
	2013	2014	2015	2013	2014	2015	2013	2014	2015	2013	2014	2015
	<b>Landfill Gas</b>	314	45	45	134	90	90	134	90	90	314	45
<b>Hydro</b>	104	104	104	0	104	52	0	104	52	104	104	104
<b>On-Shore Wind</b>	491	1,251	1,288	630	951	959	868	1,529	1,797	307	841	763
<b>Total</b>	909	1,400	1,437	764	1,144	1,100	1,003	1,723	1,939	725	990	912

Figure 1 shows the total capacity that cleared the supply curve model in the Base Reference case and each of the sensitivity cases, by year. Offshore wind, solar, and biomass did not clear the model (i.e., were not selected to meet demand) in any of the Base or sensitivity cases. Figure 2 shows new generation in GWh per year that cleared the model annually. Figure 3 and Figure 4 show the summation across all years by technology.

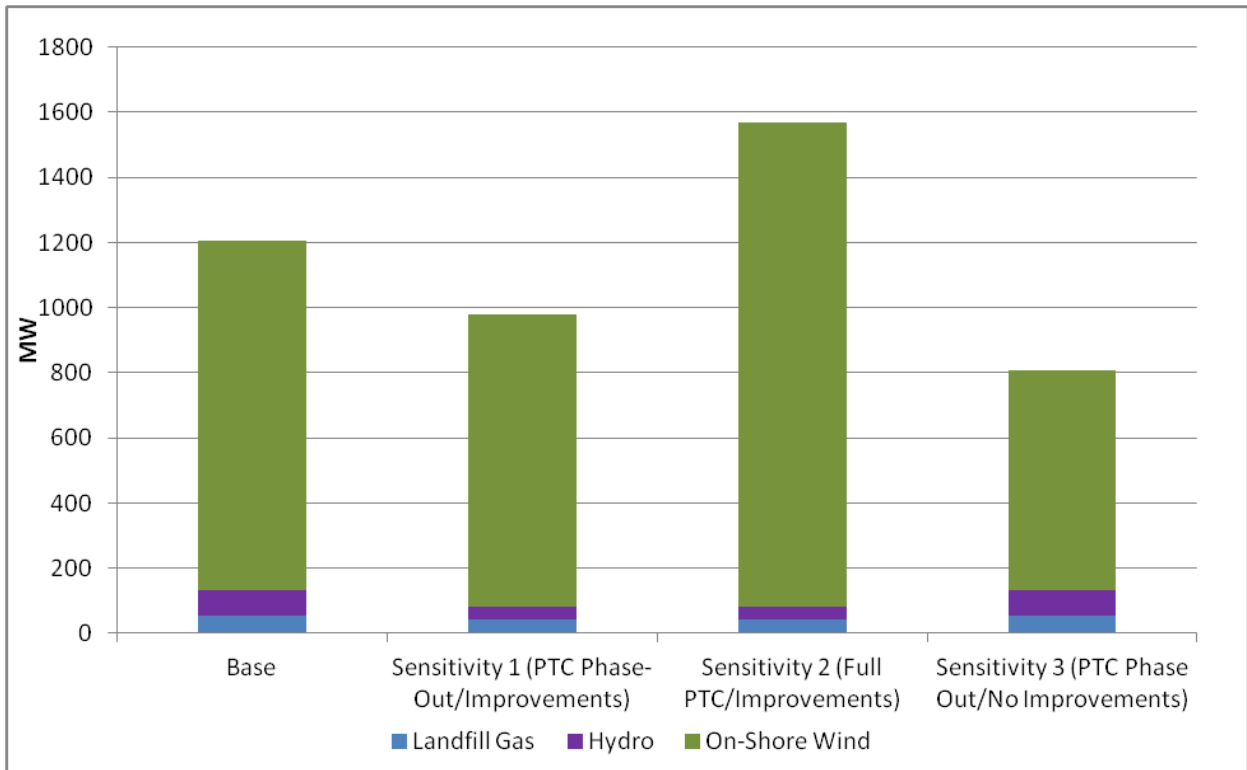
**Figure 1. Reference Case Annual Incremental Capacity Procured (MW)**



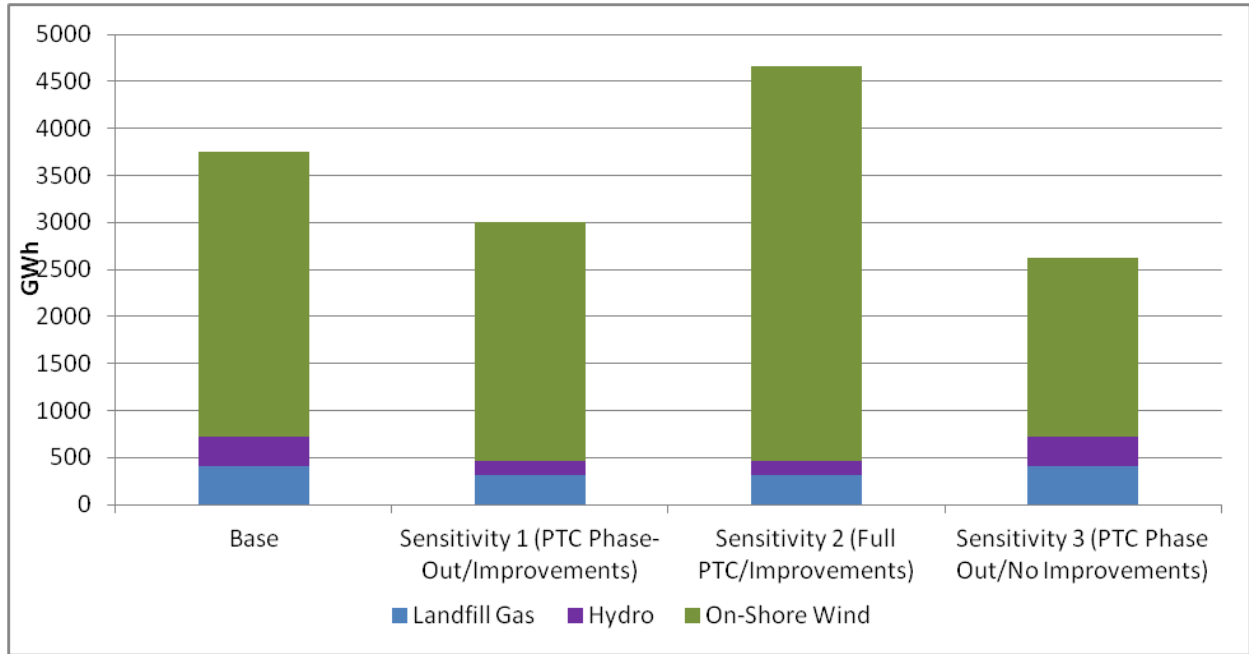
**Figure 2. Reference Case Annual Incremental Renewable Generation Procured (GWh)**



**Figure 3. Reference Case Incremental Capacity Additions by Type, Base and Sensitivity Cases (MW)**



**Figure 4. Reference Case Incremental Renewable Energy Generation by Type, Base and Sensitivity Cases (GWh/yr)**



## 2.5 Key Findings

In the Reference Case, reflecting expenditure in Main Tier procurements of the currently authorized funding of \$1.316 billion, new renewable energy procured by the end of 2015 is expected to approximate 3,700 GWh. In combination with the Current Portfolio, total program progress would approach 8,200 GWh, which represents 86% of the Main Tier program target. Should the PTC be phased out as modeled in the PTC Phase-out Sensitivity case, available funding would be sufficient to procure a reduced total of 3,000 GWh of additional renewable generation resulting in total program progress of 7,500GWh, representing 79% of the Main Tier program target.

## 2.6 Factors Influencing Program Progress

The outlook for meeting RPS Main Tier program goals in 2015 appears more challenging than a few years ago. Market conditions in 2013 continue to evolve from conditions in 2004 when the RPS Program was designed and in 2009 during the mid-course review. Some of the factors that influence the results of this cost analysis and program achievements in general are described in the following sections.

### 2.6.1 Wholesale Electricity Prices

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 as the cost study results demonstrate, is expected to reduce the quantity of RPS Attributes that can be purchased with the available Main Tier budget.

### 2.6.2 Federal Incentives

Although the PTC phase-out has a material impact on NYSERDA's buying power, this impact is partially offset by correspondingly lower onshore wind project financing costs (described in Volume 1) that may be feasible in a post-PTC world in which equity investment is not limited to those few with the tax appetite to fully monetize federal tax credits, as well as technology improvement as described earlier. In addition, the impact of phasing out the PTC is modest in this scenario since modeled purchases are complete, and projects are assumed to come on-line prior to the full withdrawal of the PTC in the phase-out scenario.

### 2.6.3 Evolution of Wind Turbine Design, Cost and Performance

Wind turbine configurations have been changing in the past several years. Towers have increased in height, rotor diameters have increased, and other aspects of the technology have evolved to more effectively capture wind energy in low-wind speed regimes. This is good news for states such as New York that have generally good, but not superior, wind resources. This trend in other parts of the country is resulting in reduced cost per MWh and a greater number of MWh produced per MW, which increases project revenue from the sale of commodity energy, reducing the premium needed to be paid by ratepayers to support project development. In the Midwest, where winds are far more consistent and wind speeds higher, these technology improvements are demonstrating that wind projects can result in capacity factors approaching 50%.

NYSERDA anticipates seeing more projects in New York State use the latest generation of low-wind speed turbines. One project using new General Electric 1.6 MW turbines with these operating characteristics is now under construction. This Cost Study analysis assumes capacity factors increasing to 32%, from historic averages of around 26 to 27%, based on adoption of new technologies and project design parameters. If, as some predict, capacity factors increase to around 35-38% in New York State, such increased performance would place downward pressure on REC prices and increase progress in the Main Tier program.<sup>9</sup>

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<sup>9</sup> For example, see National Renewable Energy Laboratory. 2012. *The Past and Future Cost of Wind Energy*. IEA Wind Task 26. NREL/TP--6A20--53510.

## **2.6.4 Siting**

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.

## **2.6.5 Project Under-Performance**

Although approximately 4.5 million MWh are currently under contract for 2015, actual production will likely vary from time to time. Renewable resources, such as wind and hydroelectric, are by nature intermittent making it difficult for facility operators to estimate their annual electricity production with a high degree of accuracy. In addition, financing and construction-related impediments can cause delays in facility construction. Project development delays and under-performance of operating projects have unfortunately impacted program progress. As such, data reported at any given time may reflect unexpected variations in performance toward reaching the 2015 targets. Underproduction and project delays and setbacks have not been overlooked in Main Tier program and contract design. To ensure progress toward the Main Tier target and to ensure other projects are afforded timely opportunities for funding, NYSERDA contractually requires 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. 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

## **2.7 Considerations for Future Program Implementation**

### **2.7.1 Timing**

The Reference Case cost study analysis described in this section shows NYSERDA committing all of the currently authorized funding by 2015; this is optimistic and energy market trends suggest that alternate approaches are worth consideration. The development pipeline in New York has slowed somewhat, primarily in response to uncertainty over federal incentives and lower expectations for wholesale power revenues. Many new/anticipated projects are only in early stages in terms of completing interconnection studies with the NYISO or permitting activities, and are likely not in a position to respond to a short-term RPS solicitation, which requires considerable financial security for commercial operation milestones that they will have difficulty satisfying.

NYSERDA continues to believe that a well-paced program that adheres to some regularity in scheduled offerings will reinvigorate the market, support steadier project development activities, and enable more informed estimates of project costs and project schedules and more attractive bid prices. Although striving to meet the goal on the 2015 prescribed schedule is a worthy objective, cost-effectiveness of attaining the target is also an important goal, and New York State has avoided committing to speculative projects at excessive prices merely to meet a program target. Additionally, NYSERDA continues to believe that New York should continue to proceed carefully so that it can continue to capture cost-reducing innovations in the renewable industry over time, avoid less-than-optimal program outcomes by only supporting technologies and projects that are market-ready, benefit from remaining federal subsidies<sup>10</sup> and enjoy the benefits of new financing options<sup>11</sup> that may emerge in response to reducing federal subsidies. Pacing commitments has proven effective at keeping costs reasonable. While it is possible that program commitments fully encumbering the remaining RPS Main Tier budget could be made before the end of 2015, a continuation of procurements and contracting of appropriate technologies and resources for some period beyond 2015 would likely produce a preferable outcome.

## 2.7.2 Commodity Pricing

The impacts of reduced natural gas prices are not limited to renewable energy projects; the reduction in price has also impacted the energy market as a whole. In addition to the economic pressure that low gas prices place on renewable projects, they also affect conventional generation facilities, including coal plants. Retirements of coal-fired plants would also erode the potential for biomass co-firing. The cost updates contained herein include a reduction in available biomass co-firing to reflect this market view. In addition to an impact on the overall target, a reduction in biomass may also reduce the diversity of the RPS portfolio.

## 2.7.3 Commodity Revenue Risks

NYSERDA periodically engages with stakeholders to gauge the market for participation in RPS program solicitations and to discuss challenges to project development presented by changes in the energy markets. Project developers often suggest changes to program implementation processes that, from their perspective, would enhance opportunities for project investment in New York State. Many of the issues relate to risks borne by project developers, and often are connected with project expectations of wholesale commodity revenue and its impact on project development and program costs.

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<sup>10</sup> If federal incentives are extended, re-accelerating project development would take some time initially, and the structure of any federal commitment (particularly any phase-out schedule) would hopefully account for this lag; if not, projects in New York State might be at a disadvantage as time to re-engage and move through permitting processes in New York could result in New York projects foregoing higher levels of federal incentives available in the early years of any phase-out schedule.

<sup>11</sup> Master limited partnerships (MLPs) and real estate invest trusts (REITs) are examples of financing innovations being developed or considered that could potentially reduce the cost of financing capital-intensive renewable energy projects. Legislative changes may be required to enable such financing vehicles.

When first introduced, project developers supported the New York RPS model as a favorable market for project development compared to other RPS models in use in other deregulated markets. Ample projects entered the market and New York State benefited from numerous competing development options. The main drivers making New York an attractive market were the State's commitment to its RPS, policy and regulatory certainty for the program period, regularly scheduled solicitations, and, while not universally favored by developers, 10-year REC contracts. New York State maintained a reputation as a favorable market was despite the challenges of siting and permitting projects in New York and the uncertainty over the timing and level of federal incentives (which has a material impact on development success and program costs, as well as achieving program objectives).

However, RPS procurement/contracting mechanisms in other deregulated markets have migrated to address initial program structural deficiencies. Some developers have voiced a need for changes in New York's program. Evolution in other states has included combinations of long-term contracting policies under which both energy and RPS Attributes may be sold, thus hedging commodity market price risk, which New York's current RPS design does not offer, and longer periods of support.

Some alternate models, as proposed by developers, to assure project finance on attractive terms have included the use of longer term contract commitments by NYSEERDA, procurement models that employ contracts-for-differences (CfD), where project revenues are predictable and stable despite commodity price volatility, or other risk sharing processes. Alternatives have been considered and rejected by the Commission in the past for several reasons. One important concern is that such arrangements transfer market risks to ratepayers, who otherwise have no viable means to hedge against that risk.<sup>12</sup> NYSEERDA has come to understand that some developers have been able to cost-effectively secure hedges on commodity price risks for at least three to as many as seven years, demonstrating that developers have the capacity to hedge and at lower costs than would ratepayers. However, NYSEERDA concedes that long-term cost-effective hedging opportunities remain uncertain.

NYSEERDA believes that the following factors all suggest that New York State may benefit from a renewed consideration of program structures, including contract tenure and other program design issues:

- Upward trending of RPS Attribute pricing in the Main Tier RPS program.
- Reduced number of viable development prospects.<sup>13</sup>
- Emerging opportunities to consider alternative financing strategies, such as those that may emerge through the State's Green Banking initiative, and expanded renewable energy policy objectives.

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<sup>12</sup> Case 03-E-0188, "Order Resolving Main Tier Issues," issued and effective April 1, 2010.

<sup>13</sup> Based on NYSEERDA's observation of the number of renewable projects that are in early stages of the NYISO interconnection queue or in permitting.

# Appendix A: Cost Study Key Input Assumptions

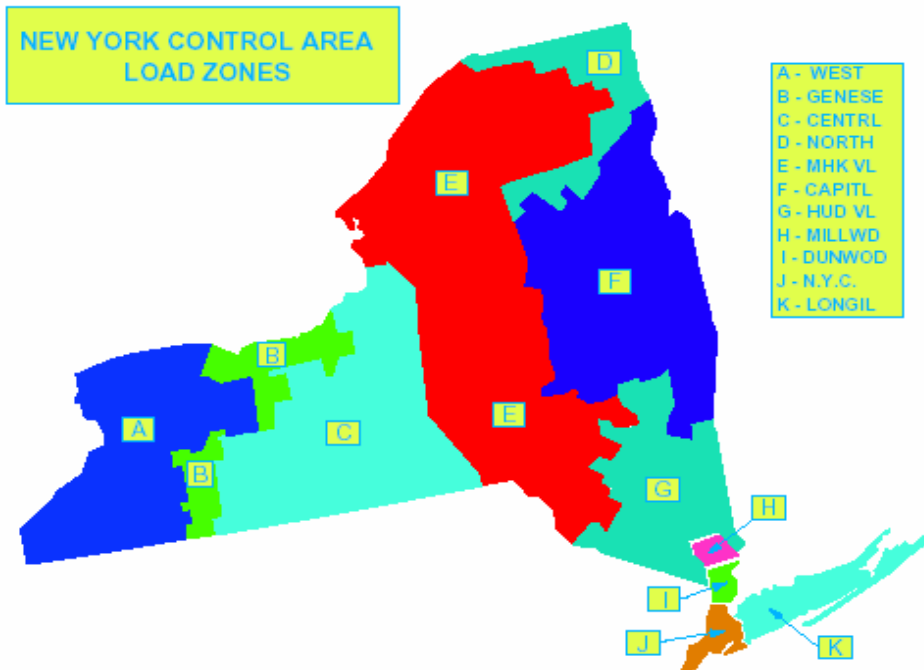
## Commodity Prices

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 11 NYISO zones. For purposes of efficiency and transparency of the analysis, the 11 NYISO zones were aggregated into three “Megazones” as shown in Figure 3A-1 that capture the vast majority of market price differentials across the state, based on an analysis of zonal market prices:

- Megazone 1 = NYISO zones A, B, C, D and E
- Megazone 2 = NYISO zones F, G, H and I
- Megazone 3 = NYISO zones J and K.

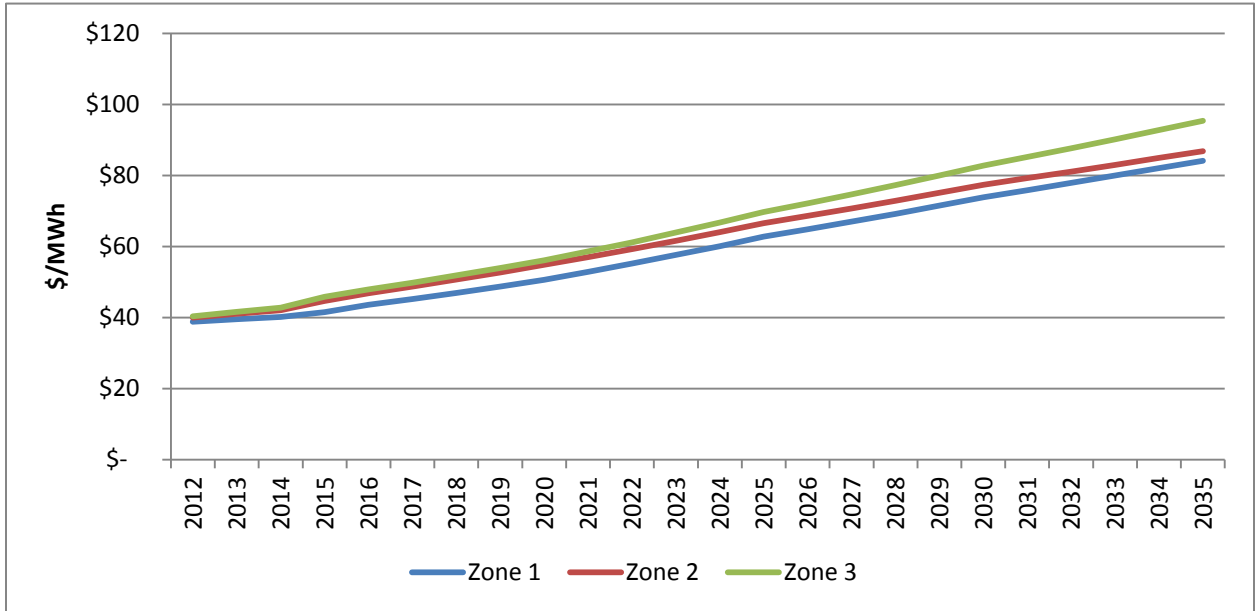
Within each megazone, prices have tended to be very similar, and transmission constraints are minimal relative to the constraints between megazones.

**Figure 3A-1: NYISO Zones**

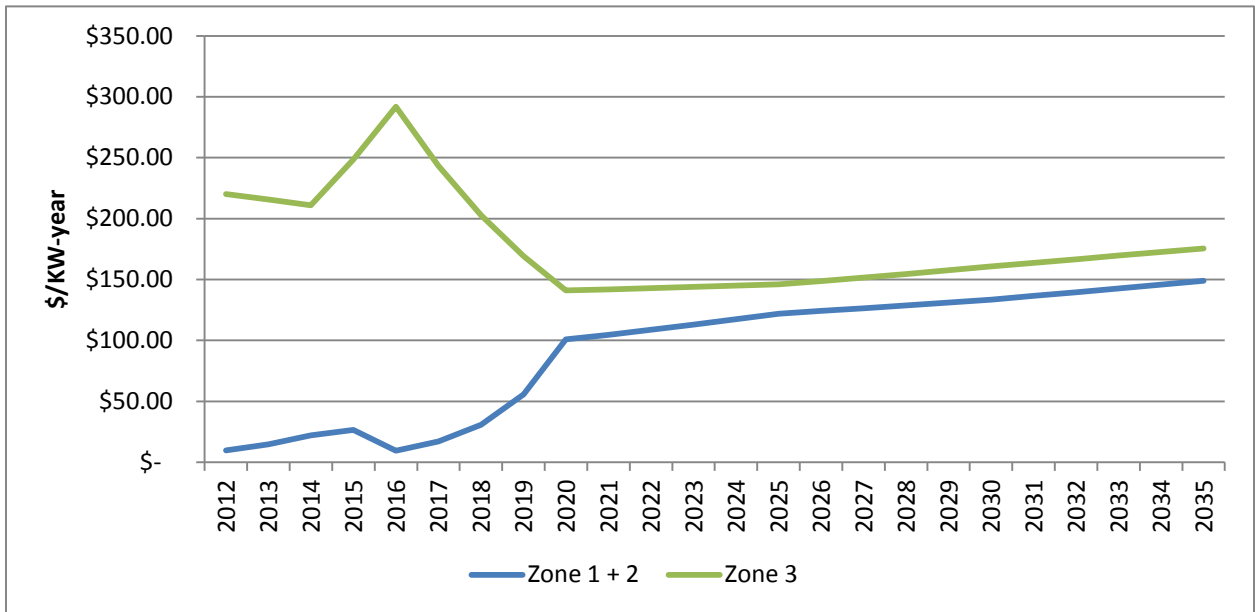


Wholesale energy and capacity prices used in the Reference Case come from the most recent analysis completed for the New York State Energy Plan by ICF International. Figures 3A-2 and 3A-3 show the energy and capacity prices.

**Figure 3A-2. Energy Prices by Year (\$/MWh)**



**Figure 3A-3. Capacity Prices by Year (\$/kW-year)**



## Levelized Commodity Values

As described in Volume 1, a portion of the renewable premium calculation is determining the difference between resources' levelized cost and levelized commodity revenue.

The "commodity market value" absent RPS revenues is a function of a generator's seasonal and time-of-day production profile, and the commodity market LBMP prices available at its location. Additionally, a capacity value associated with the effective capacity value of each renewable resource is included in this analysis. Other potential revenue streams, such as ancillary services, were not included. To the extent that such revenues are available, the cost premium required by renewable resources would be lower than projected herein.

The commodity market value of a renewable resource will be influenced, in part, by where within New York it is located. Under present wholesale market design, generators are paid for their output based on the specific node at which their output enters the bulk transmission system. For the purpose of testing the cost-effectiveness of renewable resources, the state was divided into three "Megazones" that capture the vast majority of projected price differentiation within New York.

The commodity value of a renewable project's output will also depend to some extent on the seasons and times of day during which it generates. This is because different resources have different production profiles, and wholesale market prices tend to be differentiated significantly by season and time of day. Generation profiles as used in the 2004 Report were again applied in this study.

The NYSERDA Technology Assessment estimated the relative output of potential renewable resources in terms of the following six different seasonal and time of day categories ("time slices") in which wholesale market prices were expected to be similar:

- Summer On Peak: June – August weekdays, noon to 6 pm
- Summer Off Peak: June – August, midnight to 8 am weekdays; all weekend hours June – August; and May, September and October, all hours
- Summer Shoulder: Weekdays June – August, 8 am to noon and 6pm to midnight
- Winter On Peak: December – February, noon to 8 pm
- Winter Off Peak: December – February, midnight to 8am and all weekend hours; March, April and November, all hours
- Winter Shoulder: Weekdays December – February, 8 am to noon and 8 pm to midnight

Below are the 20-year levelized values in \$/MWh for capacity coming on-line in the specified year. A discount rate of 10% was used in the calculation of levelized commodity prices. These values are derived from the forecast shown in Figure 3A-4.

**Table 3A-1: Nominal 20-Year Levelized Energy Commodity Prices by Megazone**

<b>Zone 1, Market Price \$/MWh</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>
<i>Time Period 1</i>	\$ 98.52	\$ 102.47	\$ 106.64
<i>Time Period 2</i>	\$ 43.76	\$ 45.28	\$ 46.81
<i>Time Period 3</i>	\$ 62.47	\$ 64.99	\$ 67.57
<i>Time Period 4</i>	\$ 79.88	\$ 83.17	\$ 86.42
<i>Time Period 5</i>	\$ 52.73	\$ 54.73	\$ 56.71
<i>Time Period 6</i>	\$ 73.62	\$ 76.65	\$ 79.63
<b>Zone 2, Market Price \$/MWh</b>			
<i>Time Period 1</i>	\$ 105.18	\$ 108.81	\$ 112.60
<i>Time Period 2</i>	\$ 48.61	\$ 50.27	\$ 51.92
<i>Time Period 3</i>	\$ 65.21	\$ 67.51	\$ 69.90
<i>Time Period 4</i>	\$ 82.90	\$ 86.25	\$ 89.59
<i>Time Period 5</i>	\$ 55.55	\$ 57.60	\$ 59.61
<i>Time Period 6</i>	\$ 74.39	\$ 77.38	\$ 80.33
<b>Zone 3, Market Price \$/MWh</b>			
<i>Time Period 1</i>	\$ 115.16	\$ 119.60	\$ 124.27
<i>Time Period 2</i>	\$ 51.14	\$ 53.03	\$ 54.95
<i>Time Period 3</i>	\$ 69.75	\$ 72.50	\$ 75.46
<i>Time Period 4</i>	\$ 86.79	\$ 90.53	\$ 94.34
<i>Time Period 5</i>	\$ 56.49	\$ 58.70	\$ 60.89
<i>Time Period 6</i>	\$ 75.43	\$ 78.64	\$ 81.84

In this study, the value of capacity from the capacity market to renewable generators is directly included. The capacity market is divided into three zones: Rest of New York, New York City, and Long Island. The latter two are grouped into Megazone 3 in the study. Both Megazone 1 and 2 share the capacity value associated with Rest of NY.

Below are the 20-year levelized values in \$/kW-year for capacity coming on-line in the specified year. A discount rate of 10% was used in the calculation of levelized commodity prices.

**Table 3A-2: Nominal 20-Year Levelized Capacity Prices**

<b>Zone 1, nominal</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>
<i>Capacity Price \$/kW-year</i>	\$ 78.16	\$ 85.45	\$ 95.55
<b>Zone 2, nominal</b>			
<i>Capacity Price \$/kW-year</i>	\$ 78.16	\$ 85.45	\$ 95.55
<b>Zone 3, nominal</b>			
<i>Capacity Price \$/kW-year</i>	\$ 188.07	\$ 180.77	\$ 167.68

NYISO will only give credit for a unit's "reliable" capacity that is available during summer and winter peaks. For dispatchable units, such as those utilizing biomass or landfill gas, the reliable capacity is assumed to be 100% of the rated capacity. For non-dispatchable, or intermittent, units, such as wind and hydro, adjustments were made to reflect their "reliable" capacity. Because wind has lower capacity factors during summer peak periods, the maximum capacity value for wind would be 10% for on-shore wind resources and 35% for wind resources off the shore of Long Island, which is the estimated reliable capacity from NYSERDA's Wind Integration Study.<sup>14</sup> For hydro facilities, the capacity factor applied in this study is equivalent to the "reliable" capacity.

## Resource Specific Levelized Commodity Values

Resource specific generation profiles were developed in earlier cost study work and used to determine the levelized commodity value for each resource block as shown in Table 3A-3. Wind profiles remain unchanged from the 2004 Report, which were based on an analysis of actual New York wind data and a Vestas V47 production curve for Western New York (applied to Zones 1 and 2 as well as off-shore wind in the Great Lakes) and Long Island (applied to Zone 3 wind and Long Island off-shore). Biomass and hydro came from the NYSERDA Technical Assessment. All other New York resources were assumed to be baseload, with production allocated in proportion to the hours in each time period.

**Table 3A-3: Percentage of Annual Resource Output by Time Period**

	Time Period					
	1	2	3	4	5	6
<b>Wind Zone 1</b>	2.4%	31.0%	3.6%	8.3%	46.7%	7.9%
<b>Wind Zone 2</b>	2.4%	31.0%	3.6%	8.3%	46.7%	7.9%
<b>Wind Zone 3</b>	3.2%	28.4%	4.4%	9.1%	45.7%	9.2%
<b>Landfill Gas</b>	4.5%	38.5%	7.4%	5.8%	37.9%	5.8%
<b>Biomass</b>	4.5%	38.4%	7.5%	5.9%	37.8%	5.9%
<b>Biomass CHP</b>	5.9%	36.9%	7.6%	7.4%	36.4%	5.8%
<b>Large Hydro Upgrade</b>	3.7%	32.1%	6.2%	6.9%	44.3%	6.8%
<b>Low-impact/Small Hydro</b>	4.0%	32.0%	6.0%	7.0%	44.0%	7.0%

<sup>14</sup> "The Effects of Integrating Wind Power on Transmission System Planning, Reliability, and Operations. Report on Phase 2: System Performance Evaluation," March 4, 2005  
<[http://www.nysenda.org/publications/wind\\_integration\\_report.pdf](http://www.nysenda.org/publications/wind_integration_report.pdf)>

Table3A-4 shows the levelized commodity value by resource type for the three reference case years. These represent the years that the project will be installed.

**Table 3A-4: Annual Commodity Value by Resource Type per Zone**

Resource Type	Zone	2015	2016	2017
Onshore Wind	1	\$54	\$56	\$59
	2	\$57	\$59	\$62
Offshore Wind	3	\$78	\$79	\$80
Biomass CHP	1	\$64	\$67	\$71
	2	\$67	\$70	\$73
	3	\$85	\$86	\$86
Biomass	1	\$63	\$66	\$70
	2	\$67	\$70	\$73
	3	\$85	\$86	\$86
Hydro-Upgrades	1	\$60	\$63	\$66
	2	\$64	\$66	\$70
	3	\$78	\$80	\$80
Hydro-Small Low Impact	1	\$60	\$63	\$66
	2	\$64	\$66	\$70
	3	\$78	\$80	\$80
Landfill Gas	1	\$63	\$66	\$69
	2	\$66	\$69	\$72
	3	\$83	\$84	\$85

## Supply Curve

The methodology for the supply curve analysis as well as some updates to the supply curve are discussed in Volume 1 and the main body of Volume 3. The following section includes updates to the supply curve as part of this analysis. The major updates include adding solar, updating the biomass assumptions and updating the wind power blocks. Offshore wind is not assumed to be available during the Reference Case analysis time frame, so it is not included in this discussion.

## Solar Blocks

Previous RPS Main Tier cost study analyses did not include solar photovoltaic (PV) sources, as in the past there was no reason to believe that solar PV would be able to contend successfully in Main Tier competitions. As the costs of solar have declined (and are projected in the NY Solar Study to continue to do so), and with New York's solar policy looking to dramatically increase the deployment of solar PV throughout New York, solar PV supply and associated cost projections were added to the supply curve resource potential to allow consideration of whether and how solar PV may play in the RPS Main Tier. Solar blocks added to the supply curve resource potential represent MW-scale projects connected at the grid-level in four geographic locations from the 2012 New York Solar (Solar Study). The REC premium was calculated as the difference between the levelized cost of energy from the Solar Study base case and the wholesale energy and capacity prices developed for the New York State Energy Plan. Cost inputs were taken from the Solar Study and then adjusted assuming a 10-year NYSERDA RPS contract and 30% ITC. Block sizes were based on the Alt-B build-out schedule for grid-connected MW-scale projects developed for the Solar Study. Solar blocks do not clear the market (i.e., get called upon as economic responses to Main Tier solicitations) in this analysis.

## Biomass Updates

The update to the biomass resources focused on several areas: biomass fuel cost and supply; potential for biomass energy generation at existing and retired fossil generators and the cost of biomass energy generation, which are summarized as follows.

## Biomass Fuel Costs

The previous iterations of the cost study model rely on a biomass fuel supply curve that is comprised of blocks of volumes of biomass fuel sources at various prices. That fuel supply curve was based on biomass fuel data from a report completed by Antares Group in 1999.<sup>15</sup> For this update, Antares Group compared the quantities and prices of fuel from the 1999 report to similar data in the NYSERDA Renewable Fuels Roadmap completed in 2010,<sup>16,17</sup> (2010 Roadmap). This more recent report also utilized a more sophisticated New York specific method to calculate fuel quantities and prices. The end result of the comparison suggested that the prices used in the previous cost curve continue to be appropriate, but the available fuel quantities from the prior study appeared about 20 % too high. Therefore, for this analysis the available quantity of biomass fuel was reduced by 20%.

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<sup>15</sup> Antares Group Inc. *Biomass Residue Supply Curves for the United States*. U.S. Department of Energy Biomass Power Program and NREL. June 1999.

<sup>16</sup> Pace University Energy and Climate Center and Cornell University. *Renewable Fuels Roadmap and Sustainable Biomass*

<sup>17</sup> *Feedstock Supply for New York*. Prepared for NYSERDA; April 2010.  
<http://www.nysenda.ny.gov/sitecore/content/Home/Publications/Research-and-Development-Technical-Reports/Biomass-Reports/Renewable-Fuels-Roadmap.aspx>.

## Biomass Generation Potential

The potential for biomass energy generation is governed by both the availability of biomass fuel and by the potential sites for generation. The potential biomass generation resources modeled in the RPS supply curve include the following technologies:

- Co-firing at existing coal plants.
- Gasification CHP (Repower) fixed bed steam (no need for fluidized bed).
- Gasification CHP (New).
- Repowering former steam units with FB Boilers.
- Greenfield Stoker with SCR.

Due to recent changes to air emission regulations and the drop in natural gas prices, there have been retirements in the fleet of fossil resources, which has reduced the potential stock of coal power plants available for co-firing, as well as the stock of candidate repowering CHP opportunities and existing and former steam units. The potential for these technologies used in prior cost study updates was based upon existing generator data in the NYISO Gold Book at the time. The resource potential used in this cost study update has been updated to reflect updated data on the current power plant fleet in the 2012 Gold Book. While some co-firing potential theoretically remains, the co-firing potential was reduced to zero due to the uncertain future of many coal plants driven by both the pending U.S. Environmental Protection Agency regulations and the lack of project conversion activity visible in the development pipeline.

The potential for Greenfield Biomass was also reduced by 20% to reflect the reduced fuel quantity in the biomass supply curve. Table 3A-5 shows the adjusted potential.

## Biomass Costs

The installed costs and capacity factors were adjusted for some technologies. The installed cost of the biomass stoker was adjusted down by 10% and the cost of co-firing was adjusted up by 10 percent to reflect the latest industry experience. The capacity factors of the stoker and repower categories were also adjusted downward for the same reason. Table 3A-5 shows the updated costs and capacity factors.

Table 3A-5. Biomass Potential and Cost Changes

	Zone	Capacity Factor		MW Potential		Capital Costs (2011 dollars)	
		Old Value	Updated Value	Old Value	Updated Value	Old Value	Updated Value
<b>CHP Existing</b>	1	80%	80%	96	30	\$3,500	\$3,500
<b>CHP New</b>	1	80%	80%	58	46	\$4,700	\$4,700
<b>Co-firing w/Coal NY</b>	1	70%	70%	76.975	0	\$375	\$413
<b>Stoker NY</b>	1	85%	80%	431	345	\$4,250	\$3,900
<b>Fluidized Bed Repower Existing</b>	1	85%	80%	286.275	122.525	\$1,300	\$1,300
<b>Fluidized Bed Repower Retire</b>	1	85%	80%	45.65	186.575	\$1,100	\$1,100
<b>CHP Existing</b>	2	80%	80%	4	5	\$6,450	\$6,450
<b>CHP New</b>	2	80%	80%	0	0	\$4,700	\$4,700
<b>Co-firing w/Coal NY</b>	2	70%	70%	29.12	0	\$375	\$413
<b>Stoker NY</b>	2	85%	80%	500	400	\$4,250	\$3,900
<b>Fluidized Bed Repower Existing</b>	2	85%	80%	62.425	48.675	\$1,300	\$1,300
<b>Fluidized Bed Repower Retire</b>	2	85%	80%	217.25	122.375	\$1,100	\$1,100
<b>CHP Existing</b>	3	80%	80%	89	79	\$3,500	\$3,500
<b>CHP New</b>	3	80%	80%	59	47	\$4,700	\$4,700
<b>Co-firing w/Coal NY</b>	3	55%	55%	0	0	\$375	\$413
<b>Stoker NY</b>	3	80%	80%	0	0	\$4,250	\$3,900
<b>Fluidized Bed Repower Existing</b>	3	85%	80%	131.75	131.75	\$1,300	\$1,300
<b>Fluidized Bed Repower Retire</b>	3	85%	80%	48.45	24.225	\$1,100	\$1,100

## Onshore Wind Blocks

Onshore wind blocks were grouped into four size categories:

- Small projects less than 20 MW.
- Medium projects between 20-100 MW.
- Large projects more than 100 MW.
  - >100 MW (large).
  - >200 MW (very large) blocks.

The large (>100 MW) blocks dominate the supply that is called upon in the model results, and are modeled as 100 MW projects, even though the land area used to calculate block potential is able to handle much larger projects. These projects average 100 MW, which can be thought of as an average of 75 MW and 125 MW projects, consistent with a spread of projects within that range which dominate the current interconnection queue.

Some of the resource potential formerly in the large (>100 MW) wind blocks was reallocated to create supply blocks representing very large wind projects in Upstate New York (assuming an average project size of 200 MW.) The overnight capital costs for these larger resource blocks include a transmission adder of \$250/kW as a proxy for upstream transmission upgrades required to integrate these sources of supply injected within constrained locations on the grid.

A review of current analyses and operating experience supports continued expectations for decreases in installed cost and increases in performance.<sup>18</sup> Therefore, onshore wind capital costs were adjusted from the March 2012 analysis by adjusting the installed cost and capacity factors of additional supply curve blocks to correspond to the use of taller towers, longer blades and low wind-speed technologies becoming ubiquitous throughout the region. For this analysis, all resource blocks having less robust wind resources were modeled as having 100m rotor diameter and having a height of 100 meters (m) to the rotor hub. Capacity factor and capital costs increased as a result of the change. For those resource blocks in higher wind speed locations, turbines were assumed to have a 100 m rotor diameter and a height of 90 m to the rotor hub. Resource blocks in the highest wind speed locations were assumed to have a 100 m rotor diameter and a height of 80 m to the rotor hub. The MW resource potential of each resource block was estimated by assessing available land and power density, derating based on a permitting success factor of 10%, and removing resource potential corresponding to any projects that are operating or under construction.

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<sup>18</sup> Wisner, R.; Lantz, E.; Bolinger, M.; Hand, M. 2012. *Recent Developments in the Levelized Cost of Energy From U.S. Wind Power Projects*. Lawrence Berkeley National Laboratory, Berkeley, CA. <http://eetd.lbl.gov/ea/ems/reports/wind-energy-costs-2-2012.pdf>

The onshore wind cost and potential assumptions are shown in Table 3A-6.

**Table 3A-6. Onshore Wind Potential and Cost Assumptions**

Resource Block	Capacity Factor	Maximum MW in Block	Modeled Project Size (MW)	Total Installed Cost (2011\$/kW of rated max output)	Fixed O&M (2011\$/kw-yr)	Variable O&M Costs (2011\$/MWh)	Transmission Cost Adder (2011\$/kw)
Wind Small Zone1 P3T1	30%	488	10	\$ 2,838	\$ 70	\$ 0.57	\$ 96.89
Wind Small Zone2 P3T1	32%	117	10	\$ 2,838	\$ 70	\$ 0.57	\$ 96.89
Wind Small Zone1 P3T2	30%	106	10	\$ 2,838	\$ 70	\$ 0.57	\$ 290.66
Wind Small Zone2 P3T2	32%	19	10	\$ 2,838	\$ 70	\$ 0.57	\$ 290.66
Wind Small Zone1 P3T3	30%	85	10	\$ 2,838	\$ 70	\$ 0.57	\$ 581.31
Wind Small Zone2 P3T3	32%	16	10	\$ 2,838	\$ 70	\$ 0.57	\$ 581.31
Wind Small Zone1 P3T4	30%	4	10	\$ 2,838	\$ 70	\$ 0.57	\$ 1,162.63
Wind Small Zone2 P3T4	32%	11	10	\$ 2,838	\$ 70	\$ 0.57	\$ 1,162.63
Wind Small Zone1 P4T1	32%	96	10	\$ 2,838	\$ 70	\$ 0.57	\$ 96.89
Wind Small Zone2 P4T1	35%	81	10	\$ 2,838	\$ 70	\$ 0.57	\$ 96.89
Wind Small Zone1 P4T2	32%	95	10	\$ 2,838	\$ 70	\$ 0.57	\$ 290.66
Wind Small Zone2 P4T2	35%	18	10	\$ 2,838	\$ 70	\$ 0.57	\$ 290.66
Wind Small Zone1 P4T3	32%	52	10	\$ 2,838	\$ 70	\$ 0.57	\$ 581.31
Wind Small Zone2 P4T3	35%	6	10	\$ 2,838	\$ 70	\$ 0.57	\$ 581.31
Wind Small Zone1 P4T4	32%	1	10	\$ 2,838	\$ 70	\$ 0.57	\$ 1,162.63
Wind Small Zone2 P4T4	35%	7	10	\$ 2,838	\$ 70	\$ 0.57	\$ 1,162.63
Wind Small Zone1 P5T1	30%	23	10	\$ 2,686	\$ 70	\$ 0.57	\$ 96.89
Wind Small Zone2 P5T1	33%	14	10	\$ 2,686	\$ 70	\$ 0.57	\$ 96.89
Wind Small Zone1 P5T2	30%	19	10	\$ 2,686	\$ 70	\$ 0.57	\$ 290.66
Wind Small Zone2 P5T2	33%	6	10	\$ 2,686	\$ 70	\$ 0.57	\$ 290.66
Wind Small Zone1 P5T3	30%	19	10	\$ 2,686	\$ 70	\$ 0.57	\$ 581.31
Wind Small Zone2 P5T3	33%	3	10	\$ 2,686	\$ 70	\$ 0.57	\$ 581.31
Wind Small Zone2 P5T4	33%	1	10	\$ 2,686	\$ 70	\$ 0.57	\$ 1,162.63
Wind Small Zone1 P6T1	30%	39	10	\$ 2,584	\$ 70	\$ 0.57	\$ 96.89
Wind Small Zone2 P6T1	34%	13	10	\$ 2,584	\$ 70	\$ 0.57	\$ 96.89
Wind Small Zone1 P6T2	30%	9	10	\$ 2,584	\$ 70	\$ 0.57	\$ 290.66
Wind Small Zone2 P6T2	34%	2	10	\$ 2,584	\$ 70	\$ 0.57	\$ 290.66
Wind Small Zone1 P6T3	30%	32	10	\$ 2,584	\$ 70	\$ 0.57	\$ 581.31
Wind Small Zone2 P6T3	34%	5	10	\$ 2,584	\$ 70	\$ 0.57	\$ 581.31
Wind Medium Zone1 P3T1	30%	0	60	\$ 2,291	\$ 66	\$ 0.57	\$ 88.27
Wind Medium Zone2 P3T1	32%	67	60	\$ 2,291	\$ 66	\$ 0.57	\$ 88.27
Wind Medium Zone1 P3T3	30%	20	60	\$ 2,291	\$ 66	\$ 0.57	\$ 335.87
Wind Medium Zone1 P4T1	32%	0	60	\$ 2,291	\$ 66	\$ 0.57	\$ 88.27
Wind Medium Zone2 P4T1	35%	149	60	\$ 2,291	\$ 66	\$ 0.57	\$ 88.27
Wind Medium Zone1 P4T3	32%	9	60	\$ 2,291	\$ 66	\$ 0.57	\$ 335.87
Wind Medium Zone1 P5T1	30%	0	60	\$ 2,168	\$ 66	\$ 0.57	\$ 88.27
Wind Medium Zone2 P5T1	33%	19	60	\$ 2,168	\$ 66	\$ 0.57	\$ 88.27
Wind Medium Zone1 P5T3	30%	4	60	\$ 2,168	\$ 66	\$ 0.57	\$ 335.87
Wind Medium Zone1 P6T1	30%	8	60	\$ 2,085	\$ 66	\$ 0.57	\$ 88.27
Wind Medium Zone2 P6T1	34%	11	60	\$ 2,085	\$ 66	\$ 0.57	\$ 88.27
Wind Medium Zone1 P6T3	30%	3	60	\$ 2,085	\$ 66	\$ 0.57	\$ 335.87
Wind Large Zone1 P3T1A	30%	714	100	\$ 2,027	\$ 66	\$ 0.57	\$ 88.27
Wind Large Zone1 P3T1B	30%	1893	200	\$ 2,027	\$ 66	\$ 0.57	\$ 338.27
Wind Large Zone2 P3T1	32%	133	100	\$ 2,027	\$ 66	\$ 0.57	\$ 88.27
Wind Large Zone1 P4T1A	32%	5361	100	\$ 2,027	\$ 66	\$ 0.57	\$ 88.27
Wind Large Zone1 P4T1B	32%	5361	200	\$ 2,027	\$ 66	\$ 0.57	\$ 338.27
Wind Large Zone2 P4T1	35%	205	100	\$ 2,027	\$ 66	\$ 0.57	\$ 88.27
Wind Large Zone1 P5T1A	30%	591	100	\$ 1,917	\$ 66	\$ 0.57	\$ 88.27
Wind Large Zone1 P5T1B	30%	1197	200	\$ 1,917	\$ 66	\$ 0.57	\$ 338.27
Wind Large Zone2 P5T1	33%	26	100	\$ 1,917	\$ 66	\$ 0.57	\$ 88.27
Wind Large Zone1 P6T1A	30%	199	100	\$ 1,844	\$ 66	\$ 0.57	\$ 88.27
Wind Large Zone1 P6T1B	30%	199	200	\$ 1,844	\$ 66	\$ 0.57	\$ 338.27
Wind Large Zone2 P6T1	34%	3	100	\$ 1,844	\$ 66	\$ 0.57	\$ 88.27

# Levelized Costs

The levelized costs calculated for each supply block and sensitivity are include in Tables 3A-7 and 3A-8.

**Table 3A-7: Wind Resources, Levelized Costs by Sensitivity**

Resource Block	Resource Type	Zone	Base (Full PTC/No Improvements)			Sensitivity 1 (PTC Phase Out/Improvements)			Sensitivity 2 (Full PTC/Improvements)			Sensitivity 3 (PTC Phase Out/No Improvements)		
			2015	2016	2017	2015	2016	2017	2015	2016	2017	2015	2016	2017
Wind Small Zone1 P3T1	<20 MW	1	\$ 138	\$ 141	\$ 143	\$ 139	\$ 143	\$ 147	\$ 132	\$ 133	\$ 133	\$ 144	\$ 151	\$ 158
Wind Small Zone2 P3T1	<20 MW	2	\$ 127	\$ 130	\$ 132	\$ 129	\$ 133	\$ 136	\$ 122	\$ 122	\$ 122	\$ 134	\$ 140	\$ 146
Wind Small Zone1 P3T2	<20 MW	1	\$ 147	\$ 150	\$ 153	\$ 148	\$ 153	\$ 156	\$ 141	\$ 142	\$ 142	\$ 153	\$ 161	\$ 167
Wind Small Zone2 P3T2	<20 MW	2	\$ 135	\$ 138	\$ 141	\$ 137	\$ 141	\$ 145	\$ 130	\$ 131	\$ 131	\$ 142	\$ 149	\$ 155
Wind Small Zone1 P3T3	<20 MW	1	\$ 160	\$ 164	\$ 167	\$ 162	\$ 167	\$ 171	\$ 155	\$ 156	\$ 156	\$ 167	\$ 174	\$ 181
Wind Small Zone2 P3T3	<20 MW	2	\$ 148	\$ 151	\$ 154	\$ 150	\$ 154	\$ 158	\$ 143	\$ 144	\$ 144	\$ 155	\$ 162	\$ 168
Wind Small Zone1 P3T4	<20 MW	1	\$ 187	\$ 192	\$ 195	\$ 189	\$ 194	\$ 199	\$ 182	\$ 184	\$ 184	\$ 194	\$ 202	\$ 210
Wind Small Zone2 P3T4	<20 MW	2	\$ 173	\$ 177	\$ 181	\$ 175	\$ 180	\$ 185	\$ 168	\$ 170	\$ 171	\$ 180	\$ 188	\$ 195
Wind Small Zone1 P4T1	<20 MW	1	\$ 124	\$ 127	\$ 130	\$ 126	\$ 131	\$ 134	\$ 120	\$ 120	\$ 120	\$ 131	\$ 138	\$ 144
Wind Small Zone2 P4T1	<20 MW	2	\$ 113	\$ 116	\$ 118	\$ 116	\$ 120	\$ 123	\$ 109	\$ 109	\$ 109	\$ 120	\$ 126	\$ 132
Wind Small Zone1 P4T2	<20 MW	1	\$ 133	\$ 136	\$ 138	\$ 135	\$ 139	\$ 143	\$ 128	\$ 129	\$ 128	\$ 140	\$ 146	\$ 153
Wind Small Zone2 P4T2	<20 MW	2	\$ 121	\$ 124	\$ 126	\$ 123	\$ 127	\$ 131	\$ 116	\$ 117	\$ 117	\$ 128	\$ 134	\$ 140
Wind Small Zone1 P4T3	<20 MW	1	\$ 145	\$ 149	\$ 151	\$ 147	\$ 152	\$ 156	\$ 140	\$ 141	\$ 141	\$ 152	\$ 159	\$ 166
Wind Small Zone2 P4T3	<20 MW	2	\$ 133	\$ 136	\$ 138	\$ 135	\$ 139	\$ 143	\$ 128	\$ 129	\$ 129	\$ 139	\$ 146	\$ 152
Wind Small Zone1 P4T4	<20 MW	1	\$ 170	\$ 174	\$ 177	\$ 172	\$ 178	\$ 182	\$ 166	\$ 167	\$ 168	\$ 177	\$ 185	\$ 192
Wind Small Zone2 P4T4	<20 MW	2	\$ 156	\$ 160	\$ 162	\$ 158	\$ 163	\$ 168	\$ 151	\$ 153	\$ 153	\$ 163	\$ 170	\$ 177
Wind Small Zone1 P5T1	<20 MW	1	\$ 131	\$ 134	\$ 136	\$ 132	\$ 137	\$ 140	\$ 126	\$ 126	\$ 126	\$ 137	\$ 144	\$ 150
Wind Small Zone2 P5T1	<20 MW	2	\$ 114	\$ 116	\$ 118	\$ 116	\$ 120	\$ 124	\$ 109	\$ 110	\$ 109	\$ 121	\$ 127	\$ 133
Wind Small Zone1 P5T2	<20 MW	1	\$ 140	\$ 143	\$ 145	\$ 141	\$ 146	\$ 150	\$ 135	\$ 135	\$ 135	\$ 146	\$ 153	\$ 160
Wind Small Zone2 P5T2	<20 MW	2	\$ 122	\$ 125	\$ 127	\$ 124	\$ 128	\$ 132	\$ 117	\$ 118	\$ 118	\$ 129	\$ 135	\$ 141
Wind Small Zone1 P5T3	<20 MW	1	\$ 153	\$ 157	\$ 160	\$ 155	\$ 160	\$ 164	\$ 148	\$ 149	\$ 149	\$ 160	\$ 167	\$ 174
Wind Small Zone2 P5T3	<20 MW	2	\$ 134	\$ 137	\$ 140	\$ 136	\$ 141	\$ 145	\$ 130	\$ 130	\$ 131	\$ 141	\$ 148	\$ 154
Wind Small Zone1 P5T4	<20 MW	2	\$ 158	\$ 162	\$ 165	\$ 161	\$ 166	\$ 170	\$ 154	\$ 155	\$ 156	\$ 165	\$ 173	\$ 179
Wind Small Zone1 P6T1	<20 MW	1	\$ 122	\$ 125	\$ 127	\$ 124	\$ 128	\$ 132	\$ 117	\$ 118	\$ 118	\$ 129	\$ 135	\$ 141
Wind Small Zone2 P6T1	<20 MW	2	\$ 104	\$ 106	\$ 108	\$ 106	\$ 110	\$ 114	\$ 100	\$ 100	\$ 100	\$ 111	\$ 117	\$ 122
Wind Small Zone1 P6T2	<20 MW	1	\$ 131	\$ 134	\$ 136	\$ 133	\$ 137	\$ 141	\$ 126	\$ 127	\$ 127	\$ 138	\$ 144	\$ 151
Wind Small Zone2 P6T2	<20 MW	2	\$ 111	\$ 114	\$ 116	\$ 114	\$ 118	\$ 122	\$ 107	\$ 108	\$ 108	\$ 118	\$ 125	\$ 130
Wind Small Zone1 P6T3	<20 MW	1	\$ 144	\$ 147	\$ 150	\$ 146	\$ 151	\$ 155	\$ 139	\$ 140	\$ 141	\$ 151	\$ 158	\$ 164
Wind Small Zone2 P6T3	<20 MW	2	\$ 123	\$ 126	\$ 128	\$ 126	\$ 130	\$ 134	\$ 119	\$ 120	\$ 120	\$ 130	\$ 137	\$ 143
Wind Medium Zone1 P3T1	20-100 MW	1	\$ 110	\$ 113	\$ 115	\$ 113	\$ 117	\$ 120	\$ 106	\$ 106	\$ 106	\$ 117	\$ 123	\$ 129
Wind Medium Zone2 P3T1	20-100 MW	2	\$ 101	\$ 103	\$ 105	\$ 104	\$ 108	\$ 111	\$ 97	\$ 97	\$ 97	\$ 108	\$ 114	\$ 120
Wind Medium Zone1 P3T3	20-100 MW	1	\$ 122	\$ 124	\$ 127	\$ 124	\$ 129	\$ 132	\$ 117	\$ 118	\$ 118	\$ 128	\$ 135	\$ 141
Wind Medium Zone1 P4T1	20-100 MW	1	\$ 99	\$ 101	\$ 103	\$ 102	\$ 106	\$ 110	\$ 95	\$ 95	\$ 95	\$ 106	\$ 112	\$ 118
Wind Medium Zone2 P4T1	20-100 MW	2	\$ 90	\$ 92	\$ 93	\$ 93	\$ 97	\$ 100	\$ 86	\$ 86	\$ 86	\$ 96	\$ 102	\$ 108
Wind Medium Zone1 P4T3	20-100 MW	1	\$ 110	\$ 112	\$ 114	\$ 113	\$ 117	\$ 121	\$ 106	\$ 106	\$ 106	\$ 117	\$ 123	\$ 129
Wind Medium Zone1 P5T1	20-100 MW	1	\$ 104	\$ 107	\$ 109	\$ 107	\$ 111	\$ 115	\$ 100	\$ 101	\$ 100	\$ 111	\$ 117	\$ 123
Wind Medium Zone2 P5T1	20-100 MW	2	\$ 90	\$ 92	\$ 94	\$ 93	\$ 97	\$ 101	\$ 87	\$ 87	\$ 87	\$ 97	\$ 103	\$ 108
Wind Medium Zone1 P5T3	20-100 MW	1	\$ 116	\$ 119	\$ 121	\$ 119	\$ 123	\$ 127	\$ 112	\$ 112	\$ 113	\$ 123	\$ 129	\$ 135
Wind Medium Zone1 P6T1	20-100 MW	1	\$ 97	\$ 100	\$ 101	\$ 100	\$ 104	\$ 108	\$ 93	\$ 94	\$ 94	\$ 104	\$ 110	\$ 116
Wind Medium Zone2 P6T1	20-100 MW	2	\$ 82	\$ 84	\$ 85	\$ 85	\$ 89	\$ 93	\$ 79	\$ 79	\$ 78	\$ 89	\$ 94	\$ 100
Wind Medium Zone1 P6T3	20-100 MW	1	\$ 109	\$ 111	\$ 113	\$ 112	\$ 116	\$ 120	\$ 105	\$ 105	\$ 105	\$ 115	\$ 122	\$ 127
Wind Large Zone1 P3T1A	>100 MW	1	\$ 91	\$ 93	\$ 95	\$ 95	\$ 99	\$ 102	\$ 88	\$ 88	\$ 88	\$ 98	\$ 104	\$ 109
Wind Large Zone1 P3T1B	>200 MW	1	\$ 102	\$ 105	\$ 106	\$ 106	\$ 110	\$ 114	\$ 99	\$ 99	\$ 99	\$ 109	\$ 115	\$ 121
Wind Large Zone2 P3T1	>100 MW	2	\$ 83	\$ 85	\$ 87	\$ 87	\$ 91	\$ 94	\$ 80	\$ 80	\$ 80	\$ 90	\$ 96	\$ 101
Wind Large Zone1 P4T1A	>100 MW	1	\$ 82	\$ 84	\$ 85	\$ 85	\$ 89	\$ 93	\$ 78	\$ 79	\$ 78	\$ 89	\$ 94	\$ 99
Wind Large Zone1 P4T1B	>200 MW	1	\$ 92	\$ 94	\$ 96	\$ 95	\$ 100	\$ 103	\$ 89	\$ 89	\$ 89	\$ 99	\$ 104	\$ 110
Wind Large Zone2 P4T1	>100 MW	2	\$ 73	\$ 75	\$ 76	\$ 77	\$ 81	\$ 85	\$ 70	\$ 71	\$ 70	\$ 80	\$ 86	\$ 91
Wind Large Zone1 P5T1A	>100 MW	1	\$ 87	\$ 89	\$ 90	\$ 90	\$ 94	\$ 98	\$ 83	\$ 83	\$ 83	\$ 93	\$ 99	\$ 105
Wind Large Zone1 P5T1B	>200 MW	1	\$ 97	\$ 100	\$ 101	\$ 101	\$ 105	\$ 109	\$ 94	\$ 95	\$ 95	\$ 104	\$ 110	\$ 116
Wind Large Zone2 P5T1	>100 MW	2	\$ 74	\$ 76	\$ 77	\$ 78	\$ 82	\$ 86	\$ 71	\$ 71	\$ 71	\$ 81	\$ 87	\$ 92
Wind Large Zone1 P6T1A	>100 MW	1	\$ 81	\$ 82	\$ 84	\$ 84	\$ 88	\$ 92	\$ 77	\$ 78	\$ 78	\$ 87	\$ 93	\$ 98
Wind Large Zone1 P6T1B	>200 MW	1	\$ 91	\$ 93	\$ 95	\$ 95	\$ 99	\$ 103	\$ 88	\$ 89	\$ 89	\$ 98	\$ 104	\$ 109
Wind Large Zone2 P6T1	>100 MW	2	\$ 67	\$ 69	\$ 70	\$ 71	\$ 75	\$ 79	\$ 64	\$ 64	\$ 64	\$ 74	\$ 79	\$ 84

**Table 3A-8: Other Resources Levelized Costs by Sensitivity**

Resource Block	Resource Type	Zone	Base (Full PTC/No Improvements)			Sensitivity 1 (PTC Phase Out/Improvements)			Sensitivity 2 (Full PTC/Improvements)			Sensitivity 3 (PTC Phase Out/No Improvements)		
			2015	2016	2017	2015	2016	2017	2015	2016	2017	2015	2016	2017
Biomass CHP Existing NY z1	Biomass (Zone 1)	1	\$ 133	\$ 136	\$ 138	\$ 133	\$ 136	\$ 138	\$ 133	\$ 136	\$ 138	\$ 133	\$ 136	\$ 138
Biomass CHP New NY z1	Biomass (Zone 1)	1	\$ 157	\$ 160	\$ 162	\$ 157	\$ 160	\$ 162	\$ 157	\$ 160	\$ 162	\$ 157	\$ 160	\$ 162
Biomass Co-firing w/Coal NY-z1	Biomass (Zone 1)	1	\$ 35	\$ 35	\$ 36	\$ 35	\$ 35	\$ 36	\$ 35	\$ 35	\$ 36	\$ 35	\$ 35	\$ 36
Biomass Stoker NY z1	Biomass (Zone 1)	1	\$ 159	\$ 163	\$ 166	\$ 162	\$ 168	\$ 173	\$ 159	\$ 163	\$ 166	\$ 162	\$ 168	\$ 173
Fluidized Bed Repower Existing NY z1	Biomass (Zone 1)	1	\$ 108	\$ 110	\$ 113	\$ 111	\$ 116	\$ 120	\$ 108	\$ 110	\$ 113	\$ 111	\$ 116	\$ 120
Fluidized Bed Repower Retire NY z1	Biomass (Zone 1)	1	\$ 103	\$ 106	\$ 108	\$ 107	\$ 111	\$ 115	\$ 103	\$ 106	\$ 108	\$ 107	\$ 111	\$ 115
Biomass CHP Existing NY z2	Biomass (Zone 2)	2	\$ 280	\$ 289	\$ 298	\$ 280	\$ 289	\$ 298	\$ 280	\$ 289	\$ 298	\$ 280	\$ 289	\$ 298
Biomass CHP New NY z2	Biomass (Zone 2)	2	\$ 191	\$ 197	\$ 202	\$ 191	\$ 197	\$ 202	\$ 191	\$ 197	\$ 202	\$ 191	\$ 197	\$ 202
Biomass Co-firing w/Coal NY-z2	Biomass (Zone 2)	2	\$ 57	\$ 60	\$ 63	\$ 57	\$ 60	\$ 63	\$ 57	\$ 60	\$ 63	\$ 57	\$ 60	\$ 63
Biomass Stoker NY z2	Biomass (Zone 2)	2	\$ 184	\$ 190	\$ 196	\$ 188	\$ 195	\$ 203	\$ 184	\$ 190	\$ 196	\$ 188	\$ 195	\$ 203
Fluidized Bed Repower Existing NY z2	Biomass (Zone 2)	2	\$ 135	\$ 140	\$ 144	\$ 138	\$ 145	\$ 152	\$ 135	\$ 140	\$ 144	\$ 138	\$ 144	\$ 152
Fluidized Bed Repower Retire NY z2	Biomass (Zone 2)	2	\$ 130	\$ 135	\$ 140	\$ 134	\$ 140	\$ 147	\$ 130	\$ 135	\$ 140	\$ 134	\$ 140	\$ 147
Biomass CHP Existing NY z3	Biomass (Zone 3)	3	\$ 275	\$ 281	\$ 286	\$ 275	\$ 281	\$ 286	\$ 275	\$ 281	\$ 286	\$ 275	\$ 281	\$ 286
Biomass CHP New NY z3	Biomass (Zone 3)	3	\$ 299	\$ 305	\$ 311	\$ 299	\$ 305	\$ 311	\$ 299	\$ 305	\$ 311	\$ 299	\$ 305	\$ 311
Biomass Co-firing w/Coal NY-z3	Biomass (Zone 3)	3	\$ 132	\$ 135	\$ 138	\$ 132	\$ 135	\$ 138	\$ 132	\$ 135	\$ 138	\$ 132	\$ 135	\$ 138
Biomass Stoker NY z3	Biomass (Zone 3)	3	\$ 265	\$ 271	\$ 276	\$ 268	\$ 276	\$ 284	\$ 265	\$ 271	\$ 276	\$ 268	\$ 276	\$ 284
Fluidized Bed Repower Existing NY z3	Biomass (Zone 3)	3	\$ 220	\$ 225	\$ 230	\$ 223	\$ 230	\$ 237	\$ 220	\$ 225	\$ 230	\$ 223	\$ 230	\$ 237
Fluidized Bed Repower Retire NY z3	Biomass (Zone 3)	3	\$ 215	\$ 220	\$ 225	\$ 219	\$ 226	\$ 233	\$ 215	\$ 220	\$ 225	\$ 219	\$ 226	\$ 233
New Low-Impact Hydro NY z1	Hydro (new low-impact <30MW ROR)	1	\$ 159	\$ 162	\$ 165	\$ 159	\$ 162	\$ 165	\$ 159	\$ 162	\$ 165	\$ 159	\$ 162	\$ 165
New Low-Impact Hydro NY z2	Hydro (new low-impact <30MW ROR)	2	\$ 159	\$ 162	\$ 165	\$ 159	\$ 162	\$ 165	\$ 159	\$ 162	\$ 165	\$ 159	\$ 162	\$ 165
New Low-Impact Hydro NY z3	Hydro (new low-impact <30MW ROR)	3	\$ 159	\$ 162	\$ 165	\$ 159	\$ 162	\$ 165	\$ 159	\$ 162	\$ 165	\$ 159	\$ 162	\$ 165
Hydro Upgrades NY z1	Hydro (upgrades)	1	\$ 81	\$ 83	\$ 84	\$ 88	\$ 93	\$ 99	\$ 81	\$ 83	\$ 84	\$ 88	\$ 93	\$ 99
Hydro Upgrades NY z2	Hydro (upgrades)	2	\$ 81	\$ 83	\$ 84	\$ 88	\$ 93	\$ 99	\$ 81	\$ 83	\$ 84	\$ 88	\$ 93	\$ 99
Hydro Upgrades NY z3	Hydro (upgrades)	3	\$ 81	\$ 83	\$ 84	\$ 88	\$ 93	\$ 99	\$ 81	\$ 83	\$ 84	\$ 88	\$ 93	\$ 99
Very Small New Hydro NY z1	Hydro (very small new)	1	\$ 326	\$ 333	\$ 340	\$ 326	\$ 333	\$ 340	\$ 326	\$ 333	\$ 340	\$ 326	\$ 333	\$ 340
Very Small New Hydro NY z2	Hydro (very small new)	2	\$ 326	\$ 333	\$ 340	\$ 326	\$ 333	\$ 340	\$ 326	\$ 333	\$ 340	\$ 326	\$ 333	\$ 340
Very Small New Hydro NY z3	Hydro (very small new)	3	\$ 326	\$ 333	\$ 340	\$ 326	\$ 333	\$ 340	\$ 326	\$ 333	\$ 340	\$ 326	\$ 333	\$ 340
Landfill Gas IC Engines NY z1	Landfill Gas	1	\$ 63	\$ 64	\$ 66	\$ 66	\$ 70	\$ 73	\$ 63	\$ 64	\$ 66	\$ 66	\$ 70	\$ 73
Landfill Gas IC Engines NY z2	Landfill Gas	2	\$ 68	\$ 69	\$ 71	\$ 71	\$ 75	\$ 78	\$ 68	\$ 69	\$ 71	\$ 71	\$ 75	\$ 78
Landfill Gas IC Engines NY z3	Landfill Gas	3	\$ 95	\$ 97	\$ 99	\$ 98	\$ 102	\$ 106	\$ 95	\$ 97	\$ 99	\$ 98	\$ 102	\$ 106
Landfill Gas Microturbines NY z1	Landfill Gas	1	\$ 117	\$ 119	\$ 122	\$ 120	\$ 125	\$ 129	\$ 117	\$ 119	\$ 122	\$ 120	\$ 125	\$ 129
Landfill Gas Microturbines NY z2	Landfill Gas	2	\$ 119	\$ 121	\$ 124	\$ 122	\$ 127	\$ 131	\$ 119	\$ 121	\$ 124	\$ 122	\$ 127	\$ 131
Landfill Gas Microturbines NY z3	Landfill Gas	3	\$ 127	\$ 129	\$ 132	\$ 130	\$ 135	\$ 139	\$ 127	\$ 129	\$ 132	\$ 130	\$ 135	\$ 139
Upstate MW Scale	Solar	1	\$ 302	\$ 293	\$ 285	\$ 302	\$ 293	\$ 285	\$ 302	\$ 293	\$ 285	\$ 302	\$ 293	\$ 285
Capital MW Scale	Solar	2	\$ 291	\$ 283	\$ 275	\$ 291	\$ 283	\$ 275	\$ 291	\$ 283	\$ 275	\$ 291	\$ 283	\$ 275
Downstate MW-Scale	Solar	3	\$ 278	\$ 270	\$ 263	\$ 278	\$ 270	\$ 263	\$ 278	\$ 270	\$ 263	\$ 278	\$ 270	\$ 263
NYC MW Scale	Solar	3	\$ 299	\$ 291	\$ 283	\$ 299	\$ 291	\$ 283	\$ 299	\$ 291	\$ 283	\$ 299	\$ 291	\$ 283
Long Island MW Scale	Solar	3	\$ 288	\$ 280	\$ 273	\$ 288	\$ 280	\$ 273	\$ 288	\$ 280	\$ 273	\$ 288	\$ 280	\$ 273

NYSERDA, a public benefit corporation, offers objective information and analysis, innovative programs, technical expertise and funding to help New Yorkers increase energy efficiency, save money, use renewable energy, and reduce their reliance on fossil fuels. NYSERDA professionals work to protect our environment and create clean-energy jobs. NYSERDA has been developing partnerships to advance innovative energy solutions in New York since 1975.

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**State of New York**  
Andrew M. Cuomo, Governor

# NYSERDA

## Renewable Portfolio Standard

### Main Tier 2013 Program Review

Volume 3 – Projected Impacts from Using  
Available Uncommitted Funds

Final Report  
September 5, 2013

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