New York State Energy Research and Development Authority

Energy Efficiency and Renewable Energy Potential Study of New York State

Summary

Final Report

April 2014

Report Number 14-19

The New NY WORKS for Energy

nyserda
Energy. Innovation. Solutions.

NYSERDA's Promise to New Yorkers:

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

Mission Statement:

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

Vision Statement:

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.

Core Values:

Objectivity, integrity, public service, partnership, and innovation.

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 State 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 State – including programs to support product research, development, and demonstrations; clean-energy business development; and the knowledge-based community at the Saratoga Technology + Energy Park® (STEP®).

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 in New York State – 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 New York State policymakers 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.

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Abstract

This study presents the potential for increased adoption of energy efficiency and renewable energy technologies in New York State. It focuses on the long-term potential using a twenty-year study period, 2013–2032. Efficiency potential results are presented in terms of "achievable potential" and "economic potential" (the cost-effective energy savings). The report presents these results statewide as well as separately for each of four regional zones (Long Island, New York City, Hudson Valley, and Upstate). The efficiency portion of the study includes electricity, natural gas, and petroleum fuels in the building and industrial sectors, but excludes transportation energy use. For renewable energy, the study analyzes the economic potential and the "bounded technical potential," a measurement of what theoretically would be possible if cost were not a factor. These figures are for renewable resources serving the energy needs of buildings and electric generation. The major renewable resource categories include biomass, hydro, solar, and wind. The study also assesses alternative allocations between various renewable technology options. Overall, the study finds that large amounts of energy efficiency and renewable energy potential exist through the study period. Pursuing additional cost-effective clean energy potential in the State is anticipated to result in long-term net benefits to New York citizens.

Acknowledgements

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Summary

S.1 Study Purpose and Conclusions

The purposes of this study are to determine the long-term potential for increased adoption of energy efficiency and renewable energy resources in New York State, to better understand future options for the State's energy supply, and to support the development of State energy policy. The study focuses only on energy use in buildings and industrial applications and thus does not address clean energy potential in the transportation sector. Potential energy savings are assessed for electricity, natural gas, and petroleum fuels (heating oil, propane, and kerosene), along with associated reductions in greenhouse gases and other air pollutants.

The study finds that large reservoirs of clean energy potential exist in New York State. The efficiency potential is large relative to projected energy requirements across all fuels and sectors. Capturing the achievable efficiency potential would generate nearly $30 billion dollars of net benefits to the State and return almost two dollars for every dollar invested. The achievable potential is considerably higher than the savings targets for New York State's current programs, indicating that current and new programs will have ample opportunity to continue generating cost-effective efficiency savings and economic benefits for the State.

The study finds that in-State renewable energy sources have the technical potential to increase more than fourfold between 2010 and 2030 in a theoretical scenario where cost is not a factor. The greatest potential increase is in solar energy, which currently represents less than 1% of New York's energy supply but could rise to as much as 15% of total supply by 2030 if the State captured all solar resources that are technically viable.[1] The potential for in-State wind energy is also significant. From a technical standpoint, the study finds that 11% of the State's total energy supply could come from onshore and offshore wind by 2030. This study documents the levels of energy efficiency and renewables deployment that are possible over the next 20 years and concludes that New York State will continue to have substantial opportunities to promote a transformation in the energy sector and reap the benefits of cost-effective clean energy for its citizens and businesses well into the future.

[1] Total energy supply includes energy for transportation.

S.2 Structure of the Report

This summary provides an overview of the background, study approach, and key findings. Visit nyserda.ny.gov to download the full report, including a more detailed study overview.

The full report is presented in six parts:

- Summary
- Volume 1: Study Overview
    - Background and purpose of study
    - Study Scope and general approach
    - High-level results
- Volume 2: Energy Efficiency Methodology and Detailed Results
    - Study scope
    - Portfolio-level results
    - Residential /commercial / industrial efficiency (methodology and detailed results by sector)
- Volume 3: Renewable Energy Methodology and Detailed Results
    - Overview and approach
    - Bioenergy / hydro / solar / wind (methodology and detailed results by technology)
- Volume 4: Energy Efficiency Technical Appendices
- Volume 5: Renewable Energy Technical Appendices

S.3 Study Background

New York State's clean energy policies have led to increased implementation of cost-effective energy efficiency and renewable energy, providing substantial economic and environmental benefits while increasing the State's energy independence and decreasing the risks of future energy supply disruptions and price volatility. At the same time, New York State recognizes that it needs to do more to meet the long-term objectives outlined in the the 2014 Draft New York State Energy Plan,[2] taking advantage of technological improvements and market growth to capture further opportunities for cost-effective clean energy. With this need in mind, the New York State Energy Research and Development Authority (NYSERDA) commissioned this study.

Below we present a brief overview of the study approach followed by the key findings. The full five-volume report, including a more detailed study overview, is available on NYSERDA's web site, www.nyserda.ny.gov.

[2] See the New York State Energy Plan: http://energyplan.ny.gov/

S.4 Study Approach

This assessment of clean energy potential is based on a comprehensive suite of existing and emerging clean-energy technologies. These were evaluated relative to "baseline," or business-as-usual equipment, to determine their relative potential for saving or offsetting conventional energy, and their associated costs and benefits. To account for geographic variations in costs, building stock, and climate, each technology was separately assessed for the analysis zones of Long Island, New York City, Hudson Valley, and Upstate. Energy efficient technologies were evaluated by building type for the residential and commercial/institutional sectors and by major industrial segment. Renewable technologies include various types and scales of hydro, bioenergy, wind, and solar, for both customer-sited and utility-scale deployment. For the energy efficiency analysis, the potential for efficiency savings was evaluated at two levels:

- ***Economic Potential*** represents the level of total energy savings that could occur with adoption of all cost-effective technologies in the absence of market barriers. Technologies are defined as cost-effective if the present value of the benefits exceeds the present value of the costs over the technology's useful life.
- ***Achievable Potential*** is a subset of the economic potential, and represents the energy savings that are possible in the context of current market barriers and today's best-in-class programs to overcome them (i.e. current marketing, technical assistance, and financing approaches). This level of energy savings could be surpassed if new and innovative policies can be developed to overcome these market barriers.

The renewable energy analysis also assessed the potential for renewable energy generation at two levels:

- ***Bounded Technical Potential*** represents a theoretical level of renewable resources that could be utilized based on the performance and operating capabilities of the technologies, without consideration of costs, but constrained by certain practical factors. The constraining practical factors include institutional, social and physical limitations of land use, manufacturing and delivery infrastructure, workforce training, permitting and siting processes, transmission capacity, and intermittency. The bounded technical potential considers these factors for each individual resource on its own, but does not reflect limitations that may arise when all renewable resources are integrated together.
- ***Economic Potential*** is a subset of bounded technical potential that represents the adoption level of renewable resources that could occur if all cost-effective technologies were adopted. This level could be surpassed if innovative policies can be developed to accelerate market transformation and broaden the base of cost-effective renewable resources. Technologies are estimated to be cost-effective if the present value of the financial benefits exceeds the present value of the costs.

For each scenario, potential energy savings and renewable energy contributions are evaluated relative to base case energy usage forecasts that do not include the projected impacts of current and future New York energy efficiency programs. However, they do reflect expected changes to future State and Federal codes and standards, as well as naturally occurring market advancements.

S.5 Energy Efficiency Potential

Opportunities for cost-effective end-use efficiency in New York State are extensive in the coming decades. As detailed in Table S-1, the economic potential for energy efficiency savings by 2030 in the absence of market and social barriers, relative to the State's base case energy usage forecasts, is 45% of the electric forecast, 32% of the natural gas forecast, and 53% of the petroleum fuels forecast. Table S-1 also shows the achievable potential and expected savings from the current Energy Efficiency Portfolio Standard (EEPS), which represents the state of existing and projected energy efficiency programs as of 2013.

Table S-1. Efficiency Potential Relative to State Energy Sales Forecast, 2030.

GWh is Gigawatt-hours and TBtu is trillion British thermal units.

	Energy Savings		
Scenario	Electric (GWh)	Natural Gas (TBtu)	Petroleum Fuels (TBtu)
Economic Potential	**91,856**	**321.1**	**120.0**
% of Forecast	***45%***	***32%***	***53%***
Residential	28,553	148.7	72.3
Commercial	58,550	136.8	45.1
Industrial	4,753	35.7	2.6
Achievable Potential	**36,328**	**107.9**	**43.0**
% of Forecast	***18%***	***11%***	***20%***
Residential	9,415	49.4	26.4
Commercial	25,407	47.0	15.4
Industrial	1,506	11.5	1.3
Savings from EEPS	**17,013**	**14.1**	**n/a**
% of Forecast	***8%***	***1%***	

The commercial sector, which has the highest projected electric load growth, provides the greatest opportunities for cost-effective electric efficiency investments. The natural gas potential is lower than electric and petroleum fuels due primarily to the relatively low cost of natural gas, which makes efficiency measures less cost-effective. The residential sector has the highest achievable potential for petroleum fuels due to its relatively high reliance on those fuels for space and water heating and the fact that many of these buildings and energy systems are of older and less efficient vintage. The achievable industrial sector savings are relatively low due to the sector's proportionally small part of the usage forecast, expected reductions in New York's industrial base, and comparatively high market barriers faced by this sector.

Total 2030 economic potential savings across all fuels translate to a reduction of greenhouse gas emissions of about 49 million metric tons of CO_2-equivalent. This is equivalent to taking about 10 million cars off the road for a year.

The costs and benefits of obtaining these energy savings are presented in the following table for the full 20-year study period.

Table S-2. Present Value of Costs, Benefits, and Net Benefits, 2013-2032.

Values are in billions of 2012 dollars.

Scenario	Costs	Benefits	Net Benefits	Benefit-Cost Ratio
Economic Potential	**$73.8**	**$174.7**	**$100.9**	**2.37**
Residential	$33.5	$73.5	$40.0	2.20
Commercial	$38.0	$93.4	$55.5	2.46
Industrial	$2.4	$7.8	$5.5	3.32
Achievable Potential	**$33.3**	**$62.5**	**$29.3**	**1.88**
Residential	$16.0	$23.6	$7.6	1.47
Commercial	$15.9	$35.8	$19.9	2.25
Industrial	$1.3	$3.1	$1.8	2.36

For the economic potential, the present-value investment of about $74 billion over 20 years would result in benefits to New Yorkers of $175 billion, for a benefit-cost ratio (BCR) of 2.37. In other words, every dollar invested would provide $2.37 in benefits over the lifetimes of the adopted efficient technologies and practices.

For the achievable potential, the present-value investment of $33.3 billion would result in benefits to New Yorkers of $62.5 billion, for a benefit-cost ratio of 1.88. In other words, every dollar invested would return $1.88 in benefits.

All sectors generate substantial returns on investment, ranging from 1.5 to 2.4 dollars per dollar spent. About two thirds of the achievable net benefits would accrue from the commercial sector, with the balance coming mostly from the residential sector.

S.6 Renewable Energy Potential

New York State has a wealth of renewable energy resources, and there is significant technical and economic potential to decrease the State's dependence on fossil fuels. The bounded technical potential analysis indicates that in the absence of fiscal constraints, renewable resources could be developed to provide 41% of New York's total primary energy needs by 2030. Given that transportation is excluded from the potential analysis, it may be more relevant to consider renewable potential in the context of primary energy needs only for buildings and electric generation. If energy for transportation is excluded from the baseline projection, then renewable resources have the technical potential to provide more than half (54%) of the State's total primary energy needs by 2030. For

comparison, in 2010, renewable energy provided less than 10% of the total primary energy requirements, including energy for transportation.

Table S-3. Renewable Energy Potential (TBtu of Primary Energy, 2030).

Resource		Bounded Technical Potential (TBtu)	% of Total Primary Energy Use	Economic Potential (TBtu)	% of Total Primary Energy Use
Hydro	*Conventional*	325	8%	303	8%
	Hydro Kinetic	19	0%	0	-
Bioenergy	*Biomass*	205	5%	201	5%
	Biogas	25	1%	15	0%
Wind	*Onshore*	187	5%	99	2%
	Offshore	244	6%	25	1%
Solar	*Solar PV*	509	13%	125	3%
	Solar Thermal	97	2%	78	2%
Total		**1,611**	**41%**	**847**	**21%**

The economic potential results for renewable energy indicate that just over half of the identified bounded technical potential is found to be cost effective by 2030. These results are based on relatively conservative estimates of future cost declines for renewable energy technologies; they also exclude technologies that have not yet been proven to be commercially viable.

Focusing on electric generation, the bounded technical potential analysis indicates that new and existing renewable resources could theoretically provide 70% of New York State's electricity generation by 2030 if cost was not a factor. In this scenario, solar photovoltaics and wind generation provide the largest growth potential, combining to meet 50% of the electric generation needs by 2030.While the bounded technical potential incorporates limiting factors for each individual resource on its own, it does not reflect possible limitations that may arise from integrating all renewable resources together.

Table S-4. Renewable Energy Potential Electricity Generation (2030).

Resource		Projected Bounded Technical Potential Electricity Generation (GWh)	% of Projected Electricity Generation	Projected Economic Potential Electricity Generation (GWh)	% of Projected Electricity Generation
Hydro	*Conventional*	34,021	17%	31,668	16%
	Hydro Kinetic	2,118	1%	3.5	0%
Bioenergy	*Biomass*	1,396	1%	1213	1%
	Biogas	2,219	1%	1181	1%
Wind	*Onshore*	19,169	10%	10,113	5%
	Offshore	25,025	13%	2,571	1%
Solar	*Solar PV*	54,100	27%	13,320	7%
	Solar Thermal	928	0%	928	0%
Total		**138,975**	**70%**	**60,998**	**30%**

The economic potential for renewable electric generation, based on screening against projected avoided costs, is more modest, but still represents significant growth from current levels. By 2030, renewable generation has the economic potential to provide an additional 33,101 GWh of generation each year, which when combined with existing renewable generation, represents 30% of projected electric generation needs.

Thus, the study finds, that by 2030 renewables have the bounded technical potential to increase their contribution to New York State's energy mix to more than four times their current levels. Over the same time horizon, renewable resources have the economic potential to more than double their contributions to the State's energy supply. Developing the economic potential for renewable energy by 2030 as identified in the study would require cumulative capital investments of roughly $54 billion over a 20 year period. On an annual basis, the required capital investments would be in the range of 5% of New York's total annual energy expenditures, which were $65 billion in 2011.[3]

The study's findings indicate that New York State has a wealth of renewable energy resources and significant opportunities for investments that will increase energy independence and resilience while decreasing emissions of greenhouse gases.

[3] New York State Energy Research and Development Authority. June 2013. *Patterns and Trends, New York State Energy Profiles: 1997-2011.*

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 reliance on fossil fuels. NYSERDA professionals work to protect the environment and create clean-energy jobs. NYSERDA has been developing partnerships to advance innovative energy solutions in New York State since 1975.

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