New York State Energy Research and Development Authority

NYSERDA
Renewable Portfolio Standard Main Tier 2013 Program Review

Volume 3 — Projected Impacts from Using Available Uncommitted Funds

Final Report

September 5, 2013

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Prepared by:

New York State Energy Research and Development Authority
Albany, NY

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Executive Summary

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.[1] 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. [2]

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.[3]

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1 *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.

2 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.

3 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.[4] 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.[5] 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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4 *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.

5 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[6] 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.

[6] 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

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.[7] 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

7 New York State Department of Public Service, NSYERDA, 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.[8]

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.

[8] 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)

Sensitivity	2013	2014	2015	Total
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)

Sensitivity	2013	2014	2015
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
Landfill Gas	314	45	45	134	90	90	134	90	90	314	45	45
Hydro	104	104	104	0	104	52	0	104	52	104	104	104
On-Shore Wind	491	1,251	1,288	630	951	959	868	1,529	1,797	307	841	763
Total	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)

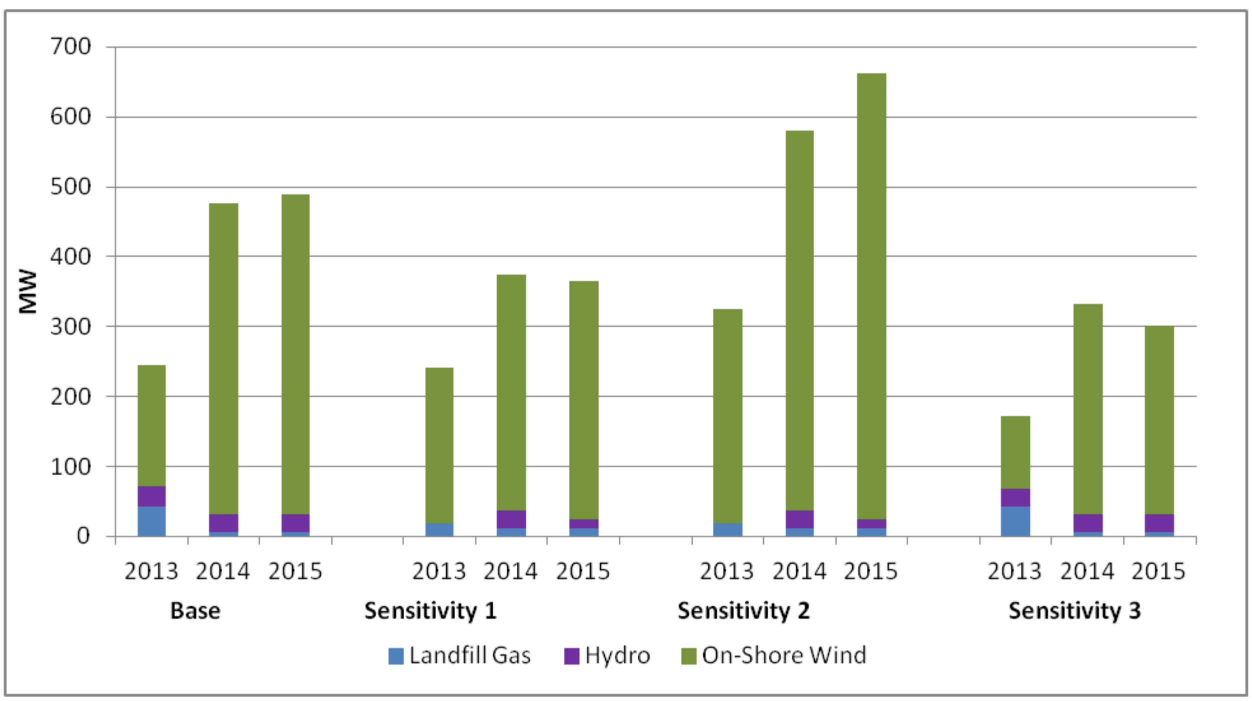


Figure 2. Reference Case Annual Incremental Renewable Generation Procured (GWh)

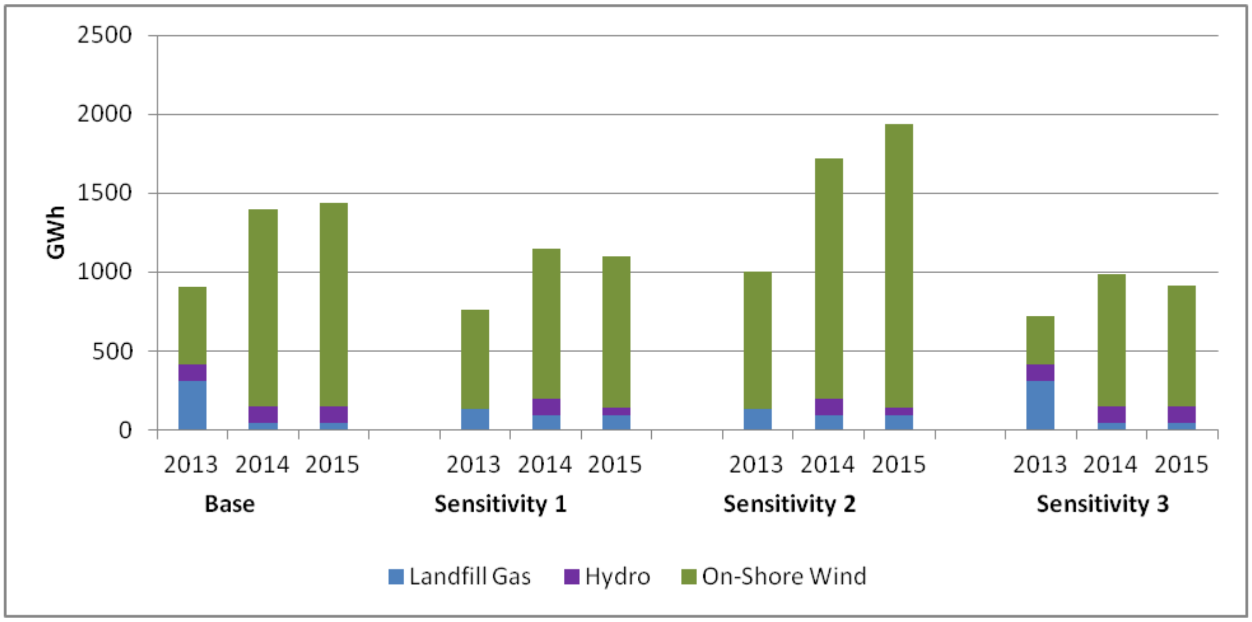


Figure 3. Reference Case Incremental Capacity Additions by Type, Base and Sensitivity Cases (MW)

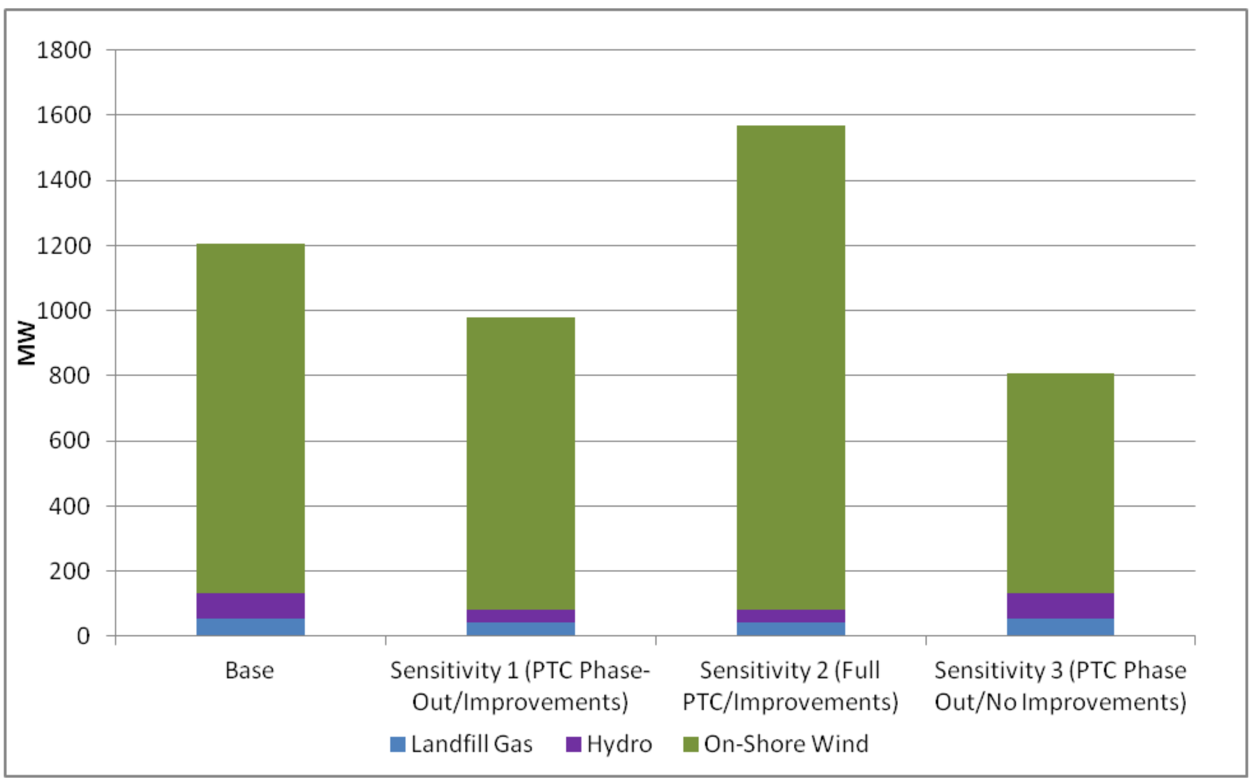
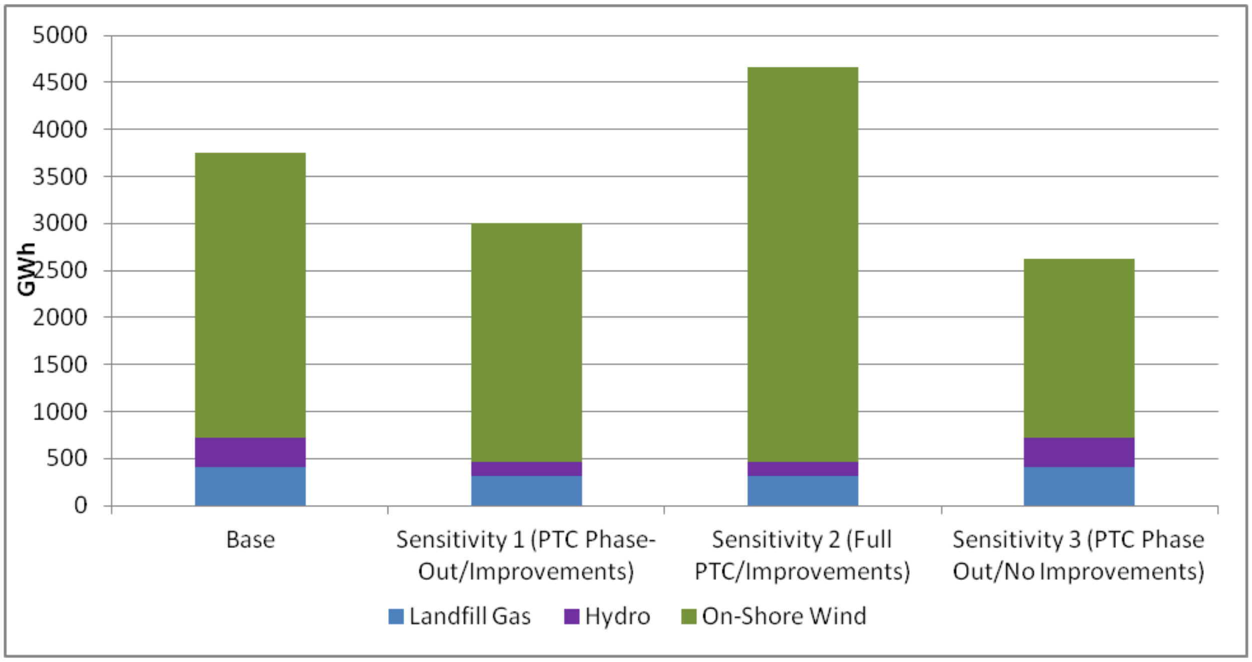


Figure 4. Reference Case Incremental Renewable Energy Generation by Type, Base and Sensitivity Cases (GWh/yr)



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.[9]

[9] 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[10] and enjoy the benefits of new financing options[11] 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.

10 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.

11 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 NYSERDA, 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.[12] NYSERDA 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, NYSERDA concedes that long-term cost-effective hedging opportunities remain uncertain.

NYSERDA 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.[13]
- 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.

[12] Case 03-E-0188, "Order Resolving Main Tier Issues," issued and effective April 1, 2010.

[13] Based on NYSERDA'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

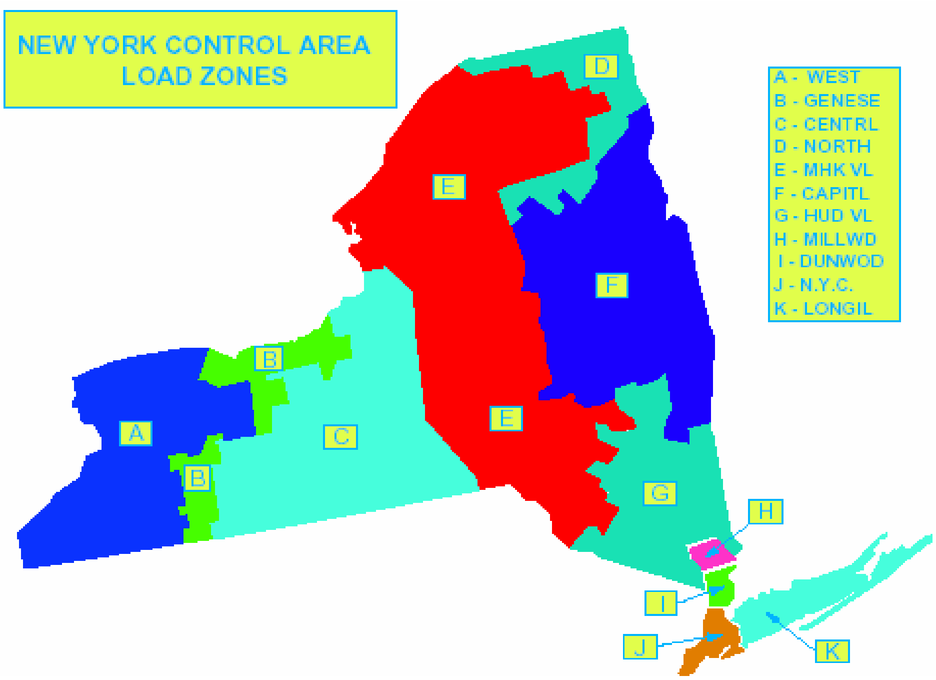
Commodity Prices

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)

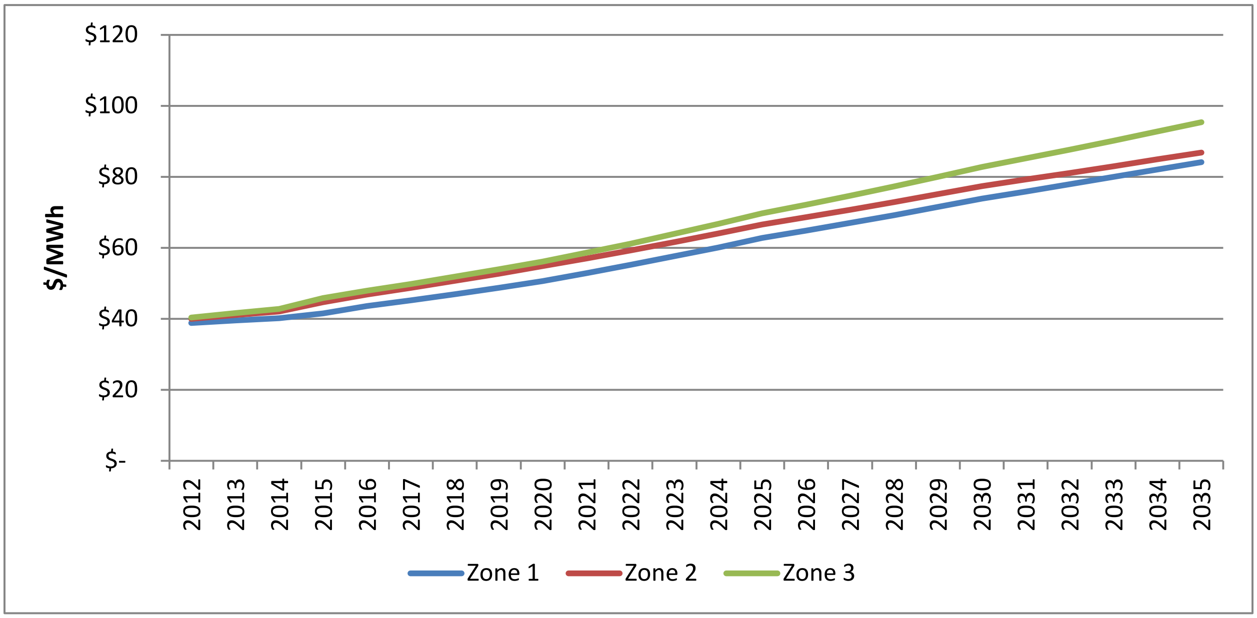
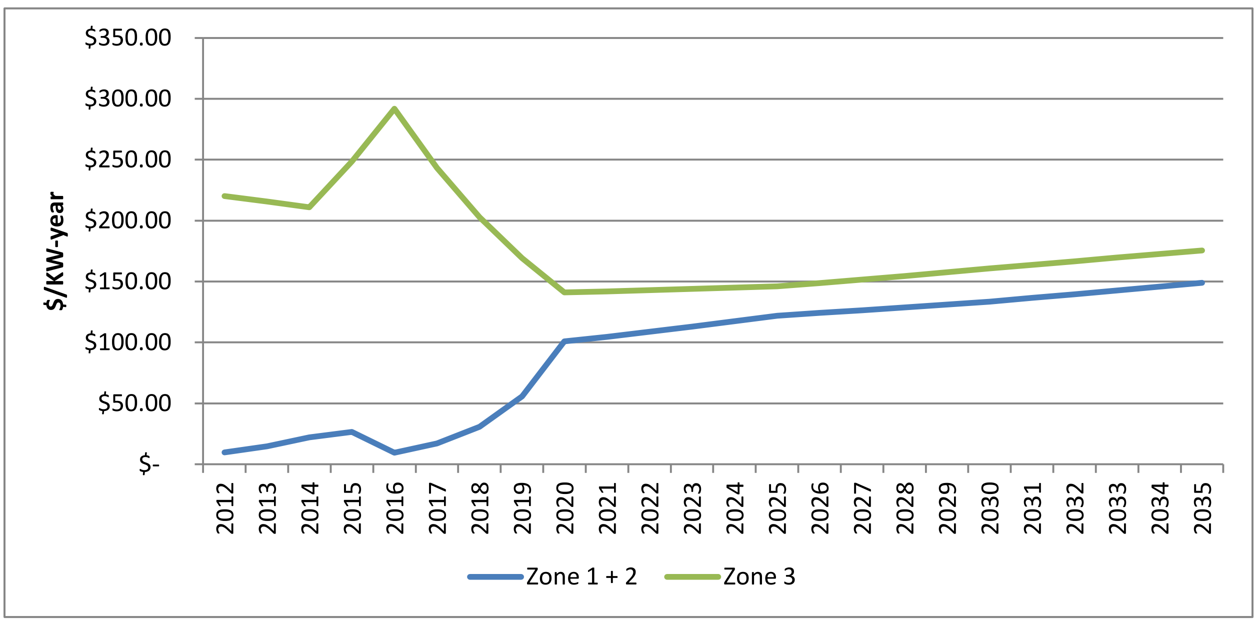


Figure 3A-3. Capacity Prices by Year ($/kW-year)



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

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

Zone 1, nominal	2015	2016	2017
Capacity Price $/kW-year	$ 78.16	$ 85.45	$ 95.55
Zone 2, nominal	**2015**	**2016**	**2017**
Capacity Price $/kW-year	$ 78.16	$ 85.45	$ 95.55
Zone 3, nominal	**2015**	**2016**	**2017**
Capacity Price $/kW-year	$ 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.[14] 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**
Wind Zone 1	2.4%	31.0%	3.6%	8.3%	46.7%	7.9%
Wind Zone 2	2.4%	31.0%	3.6%	8.3%	46.7%	7.9%
Wind Zone 3	3.2%	28.4%	4.4%	9.1%	45.7%	9.2%
Landfill Gas	4.5%	38.5%	7.4%	5.8%	37.9%	5.8%
Biomass	4.5%	38.4%	7.5%	5.9%	37.8%	5.9%
Biomass CHP	5.9%	36.9%	7.6%	7.4%	36.4%	5.8%
Large Hydro Upgrade	3.7%	32.1%	6.2%	6.9%	44.3%	6.8%
Low-impact/Small Hydro	4.0%	32.0%	6.0%	7.0%	44.0%	7.0%

[14] "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.nyserda.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.[15] 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,[16,17] (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%.

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

16 Pace University Energy and Climate Center and Cornell University. *Renewable Fuels Roadmap and Sustainable Biomass*

17 *Feedstock Supply for New York.* Prepared for NYSERDA; April 2010. http://www.nyserda.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
CHP Existing	1	80%	80%	96	30	$3,500	$3,500
CHP New	1	80%	80%	58	46	$4,700	$4,700
Co-firing w/Coal NY	1	70%	70%	76.975	0	$375	$413
Stoker NY	1	85%	80%	431	345	$4,250	$3,900
Fluidized Bed Repower Existing	1	85%	80%	286.275	122.525	$1,300	$1,300
Fluidized Bed Repower Retire	1	85%	80%	45.65	186.575	$1,100	$1,100
CHP Existing	2	80%	80%	4	5	$6,450	$6,450
CHP New	2	80%	80%	0	0	$4,700	$4,700
Co-firing w/Coal NY	2	70%	70%	29.12	0	$375	$413
Stoker NY	2	85%	80%	500	400	$4,250	$3,900
Fluidized Bed Repower Existing	2	85%	80%	62.425	48.675	$1,300	$1,300
Fluidized Bed Repower Retire	2	85%	80%	217.25	122.375	$1,100	$1,100
CHP Existing	3	80%	80%	89	79	$3,500	$3,500
CHP New	3	80%	80%	59	47	$4,700	$4,700
Co-firing w/Coal NY	3	55%	55%	0	0	$375	$413
Stoker NY	3	80%	80%	0	0	$4,250	$3,900
Fluidized Bed Repower Existing	3	85%	80%	131.75	131.75	$1,300	$1,300
Fluidized Bed Repower Retire	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.[18] 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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18 Wiser, 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 Zone2 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	$ 145	$ 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

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New York State Energy Research and Development Authority

17 Columbia Circle
Albany, New York 12203-6399

toll free: 1 (866) NYSERDA
local: (518) 862-1090
fax: (518) 862-1091

info@nyserda.ny.gov
nyserda.ny.gov

NYSERDA Renewable Portfolio Standard Main Tier 2013 Program Review

Volume 3 — Projected Impacts from Using Available Uncommitted Funds

Final Report
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