New York State Energy Research and Development Authority

Energy Efficiency and Renewable Energy Potential Study of New York State

Volume 1: Study Overview

Final Report

April 2014

Report Number 14-19

The New NY WORKS for Energy

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Energy Efficiency and Renewable Energy Potential Study of New York State

Volume 1: Study Overview

Final Report

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NYSERDA Report 14-19 NYSERDA Contract 24799 April 2014

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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

NYSERDA acknowledges with gratitude technical staff from Oak Ridge National Laboratory, the Pace Energy and Climate Center, the National Renewable Energy Laboratory, and Brookhaven National Laboratory for the technical review that they provided for this study.

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1 Background and Purpose of the Study

1.1 Introduction

The New York State Energy Research and Development Authority (NYSERDA) commissioned this study of the potential for end-use energy efficiency and renewable energy in New York State to better understand future options for New York's energy supply, and to support development of State energy policy. By "potential" we mean the potential for increased adoption of energy efficiency and renewable energy (together, "clean energy") technologies above and beyond that which would naturally occur in the absence of funded programs to promote their adoption. The potential study is limited to energy use in the buildings and industrial sectors and does not address transportation energy use. The analysis considers a twenty-year study period, from 2013 to 2032.

The primary objectives of this study were to (a) estimate the potential of existing and emerging technologies and practices to maximize the energy efficiency of end-use technologies, and (b) examine the potential to meet thermal and electric energy needs from renewable resources such as solar, wind, biomass and hydro, and (c) determine the reductions in greenhouse gases and other air pollution emissions associated with the implementation of clean energy technologies. To achieve these objectives, the study had the following key components:

- Assessment of the end-use energy efficiency potential, including:
    - The efficiency potential for electricity, natural gas, and petroleum fuels (distillate and residual fuel oil, LPG/propane, and kerosene).
    - The potential for the residential, commercial (including institutional and government), and industrial sectors, and excluding transportation.
- Assessment of renewable energy resource potential, including:
    - Grid-level electric generation.
    - Customer-sited production of electricity and thermal energy.
- Focus on the long-term (10- to 20-year) potential for adoption of clean energy technologies.
- Assessment of associated greenhouse gas and other air pollutant emission reductions due to increased adoption of clean energy technologies.

Several previous studies have assessed the potential for energy efficiency and/or renewable energy in New York State. These studies include a 2003 electric efficiency and renewable energy potential study, a 2006 natural gas potential study, and a 2008 limited update of the 2003 electric potential study.[1, 2, 3] These prior studies have helped to inform and guide a broad range of New York's regulatory proceedings and policies[4].

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[1] Optimal Energy, Inc. et al. 2003.*Energy Efficiency and Renewable Energy Resource Development Potential in New York State, Final Report.*

[2] Optimal Energy, Inc. et al. 2006.*Natural Gas Energy Efficiency Resource Development Potential in New York.*

[3] Optimal Energy, Inc. et al. 2008.*Achievable Electric Energy Efficiency Potential in New York State, Draft Report.*

[4] For example, the Energy Efficiency Portfolio Standard (EEPS), Case 07-M-0548, and the Renewable Portfolio Standard (RPS), Case 03-E-0188.

This study therefore builds upon, updates, and enhances these previous studies in order to support New York's current and future energy planning cycles.

1.2 Structure of the Report

This study 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
    - Biomass / Hydro / Solar / Wind (methodology and detailed results by technology)
- Volume 4: Energy Efficiency Technical Appendices
- Volume 5: Renewable Energy Technical Appendices

2 Study Scope and General Approach

As described above, this all-fuels potential study includes two major components: the potential for increased adoption of (a) energy efficiency, and (b) renewable energy. Collectively we refer to these as “clean energy” resources or technologies. This section provides an overview of the study scope, and the general approach and methodology used in the assessment of potential for adopting clean energy resources in New York. Volumes 2 and 3 of the study describe in more detail the approach and methodology specific to energy efficiency and renewable energy, respectively.

Energy efficiency and renewable energy are quite different in many respects, including the scale of deployment, the type of impact (end-use reduction vs. generation or substitution of non-renewable energy), the types of market barriers encountered, and the economics of implementation. Therefore, our approach to assessing the potential for energy efficiency differs from that for renewable energy. We briefly describe those differences of approach here, along with aspects of the approach common to both the energy efficiency and renewable energy potentials.

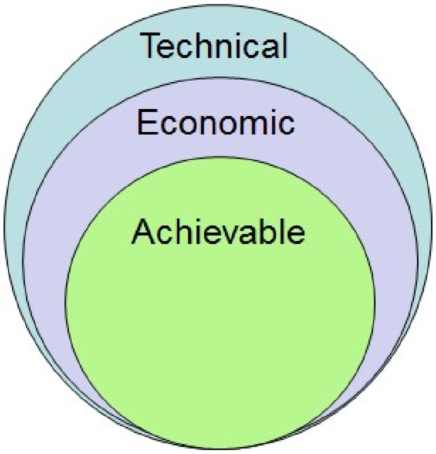
2.1 Types of Potential Assessed

Three major classes or levels of potential are typically assessed in potential studies:

- Technical Potential – Everything that is possible, regardless of cost-effectiveness, and assuming no or limited market barriers.
- Economic Potential – Everything that’s cost-effective, assuming no or limited market barriers.
- Achievable Potential – What’s really possible given the market barriers to adoption of clean energy technologies, with various scenarios possible for different constraints (typically by spending or savings targets, or policies). Achievable potential also considers non-technology costs necessary with promotion of clean of energy to overcome market barriers.

The achievable potential is thus a subset of the economic potential, which is a subset of the technical potential, as shown in the following diagram.

Figure 1. Relationship Between Technical, Economic, and Achievable Potential.



Due to the differences between them, different yet consistent potential scenarios have been performed for energy efficiency and renewable energy in order to produce estimates of potential that will better inform the State energy planning process.

The *technical potential* is highly theoretical in that it ignores cost constraints and market barriers. With completely unlimited deployment, for example, renewable energy could theoretically offset all non-renewable sources. However, for renewable energy in particular, the technical potential analysis is more useful if certain existing market barriers are reflected in the analysis. This study includes a *bounded technical potential*(BTP) for renewable energy (both customer sited and utility scale), which is bounded by the social and physical constraints of land use, manufacturing and delivery infrastructure, workforce training, the permitting and siting process, transmission capacity, and saturation of intermittent renewables. This provides an upper bound of what is possible if society were to implement those renewable technologies regardless of cost, but within those social and physical constraints.

The *economic potential* is based on the technical potential, but constrained by what is cost-effective, (i.e., to technologies for which the benefits exceed the costs).The study includes assessments of economic potential for both energy efficiency and renewable energy. Like the bounded technical potential for renewable energy, however, these are resource-constrained economic potentials. The analysis has taken into consideration constraints such as the availability of equipment and installation contractors, the need for workforce development, and ramp-up time for program implementation and market growth. Therefore, adoption of clean energy opportunities is spread out over time, rather than assuming instant capture of all available opportunities as is assumed for some potential studies. Those resource constraints, however, do not include market barriers due to customer willingness to participate in efficiency and renewable program offerings. In other words, 100% of the opportunities in which benefits exceed costs are assumed to be adopted over time, subject to the constraints described above.

The *achievable potential* recognizes the full suite of market barriers, and is thus more limited than the economic potential. For energy efficiency the study includes an achievable scenario that explores the case of efficiency program incentives that offset, on average, 50% of incremental efficiency measure costs. For renewable energy the study does not provide a full achievable potential, but instead includes a specific set of Development Path analyses that examine alternative allocations between various renewable technology options. The Development Path analyses can be useful to help examine the possible impacts of different forms of market development and/or policies to encourage and catalyze renewable energy development.

Volume 1 presents high level results for the energy efficiency economic and achievable scenarios, and for the renewable energy bounded technical and economic potential scenarios. Full details of all scenarios are presented in the subsequent volumes.

2.2 Regional Analysis Zones

New York is large and diverse enough to have significantly varying climate, economic, and market conditions across the State. These conditions affect the energy efficiency potential of different technologies and end uses. For example, efficiency or renewable energy measures installed in New York City, with relatively high temperatures and labor costs, will have different costs and/or savings than the same measures installed in cooler, less urban areas near the Canadian border. We therefore performed the analyses of efficiency and renewable energy potential separately for each of four analysis zones in order to account for their different characteristics. The study results are reported on both a statewide and regional basis.

The selection of analysis zones was limited to the electric load zones as defined by the New York Independent System Operator (NYISO). The NYISO load zones are suitable as a starting point for selecting regional analysis zones since primary electric forecast and cost data are available for them, and they provide a level of resolution that is suitable for development of applicable data related to natural gas and petroleum fuels.

The following table provides the selected regional analysis zones with several of their key characteristics.

Table 1. Regional Analysis Zones with Selected Characteristics.

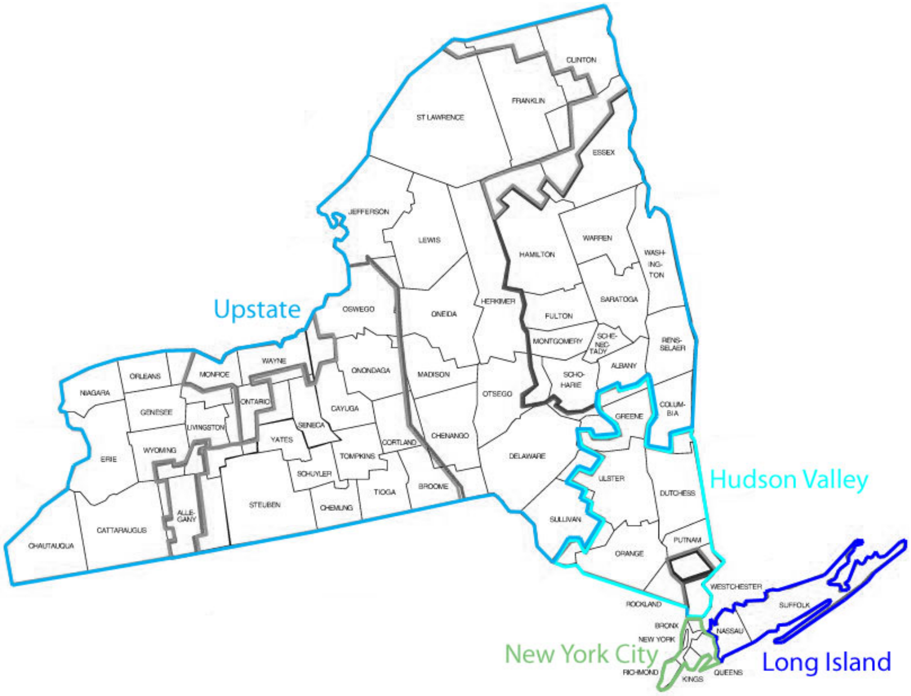
Analysis Zone	NYISO Load Zones	2010 Population	Costs Factor [a]	Heating Degree Days [b]	Cooling Degree Days [b]
Long Island	K	2.8 million	1.23	2,101	3,075
New York City	J	8.2 million	1.30	1,851	3,733
Hudson Valley	G, H, I	2.2 million	1.14	2,316	2,778
Upstate	A-F	6.1 million	0.97	3,295	2,528

a) The Costs Factor represents the combined labor and materials costs relative to the U.S. average (RSMeans 2011, Reed Construction Data). Separate labor and materials costs factors were also used for the analysis, as applicable.

b) Heating and cooling degree days are relative to a 50°F base temperature, reflecting typical commercial building climate-driven energy needs. Degree days used for residential buildings assume a base temperature of 65°F.

The figure below presents the geographical boundaries of the four analysis regions.

Figure 2. Regional Analysis Zones Geographic Boundaries.



2.3 Top-Down Approach

The general approach for this study is “top-down” as opposed to “bottom up.” In general terms, a top-down approach starts with an assessment of current and forecasted energy generation and consumption, to develop a detailed understanding of how energy is being generated and how it is used by various segments of the market and for what end uses. We then assess the opportunities for increased adoption of energy efficiency and renewable energy relative to the overall magnitude of current and forecasted energy use.

A top-down approach contrasts with a “bottom-up” approach, which begins with a fixed number of buildings or equipment installations and considers how many of these items could be addressed by efficiency and renewable energy measures. Top-down analyses, then, work from a basis of energy consumption, while bottom-up analyses work from a basis of the number of units or “widgets.” One benefit of top-down methods is that they are inherently calibrated to actual loads and forecasts.

For energy efficiency, the top-down approach starts by developing a disaggregated energy usage forecast by:

- Fuel type: electric, natural gas, petroleum fuels.
- Sector: residential, commercial (including institutional and governmental), and industrial.
- End use: lighting, cooling, etc.
- Building or industrial type: office, restaurant, retail, single family residence, etc.

We then determine the percentage by which energy use in each “bucket” can be reduced by the adoption of applicable efficiency measures over the study period.

The renewable energy potential included grid-scale and customer-sited renewable electric generation, as well as applications of renewable technologies for specific end-use applications (e.g., biomass for space heating). The top-down approach assessed the magnitude of electric generation by various sources (natural gas, coal, hydro, etc.) so that the magnitude of renewable energy generation could be estimated relative to current and forecasted electric generation. The assessment was segmented by the four major classes of renewable resources: biomass, hydro, solar, and wind. Twenty five representative technologies, providing thermal and electric generation at various scales, were selected based on current market and technical conditions and anticipated improvements during the study period. The potential for each technology was limited by the social and physical constraints such as the availability of land or biomass feedstocks, as described above under Types of Potential Assessed.

2.4 Energy Sales Forecast

Current and forecast electric, natural gas, and petroleum fuel sales, by sector, served as the starting points for characterizing the market and clean energy potential within each sector. NYSERDA provided recent annual historical energy use, as well as forecasted annual energy sales for the 20-year study period, by sector and analysis zone. Tables presenting the full forecasts for the study period can be found in Appendix B in Volume 4.

2.4.1 Electric Sales Forecast

NYSERDA provided two electric sales forecasts from the New York Independent System Operator (NYISO) in support of the study: the ‘econometric’ and the ‘base case’ forecasts. The econometric forecast, which is based on historical electric usage and economic growth projections, represents the future annual electric load in the absence of energy efficiency programs. The base case forecast represents the future annual load taking into account anticipated savings from energy efficiency programs over the next ten years. These savings are equal to the cumulative impacts of the State’s Energy Efficiency Portfolio Standard (EEPS), including projected savings attributed to increased codes and standards (C&S) and transmission and distribution (T&D) upgrades as presented in the NYISO 2012 Gold Book.[5]Because the scope of this analysis is to assess the total magnitude of cost-effective energy efficiency potential, some of which will be captured through the EEPS, this study presents its projected energy savings as a percentage of the econometric forecast.

For the top-down analysis used in this study, we required a forecast limited to the total energy usage to which building energy-saving measures can be applied. In particular, the econometric sales forecast included three components that were not applicable to building energy efficiency measures:

- Savings due to building codes and equipment standards (C&S).
- Grid-scale transmission and distribution (T&D) system upgrades.
- Transportation energy (mostly for electric trains).

These three electric energy components, based on projections provided in the NYISO 2012 Gold Book and by NYSERDA for the transportation component, were therefore subtracted from the econometric forecast to develop a base forecast for the electric energy sales disaggregation. Figure 3 shows these components of the statewide electric energy econometric forecast (at the point of generation or power purchase, as opposed to at the customer meter). Of note, commercial sector electric consumption is forecast to increase steadily over the 20-year study period, while the residential and industrial sector forecasts remain relatively constant.

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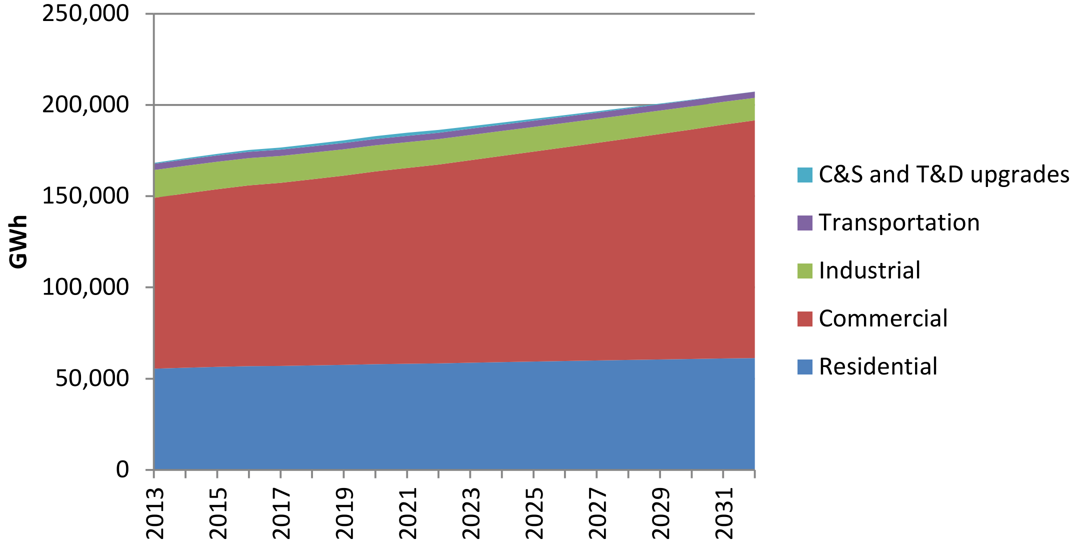
[5] New York Independent System Operator. 2012.*2012 Load and Capacity Data, “Gold Book”* (draft).

Figure 3. Statewide Electric Energy Econometric Forecast.



2.4.2 Natural Gas and Petroleum Fuels Sales Forecasts

NYSERDA provided sales forecasts broken out by sector for natural gas, distillate and residual fuel oils, propane, and kerosene. We combined the sales of distillate and residual fuel oils, propane, and kerosene into a single petroleum fuels forecast. The resulting two forecasts (natural gas and petroleum fuels) were further broken out by analysis zone by applying weighting factors. In the case of natural gas, these factors were based on sales figures provided by the various distributors around the State. In the case of petroleum fuels, the zonal factors were developed from the results of the American Community Survey[6], which reported the number of housing units using home heating oil and propane by county.

Current fuel forecasts did not incorporate the New York City policy for phasing out the use of residual fuel oil due primarily to its air quality impacts. Fuel oil #6 is expected to be phased out by the end of 2015, and fuel oil #4 by 2030. The fossil fuel forecasts were adjusted to reflect this requirement with an assumption that the residual fuel would be replaced primarily with natural gas, though constrained by the rate at which new natural gas infrastructure can be put in place.

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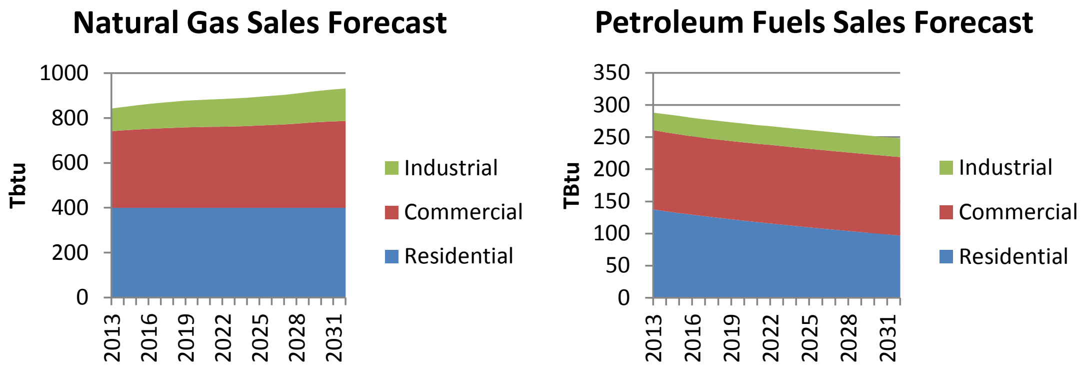
[6] U.S. Census Bureau, http://www.census.gov/acs/www/

The figures below show the statewide forecasts for natural gas and petroleum fuels.

Figure 4. Statewide Natural Gas and Petroleum Fuels Sales Forecast.



Natural Gas Sales Forecast

Petroleum Fuels Sales Forecast

Volumes 2 and 3 describe the disaggregation of the energy forecasts by market segment to support the assessment of clean energy potential from energy efficiency and renewable energy technologies, respectively.

2.4.3 Naturally Occurring Efficiency

Some energy efficiency measures are installed in the absence of efficiency programs, often referred to as “naturally occurring” efficiency. Some level of natural energy efficiency is implicit in the current and expected energy use for each sector. We have assumed that the econometric electric sales forecast, as well as the fossil fuel forecasts, reflect the expected future rates of natural efficiency. Our estimates of efficiency potential are thus above and beyond the natural efficiency occurring in the marketplace.

2.5 Market Segmentation

The market for energy efficiency applications is segmented differently for each of the residential, commercial, and industrial sectors. For the residential sector, efficiency applications are segmented primarily by major end use and building type (single family and multifamily). The commercial sector also segments the market by end-use and building type, but with a larger number of each due to the much greater variation in building types and technology applications in the commercial sector. In contrast, the industrial sector is segmented primarily by the type of industry (chemicals, mining, etc.) due to the application-specific nature of each industry.

The multifamily market spans both the residential and commercial sectors. Buildings with five or more living units were considered to be multifamily for the study. Larger multifamily buildings with central systems are generally on residential rates and were thus included in the residential analysis for this study. However, because natural gas and petroleum fuel opportunities are commercial in nature (e.g., large central boilers and water heating systems), we analyzed them under the commercial approach. We did not have suitable data for a detailed segmentation of the multifamily market between the residential and commercial sectors, and thus assumed that buildings with 20 or more units would have centralized heat and hot water suitable for the commercial analysis. Most multifamily electric usage was assumed to be in the residential sector. Given these assumptions, the multifamily segmentation was less rigorous than the primary segmentation of the residential, commercial, and industrial sectors.

The market segments are further described for each sector in Volume 2.

2.6 Avoided Costs of Energy Supply

Avoided energy supply costs ("avoided costs") are a fundamental input to the clean energy potential assessment, as they are used to estimate the dollar benefits of energy saved though efficiency or generated by renewable technologies. Avoided cost components typically include generation (electric) or commodity (gas) energy, peak capacity, and transmission and delivery capacity. The avoided costs are estimates of current and future costs for energy *on the margin* – that is, for the last unit of energy (i.e., kWh or MMBtu) supplied to customers. For example, electric generation typically includes both cheaper "base load" generation (e.g., by coal or nuclear power plants) and more expensive "peak" generation (e.g., by natural gas power plants) that can respond to the changing peak demand on the grid. The more expensive peak generation would be used for estimating the avoided cost of a kWh of energy saved or generated.

NYSERDA developed and provided a forecast of avoided electric energy costs by energy period and by analysis zone for the years 2013-2016, 2020, 2025, 2030, and 2035. Avoided costs for the intervening years were developed by linear interpolation. Because efficiency and renewable resources last longer than the twenty years for which NYSERDA projected avoided costs, we projected these values another twenty-five years into the future. Rather than extrapolating based on the trend of the previous years, costs were held constant in real terms.

The electric avoided costs incorporate both the costs of energy (kWh) and generation capacity (kW) for summer peak demand as well as the costs of transmission and distribution capacity. The full sets of electric avoided costs are presented by analysis zone and energy period in Appendix A, Volume 4.

Also listed in Appendix A are the annual avoided fossil fuel costs (both natural gas and petroleum-based fuels) developed by NYSERDA. Each set is differentiated by analysis zone and by sector. Price factors for adjusting statewide costs by zone were also provided by NYSERDA and are based on information provided by electric distribution companies. As with the electric costs, the fossil fuel avoided costs beyond 2035 were assumed constant in real terms for another twenty-five years.

The avoided costs for petroleum fuels are a weighted average of distillate fuel oil, residual fuel oil, propane, and kerosene, as these were analyzed in aggregate.

The avoided energy costs for all fuels are provided in Appendix A in Volume 4, which also includes avoided costs for water savings.

2.7 Characterization of Measures and Technologies

To assess the costs, energy savings, and other impacts of efficiency measures and renewable technologies, we “characterize” those measures and technologies relative to the baseline equipment and practices that are expected in the absence of clean energy programs. The dollar costs and benefits of each measure and technology must be understood in order to determine its cost-effectiveness (as described in the next section), and the overall costs and benefits of the various scenarios being assessed. The measure and technology characterizations thus include:

- Effective useful life, over which the equipment will function and provide benefits.
- Incremental cost relative to baseline equipment.
- Annual energy savings or renewable generation, or increased usage (e.g., combined heat and power units save electricity but increase on-site fuel usage).
- Non-energy impacts (e.g., operation and maintenance, water savings).

As needed, the characterizations change over time to reflect expected trends due to new technologies and changing baselines. Annual dollar benefits for energy savings (and costs for increased usage) are calculated based on the avoided costs of energy supply described in the previous section.

The emphasis of this study is on the long-term potential for implementation of clean energy, rather than for near-term planning. To support this approach, we generally characterized bundled or “aggregate” efficiency measures and renewable technologies as opposed to highly specific or “granular” measures. For example, we characterized commercial “interior lighting controls” in aggregate, rather than analyzing separate measures for occupancy sensors, daylight dimming, and other individual types of lighting controls.

The characterization of efficiency measures and renewable technologies is described in more detail in Volumes 2 and 3, respectively.

2.8 Assessment of Cost-Effectiveness

An efficiency measure or renewable energy technology is considered to be *cost-effective* when the benefits derived from its implementation exceed or equal the costs of that implementation. There are several perspectives from which these benefits and costs can be measured, but in this analysis we have applied a cost-effectiveness test that represents the overall benefits and costs to the economy from a particular action, regardless of who receives the benefits or incurs the costs.[7] All references to cost-effectiveness in this report are based on this same assessment of costs and benefits.

We assess cost-effectiveness based on a life-cycle cost analysis, which compares a "business as usual" or "baseline" case to a case of implementing clean energy equipment or practices. For a particular piece of equipment, the period of life-cycle analysis is the *effective useful life* of the measure or technology, during which it accrues benefits for annual saved energy or generated renewable energy. The various costs and benefits over the lifetime of a measure or technology are described in the next section.

2.8.1 Clean Energy Costs and Benefits

The costs associated with implementation of energy efficiency measures and renewable technologies include:

- The incremental cost (above baseline equipment) of efficient equipment and renewable technologies paid by the participants – including costs for equipment, installation, operation and maintenance, and removal (less salvage value).
- Increased fuel usage (e.g., increased heating load due to decreased waste heat for efficient lighting).
- Program administration costs (staff, marketing, evaluation, etc.) paid by the program administrator – applied only for total-program cost-effectiveness, not for individual efficiency measures or renewable technologies.

The benefits of efficiency measures and renewable energy technologies include:

- Avoided costs of energy supply, both electric and fossil fuel, due to the reduction in generation or extraction, transmission, distribution, and capacity costs valued at marginal cost for the periods when there is a load reduction.
- Other resource benefits (e.g., fossil fuel savings for electric measures, water savings).
- Operation & Maintenance (O&M) reduced costs.

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[7] This cost-effectiveness test is consistent with New York's current policy of applying a Total Resource Cost test for assessing the cost-effectiveness of clean energy measures and projects, and their associated programs.

Not counted in the benefits of the clean energy potential are the following sources of resource value that have been reflected in some other potential studies:

- Environmental externalities, i.e., the economic value of reducing pollutants whose societal costs are not monetized in market prices.
- Reduced market-clearing wholesale electricity prices resulting from lower demand due to pursuit of efficiency and renewable resources.
- Economic stimulus from aggregate energy cost reductions that result from the pursuit of cost-effective efficiency and renewable resources.

Last, we note that this analysis did not include any costs or benefits for financial incentives paid by entities within New York State (e.g., a utility program administrator), because these are considered to be transfer payments between parties within the bounds of the analysis, and thus are not counted as costs or benefits. However, incentives or other funds from outside the State, such as federal tax incentives, are considered a reduction in the incremental cost of efficiency measures and renewable technologies.

2.8.2 Discounting and Present Values

All dollar values in this study are in 2012 real dollars, which do not include the effects of inflation. Therefore, if a piece of clean energy equipment costs $100 in 2012, and its value goes up at the rate of inflation, we would say it costs $100 in 2020 in real dollars. This makes it easier to compare dollar values to today's values, though inflation should be factored in when comparing the values in this study to future values that include inflation.

Consistent with standard practice, we determine cost-effectiveness by comparing the *present value* of the costs to the *present value* of the benefits. The present value reflects what is assumed to be today's value of costs or benefits that may come in the future, based on the presumption that having money today is worth more to us than having it in the future. We determine the present value of money by discounting costs or benefits that occur in the future to the present using a *real discount rate*. For this study we applied a real discount rate of 5.5% per year, as is currently used in New York for assessing cost-effectiveness of clean energy measures and projects, and their associated programs.

As a real discount rate, the 5.5% per year does not reflect money losing its value due to inflation. Any inflation would be above and beyond the 5.5%. For example, if the long-term inflation rate was 2.1%, and future values included the effects of inflation, then a nominal discount rate of about 7.7% would be applied to determine the present value of money.[8]

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[8] Nominal discount rate = (real discount rate + 1) * (inflation rate + 1) – 1.

Most of the costs of energy efficiency and renewable energy investments occur at the time of purchase, though there may be future costs for increased operation and maintenance or increased fuel usage (e.g., energy efficient lighting has less waste heat and thus results in increased usage of heating fuel). In contrast, the benefits of saved energy or renewable generation come in the future over the life of each measure or project. As such, discounting the future value of money has a much greater effect on measure benefits than on its costs. For example, for a clean energy project installed today and with a discount rate of 5.5%, the benefits of energy saved or generated in year 6 will have about three quarters of its value in present dollars, and for year 13 will have about half its value. This effect of discounting the future benefits is therefore greatest for clean energy technologies with longer lives.

When an efficiency measure or renewable technology is installed, we assume that the initial costs are incurred at the time of installation, whereas the annual benefits of energy savings occur half way through each year after the installation. The annual benefits for the first year are therefore discounted by a half year to be comparable to the initial costs, and the same half-year discounting is applied to the annual benefits throughout the life of the measure or project. Regardless of when a measure is installed during a year, its first-year costs and benefits are accounted for in the year of installation.

2.9 Approach to Financing

Initial costs are a major barrier to the implementation of energy efficiency and renewable energy projects in homes and businesses. While program incentives may offset a significant portion of that cost, financing of the remaining costs may be desired or necessary for some customers, and may make the difference in deciding whether or not to pursue a project. Often the financing payments can be in arranged such that the customer has a positive cashflow due to the project’s annual benefits.

In addition to traditional bank loans, a variety of funding mechanisms have been used and proposed for financing energy efficiency and renewable energy projects, including interest-rate buydowns, on-bill financing, energy service performance contracting, and property tax financing (also known as Property Assessed Clean Energy or PACE). New York’s proposed “Green Bank”, first announced in Governor Cuomo’s 2013 State of the State, is expected to introduce a number of financing products that will use public funds to leverage private sector funds to spur investment in clean energy technologies.

While project financing can be important for increasing the implementation of clean energy options, the costs of financing and the degree to which access to capital is a market barrier are not easily quantified. As such, we have not specifically included the costs and impacts of financing options in our analysis. Rarely do potential studies include any financing costs. We consider the costs of financing to be largely reflected in the real discount rate of 5.5%, which is applied to all future benefits regardless of whether there would have been financing.[9]

More importantly, we recognize financing as one of many mechanisms for addressing market barriers and promoting implementation of cost-effective clean energy. In addition to incentives and other program activity, we assume a significant level of support for financing of clean energy options.. In addition, the availability of favorable financing options could lower the costs of achieving the same program impacts by reducing the need for incentives or other program intervention.

2.10 Analysis Model

The modeling of annual clean energy installations and their costs, future energy savings, increased usage of secondary fuels, non-energy impacts, associated dollar benefits, and determination of cost-effectiveness was performed by Optimal Energy's Portfolio Screening Tool (PST). The PST is a full-featured model for clean energy investments, providing a comprehensive accounting of the costs and benefits of individual efficiency measures, efficiency programs, and comprehensive portfolios. The model is precise in its treatment of various timing effects, including different equipment lifetimes, multiple electricity costing periods, and proper handling of cost and savings shifts over time due to early retirement (or retrofitting) of existing inefficient equipment. The PST fully accounts for annual costs and savings over the effective useful life of each measure or renewable technology, compiling these by year throughout the study period, and provides full reporting of economic and environmental impacts over time, by fuel type and market segment.

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[9] The real discount rate of 5.5% is applied to real dollars and does not include the effects of inflation, which would normally be accounted for in financing calculations. For example, if the long-term inflation rate was 2.1%, the nominal discount rate would be about 7.7%.

3 Energy Efficiency High-Level Results

The study found that large reservoirs of energy efficiency potential still exist, even as the State has and continues to pursue its aggressive clean energy initiatives. New resource opportunities continue to grow as efficient technologies improve and costs come down. Such resources, however, are partially offset as baseline energy consumption from code compliant measures also improve. Thus, a significant proportion of future clean energy resources will stem from improved practices that optimize energy consuming systems.

All electric savings and forecast energy values are at the “point of purchase” as opposed to “at meter.” Point of purchase savings correspond to avoided costs at the entrance to the utility service territories and include savings in transmission line losses. Customer meter level savings also reflect a reduction in distribution level losses commensurate with reduced system deliveries.

Table 2 provides a summary of the economic potential energy savings by sector and analysis zone, along with net levelized costs of capturing the savings. Statewide, the economic energy efficiency savings by 2030 equates to roughly 92 terawatt-hours (TWh) of electricity, and about 441 trillion Btu (TBtu) of fossil fuels.

Table 2. Synopsis of Economic Efficiency Potential, 2030.

		Energy Savings				Net Levelized Cost	
Analysis Zone	Sector	Electric (GWh)	Natural Gas (BBtu)	Petrol Fuels (BBtu)	Capacity Savings (MW)	($/kWh)	($/MMBtu)
New York City	Res	11,817	54,922	25,493	10,361	-$0.02	-$4.01
	Com	21,834	68,522	23,815	6,695	$0.00	$5.85
	Ind	1,629	2,974	1,189	236	$0.02	$3.33
	Total	**35,280**	**126,418**	**50,497**	**17,291**	**-$0.01**	**$1.33**
Long Island	Res	4,182	19,939	10,008	3,311	$0.05	$1.10
	Com	9,117	15,658	4,749	2,324	$0.02	$5.75
	Ind	716	1,878	351	104	$0.03	$2.77
	Total	**14,015**	**37,475**	**15,108**	**5,738**	**$0.03**	**$3.00**
Hudson Valley	Res	3,379	16,710	7,591	2,747	$0.04	$0.50
	Com	6,509	6,750	4,338	1,600	$0.02	$5.70
	Ind	523	2,680	278	76	$0.02	$2.50
	Total	**10,410**	**26,140**	**12,207**	**4,423**	**$0.03**	**$2.21**
Upstate	Res	9,176	57,095	29,208	7,610	$0.08	$3.65
	Com	21,090	45,863	12,208	5,177	$0.02	$4.93
	Ind	1,885	28,139	742	274	$0.03	$1.50
	Total	**32,150**	**131,097**	**42,157**	**13,062**	**$0.03**	**$3.78**
Statewide	Res	28,553	148,665	72,300	24,029	$0.03	$0.07
	Com	58,550	136,793	45,109	15,795	$0.01	$5.55
	Ind	4,753	35,672	2,560	690	$0.03	$1.85
	Total	**91,856**	**321,130**	**119,969**	**40,514**	**$0.02**	**$2.53**

Table notes:

- All values are based on cumulative costs and savings for the year 2030 under the economic scenario.
- 1 GWh = 1,000 MWh, 1 kiloton = 1,000 metric tons; 1 BBtu = 1000 MMBtu.
- Regions correspond to NY-ISO load zones: New York City (Zone J), Long Island (Zone K), Hudson Valley (Zones H,I), Upstate (remaining zones).
- Net levelized costs are calculated using the *net* measure cost per unit of energy saved, on a levelized basis over its lifetime. Programs are modeled as integrated, all-fuel programs, as many measures contribute savings to both electricity and fossil fuels with a single installation cost (incremental to baseline equipment). Net electric measure cost is the incremental cost less non-electric energy benefits and less electric distribution capacity benefits (see Appendix A, Volume 4). Net fossil fuel measure cost is the incremental cost less electric energy and distribution capacity benefits. In either case, subtracting the benefits from the measure cost can result in a negative cost. See Appendix G, Volume 4, for additional detail.

A summary of the achievable energy by sector and analysis zone, along with levelized costs of capturing the savings is shown in Table 3. Statewide, the achievable scenario would produce savings of roughly 36 terawatt-hours (TWh) of electricity, and about 151 Trillion Btu (TBtu) of fossil fuels. Overall net levelized costs to capture savings are approximately 1 cent/kWh for electricity and $4.06/MMBtu for fossil fuels.

Table 3. Synopsis of Achievable Efficiency Potential, 2030.

		Energy Savings				Net Levelized Cost	
Analysis Zone	Sector	Electric (GWh)	Natural Gas (BBtu)	Petrol Fuels (BBtu)	Capacity Savings (MW)	($/kWh)	($/MMBtu)
New York City	Res	4,004	15,655	8,038	3,229	-$0.01	-$1.58
	Com	9,318	23,609	8,130	2,788	$0.00	$4.77
	Ind	534	1,023	394	78	$0.03	$3.30
	Total	**13,857**	**40,288**	**16,562**	**6,095**	**$0.00**	**$2.26**
Long Island	Res	1,438	7,008	3,874	997	$0.05	$5.94
	Com	3,949	5,486	1,648	933	$0.02	$4.66
	Ind	231	694	176	34	$0.04	$2.93
	Total	**5,619**	**13,189**	**5,698**	**1,964**	**$0.02**	**$5.30**
Hudson Valley	Res	1,107	5,831	2,721	810	$0.04	$5.41
	Com	2,842	2,273	1,451	656	$0.02	$4.58
	Ind	162	961	156	24	$0.03	$2.85
	Total	**4,111**	**9,065**	**4,328**	**1,489**	**$0.02**	**$5.01**
Upstate	Res	2,866	20,951	11,734	2,147	$0.07	$7.27
	Com	9,298	15,599	4,129	2,147	$0.01	$3.92
	Ind	578	8,807	570	85	$0.03	$1.72
	Total	**12,742**	**45,357**	**16,433**	**4,379**	**$0.02**	**$5.40**
Statewide	Res	9,415	49,445	26,366	7,183	$0.03	$3.87
	Com	25,407	46,968	15,358	6,525	$0.01	$4.48
	Ind	1,506	11,486	1,296	220	$0.03	$2.06
	Total	**36,328**	**107,899**	**43,020**	**13,927**	**$0.01**	**$4.06**

Table notes:

- All values are based on cumulative costs and savings for the year 2030 under the achievable scenario.
- 1 GWh = 1,000 MWh, 1 kiloton = 1,000 metric tons; 1 BBtu = 1000 MMBtu.
- Regions correspond to NY-ISO load zones: New York City (Zone J), Long Island (Zone K), Hudson Valley (Zones H,I), Upstate (remaining zones).
- Net levelized costs are calculated using the *net* measure cost per unit of energy saved, on a levelized basis over its lifetime. Programs are modeled as integrated, all-fuel programs, as many measures contribute savings to both electricity and fossil fuels with a single installation cost (incremental to baseline equipment). Net electric measure cost is the incremental cost less non-electric energy benefits and less electric distribution capacity benefits (see Appendix A, Volume 4). Net fossil fuel measure cost is the incremental cost less electric energy and distribution capacity benefits. In either case, subtracting the benefits from the measure cost can result in a negative cost. See Appendix G, Volume 4, for additional detail.

The economic impacts to the New York economy from successful capture of the economic and achievable potential over the 20-year planning period is shown in Figure 4. As can be seen, these scenarios are highly cost-effective. The achievable scenario would produce over $62 billion in benefits to New York, with an investment of about $33 billion. If this scenario were pursued, it would increase the total New York economy by about $29 billion in present value 2012 dollars, and return $1.88 for every dollar invested. About two thirds of the net benefits would accrue from the commercial sector, with the balance coming mostly from residential and about 6% of the net benefits coming from the industrial sector.

Table 4. Present Value of Costs, Benefits, and Net Benefits, Economic and Achievable Scenarios, 2013-2032 (Million 2012$).

Sector	Costs (Million 2012$)	Benefits (Million 2012$)	Net Benefits (Million 2012$)	BCR
Economic	**$73,787**	**$174,720**	**$100,933**	**2.37**
Residential	$33,468	$73,465	$39,997	2.20
Commercial	$37,962	$93,438	$55,476	2.46
Industrial	$2,357	$7,817	$5,460	3.32
Achievable	**$33,270**	**$62,538**	**$29,268**	**1.88**
Residential	$16,004	$23,601	$7,597	1.47
Commercial	$15,936	$35,795	$19,859	2.25
Industrial	$1,330	$3,142	$1,813	2.36

3.1 Electric Energy Efficiency Potential

Opportunities for cost-effective electricity end-use efficiency in New York are extensive. The potential electric savings relative to the State's electric load forecast and the Energy Efficiency Portfolio Standard (EEPS) are presented in Table 5.[10]

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[10] The study relies on zonal electric load forecasts provided by the New York Independent System Operator (NYISO), which were adjusted to reflect a baseline that does not include impacts from future ratepayer-funded efficiency programs, but does assume naturally occurring efficiency gains in the market and reflects codes and standards that have recently been passed as well as those considered highly likely to pass. The electric forecast also includes transportation energy (about 2% of the forecast) that was not available for energy efficiency in the building sector.

Table 5. Summary of Economic and Achievable Electric Efficiency Potential Relative to Sales Forecast and NYS EEPS, 2020 and 2030.

	2020	2030
Statewide Forecast (GWh)	182,406	202,397
Economic EE Potential (GWh)	66,123	91,856
% of Forecast	*36%*	*45%*
Achievable EE Potential (GWh)	21,748	36,328
% of Forecast	*12%*	*18%*
Savings from EEPS (GWh)	11,230	17,013
% of Forecast	*6%*	*8%*

The economic efficiency potential represents 36% of forecast load by 2020, growing to 45% by 2030, as is evident in the above Table 5. This represents a scenario where all cost-effective efficiency resources are assumed to be adopted, regardless of market barriers or other constraints. Pursuit of the achievable scenario would result in savings of 12% of forecast load by 2020 and 18% by 2030. This scenario assumes a set of comprehensive efficiency programs that would pay, on average, about 50% of incremental measure costs in incentives to end users, somewhat higher than current New York programs. As a comparison, we also show the savings projected for the State's ongoing EEPS initiative. While current EEPS efficiency program targets are only defined through 2015, these figures represent cumulative impacts from those goals over time, along with some additional impacts from projected codes and standards and transmission and distribution upgrades, as projected by the NYISO.[11]

The total economic and achievable potential for electricity efficiency by 2030, along with the projected savings for the current EEPS initiative is shown in Figure 5. The total achievable potential by sector is shown in Figure 6. As can be seen, capture of the full achievable scenario potential would result in roughly offsetting all forecast electric load growth and provide a relatively flat future electric demand forecast. Theoretical capture of the full economic potential would result in dramatically declining electric demand until about 2024, that would then slightly climb through 2032. However, it is important to note that forecasted technology advances between 2020 and 2032 are less certain, and may be conservative. We expect that if a new study were done in 2020 it would likely find additional cost-effective efficiency opportunities not considered here due to advancements in technology and cost reductions.

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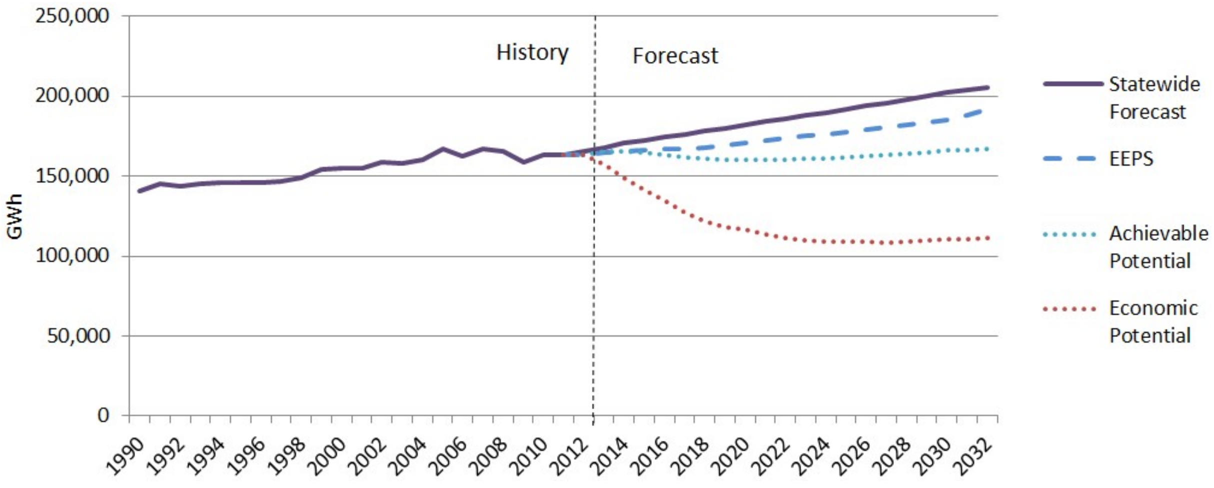
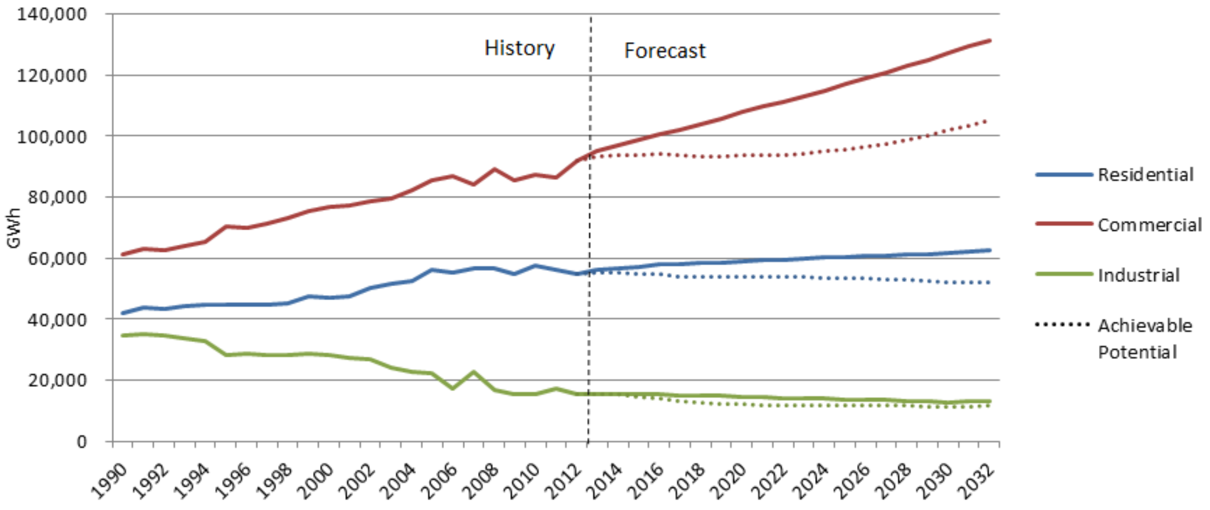
[11] Projected savings for the Energy Efficiency Portfolio Standard (EEPS) initiative are primarily attributed to energy efficiency programs, but also include savings attributed to building codes and federal appliance standards, and to upgrades to the transmission and distribution system. Citation: New York Independent System Operator. 2012. *2012 Load and Capacity Data, "Gold Book"* (draft).

Figure 5. Electric Total Forecast, Economic and Achievable Efficiency Potential, and EEPS Initiative.



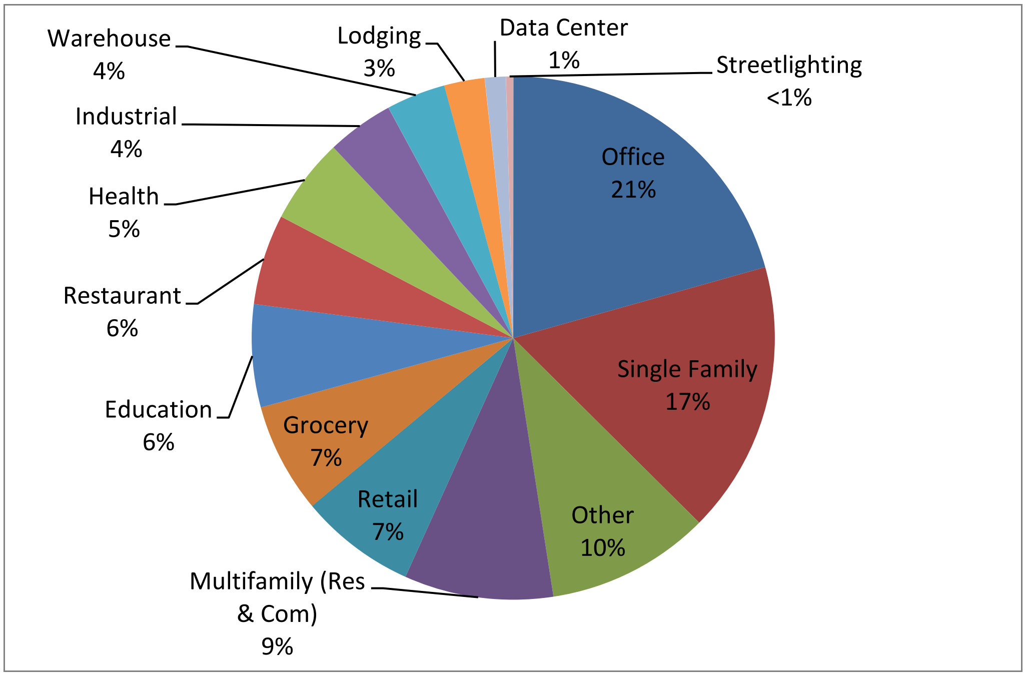
As can be seen in Figure 6, the potential is largest for the commercial sector. This is consistent with projections of most baseline electric load growth occurring in the commercial sector, with industrial loads slightly decreasing due to economic shifts in New York, and residential relatively flat over the 20 year forecast period.

Figure 6. Electric Forecast and Achievable Efficiency Potential by Sector.



The electric achievable efficiency potential by building type, for all sectors, in 2030,is shown in Figure 7. Commercial office buildings have the highest achievable potential with 21% of the total, followed by single family homes, “other” commercial buildings, and multifamily buildings. Together, these building types account for more than half the total potential.

Figure 7. Electric Achievable Efficiency Potential by Building Type (2030).



*The “Other” commercial building type includes buildings with commercial activity that do not fit into any other category (e.g. airplane hangars, crematoriums, laboratories, etc.)

3.2 Natural Gas Energy Efficiency

The analysis of natural gas potential savings was designed to identify energy efficiency potential for a 20 year period in the residential, commercial, and industrial sectors. The potential natural gas savings relative to the State’s load forecast is presented in Table 6 for the years 2020 and 2030. Economic potential is 20% of forecast load by 2020, and climbs to 33% by 2030. Capture of the achievable potential would result in a reduction of forecast load of 6% by 2020 and 11% by 2030. The natural gas potential as a percent of forecast is lower than the electric and petroleum fuels potential primarily due to the relatively low avoided costs for natural gas, which limit the cost-effective efficiency opportunities. The electric potential is also higher due to the electric measures having, on average, higher percent savings than the fossil fuel measures.

Table 6. Summary of Economic and Achievable Natural Gas Efficiency Potential Relative to Sales Forecast and NYS EEPS, 2020 and 2030.

	2020	2030
Statewide Forecast (BBtu)	896,194	960,460
Economic Potential (BBtu)	182,928	321,130
% of Forecast	*20%*	*33%*
Achievable Potential (BBtu)	53,014	107,899
% of Forecast	*6%*	*11%*
Savings from EEPS (BBtu)	14,100	14,100
% of Forecast	*2%*	*1%*

The total and individual sector potential savings in natural gas through 2030 are shown in Figure 8 and Figure 9. In the long-term, it is anticipated that baseline natural gas demand will increase, primarily in the commercial and industrial sectors as many customers are converting to natural gas from heating oil, driven either by economics or initiatives such as the New York City phase out of #6 and #4 fuel oil. As can be seen in the figures below, capture of the full achievable potential would roughly offset this growth over the 20 year period. Theoretical capture of the full economic potential would significantly decrease loads over time.

Figure 8. Natural Gas Forecast, Economic and Achievable Efficiency Potential, EEPS Initiative.

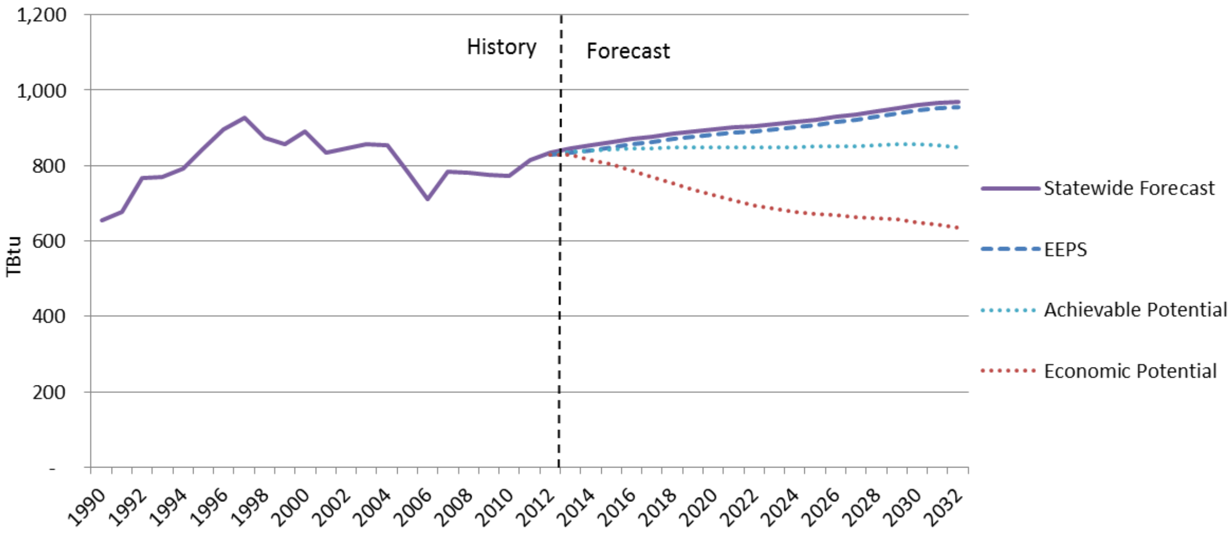
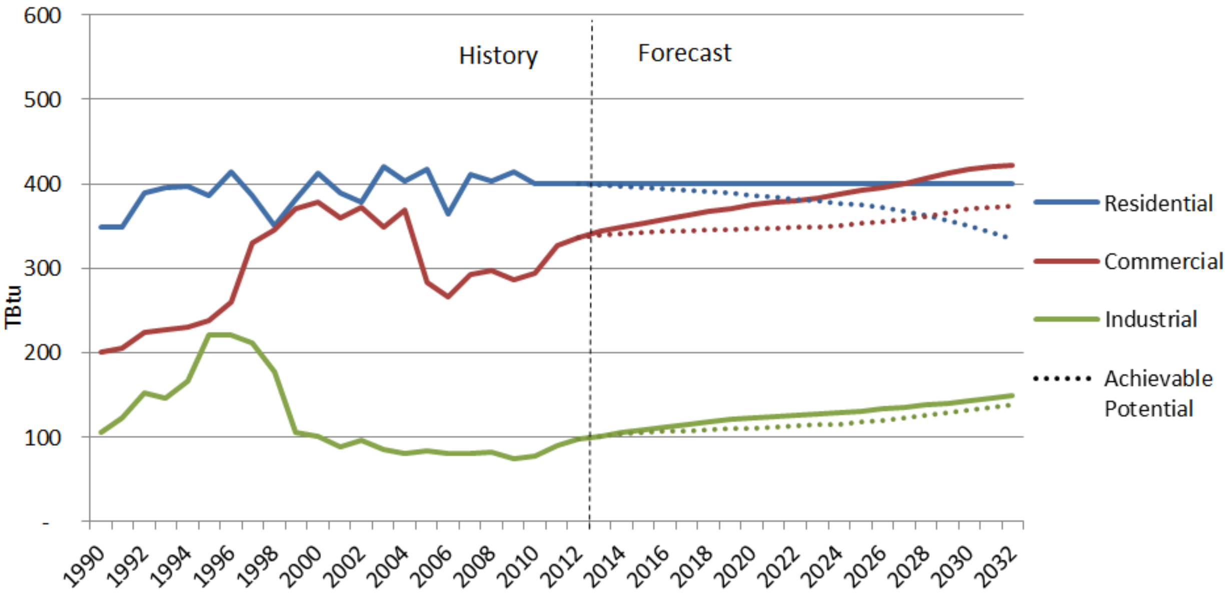
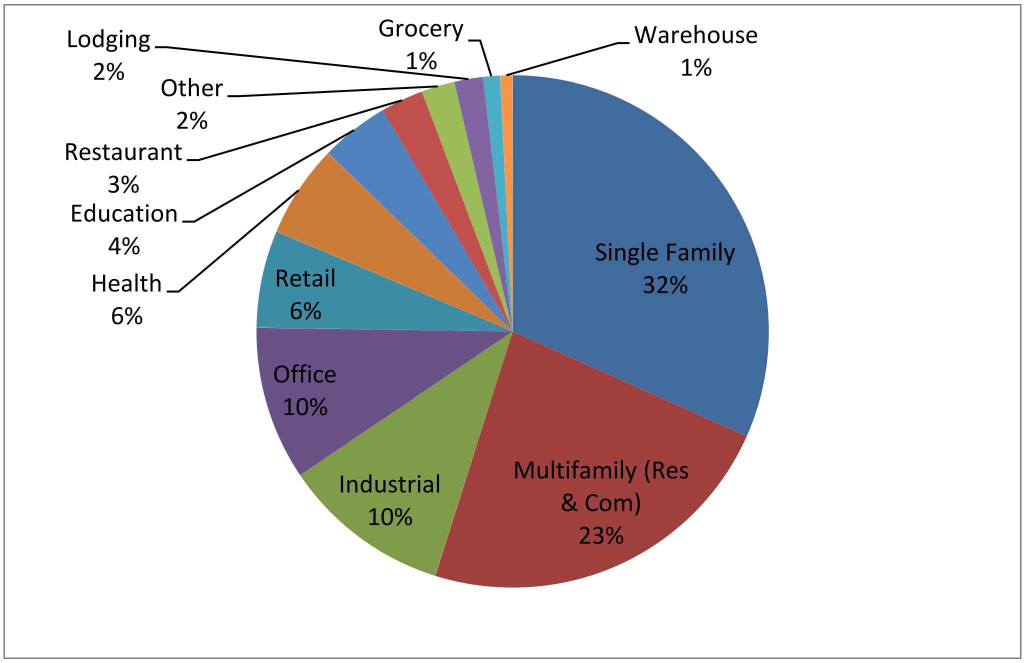


Figure 9. Natural Gas Forecast and Achievable Efficiency Potential by Sector.



The natural gas achievable efficiency potential by building type, for all sectors, in 2030 is shown in Figure 10. Single and multifamily homes account for 33% and 24% of the potential, respectively, together making up more than half the total potential. The remaining potential is spread broadly across a range of building types.

Figure 10. Natural Gas Achievable Efficiency Potential by Building Type (2030).



3.3 Petroleum Fuels Energy Efficiency

Petroleum fuels include distillate and residual fuel oil, propane, and kerosene. The potential petroleum fuel savings relative to the State's load forecast is presented in Table 7 for the years 2020 and 2030. Economic potential represents 25% of forecast 2020 petroleum demand, growing to 55% by 2030. Pursuit of the achievable scenario would result in savings of 7% and 20% of forecast petroleum demand by 2020 and 2030, respectively.

Table 7. Summary of Economic and Achievable Petroleum Fuels Efficiency Potential Relative to Sales Forecast, 2020 and 2030.

	2020	2030
Statewide Forecast (BBtu)	257,449	217,757
Economic Potential (BBtu)	63,710	119,969
% of Forecast	*25%*	*55%*
Achievable Potential (BBtu)	18,435	43,020
% of Forecast	*7%*	*20%*

The total potential savings in petroleum fuels through 2030 is shown in Figure 11 and Figure 12. In the long-term, it is anticipated that baseline demand for petroleum fuels will decrease, primarily in the commercial and industrial sectors, as many customers are converting to natural gas from heating oil and other petroleum fuels for economic or environmental reasons. New York has no petroleum use reduction goal, such as for electricity and natural gas, so these figures do not compare to the EEPS initiative.

Figure 11.Petroleum Fuels Forecast, Achievable and Economic Efficiency Potential.

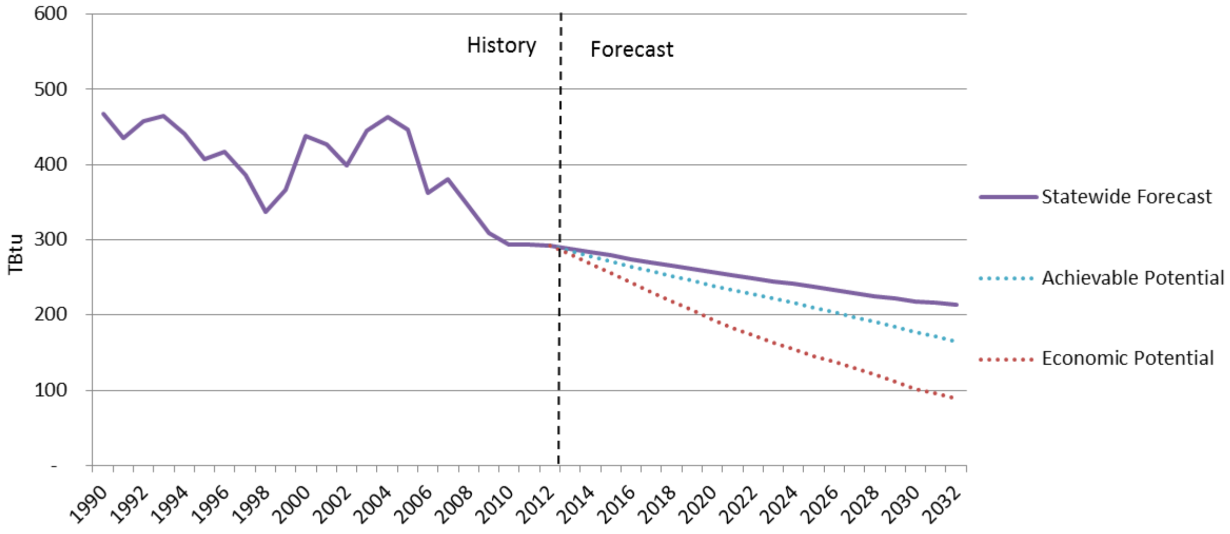


Figure 12. Petroleum Fuels Forecast and Achievable Efficiency Potential by Sector.

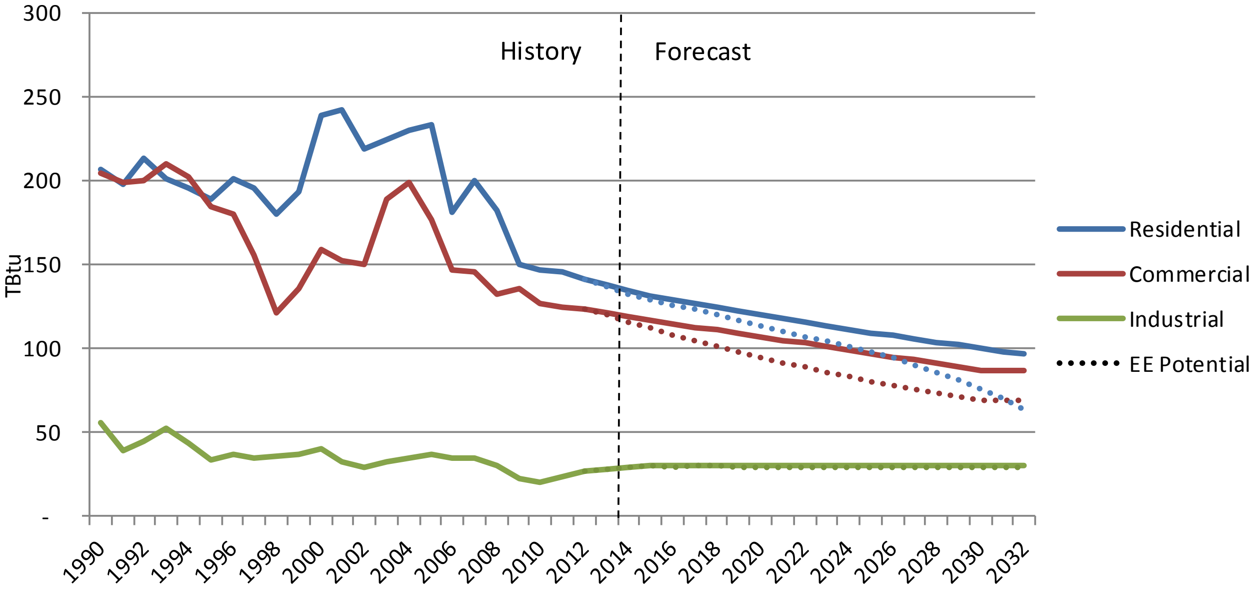
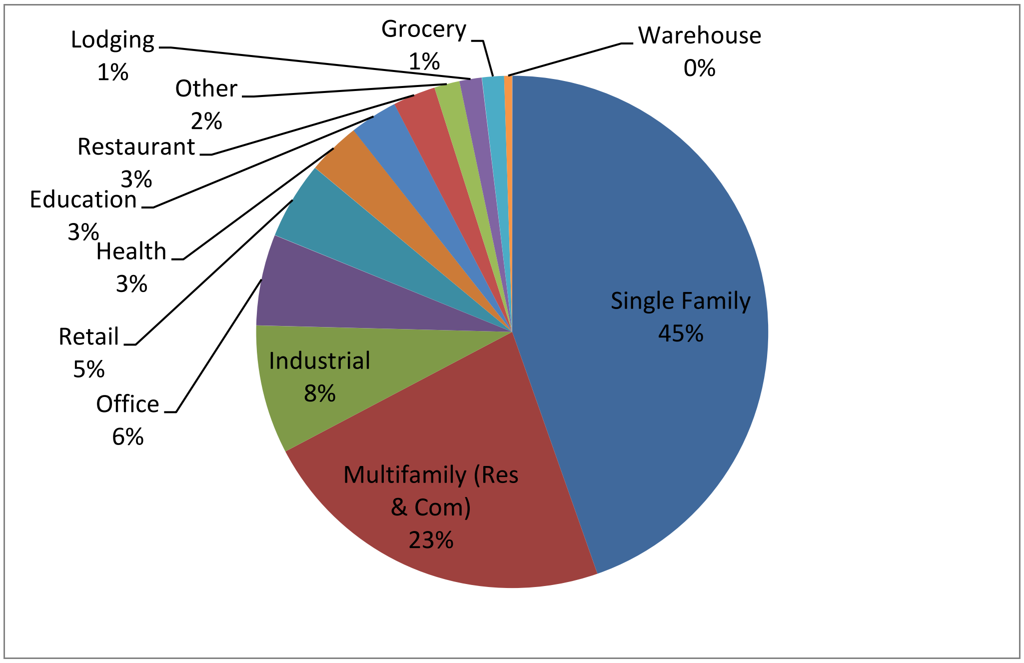


Figure 13 shows the petroleum fuels achievable efficiency potential by building type, for all sectors, in 2030. Single and multifamily homes account for 44% and 22% of the potential, respectively, together making up two thirds of the total potential. The remaining potential is spread broadly across a range of building types.

Figure 13. Petroleum Fuels Achievable Efficiency Potential by Building Type (2030).



4 Renewable Energy High-Level Results

4.1 Bounded Technical Potential

The “pure” technical potential of a renewable resource can be estimated based on the available primary renewable resource without regard for cost, social, or engineering constraints. However, “pure” technical potential offers little guidance to policy makers since it does not present a practical assessment of resource use. In contrast, the “bounded technical potential” of a renewable resource applies technical constraints, such as energy generation capacity factors and manufacturing base, developable land resource, and limiting social constraints, to the “pure” technical potential value to produce a more useful estimate.[12] Bounded technical potential is still a theoretical measure, though, as it does not consider costs or real world market constraints. The bounded technical potential of a resource is expected to increase over time as technical advances are made.

1.2.1 Primary Energy

If fully developed, the BTP for the renewable resources and applications described in this report could meet 20% of New York’s projected primary energy needs in 2020 and 41% in 2030, which are estimated to be approximately 3,852 and 3,962 trillion British thermal units (TBtu), respectively.

Wind and solar resources provide the greatest potential for growth with hydro and biomass providing significant incremental resources, but lower growth. Table 8 and Figures 14 and 15 illustrate that in comparison to 2010 when hydro and biomass are the dominant renewable resources, by 2030 renewable energy supplies in New York State could be more evenly distributed across the four major resource categories.

Table 8 includes energy used for transportation in the totals. If this energy was excluded and renewable energy was just compared to energy used for heat and electricity, then the share of renewable resources increases to 54% of New York’s projected energy needs in 2030.

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[12] For example, social constraints can include policy decisions that prohibit the development of renewable energy projects in State parks.

Table 8. Renewable Energy Bounded Technical Potential (TBtu).

Resource		In-State Use (TBtu, 2010)	% of Total Primary Energy Use (2010)	Projected In-State Bounded Potential (TBtu, 2020)	% of Projected Total Primary Energy Use (2020)	Projected In-State Bounded Potential (TBtu, 2030)	% of Projected Total Primary Energy Use (2030)
Hydro	*Conventional*	227	6%	254	7%	325	8%
	Hydro Kinetic	n/a	n/a	3.8	0%	19	0%
Bioenergy	*Biomass*	74	2%	133	4%	205	6%
	Biogas	6.6	0%	70	2%	25	1%
Wind	*Onshore*	25.3	1%	87	2%	187	5%
	Offshore	n/a	n/a	20	1%	244	6%
Solar	*Solar PV*	n/a	n/a	176	5%	509	13%
	Solar Thermal	0.0	0%	20	1%	97	2%
Total		**348**	**332**	**762**	**20%**	**1,611**	**41%**

Table notes:

1. Potential contributions from wave energy are not included in these results, due to the early stages of technical and commercial development. However, as detailed in Vol. 3 wave energy could provide a significant resource in the future – adding approximately 150 TBtu to the hydro results in 2030.
2. 2010 in-state use data is derived from the 2014 Draft New York State Energy Plan. Estimates do not include customer-sited resources.
3. TBtu/GWh factors differ by technology and year and are presented in Volume 5, Renewable Energy Technical Appendices.
4. Biomass primarily designates forestry- and agriculture-based sources of non-fossil plant materials that could be processed into various energy products. Biogas designates the methane produced from the anaerobic decomposition of biomass from sources such as landfills, wastewater treatment plants, manure, and other agricultural byproducts, and food processing facilities. Biomass includes yellow and brown grease.
5. Biomass TBtu figures are actual, not converted to Primary Energy.
6. Primary energy totals include transportation energy.

The 2010 market penetration of renewable energy sources with the bounded technical potential, relative to New York's primary energy consumption is shown in Figure 14. This can be compared to Figure 15, which shows the bounded technical potential for the renewable share of primary energy in 2030. These data show that in-state renewable energy sources have the potential to increase more than fourfold between 2010 and 2030. Figures 14 and 15 also show how the proportional makeup of the renewable energy resources could change over the same time period.

Figure 14. 2010 Mix of Renewable and Non-Renewable Primary Energy.

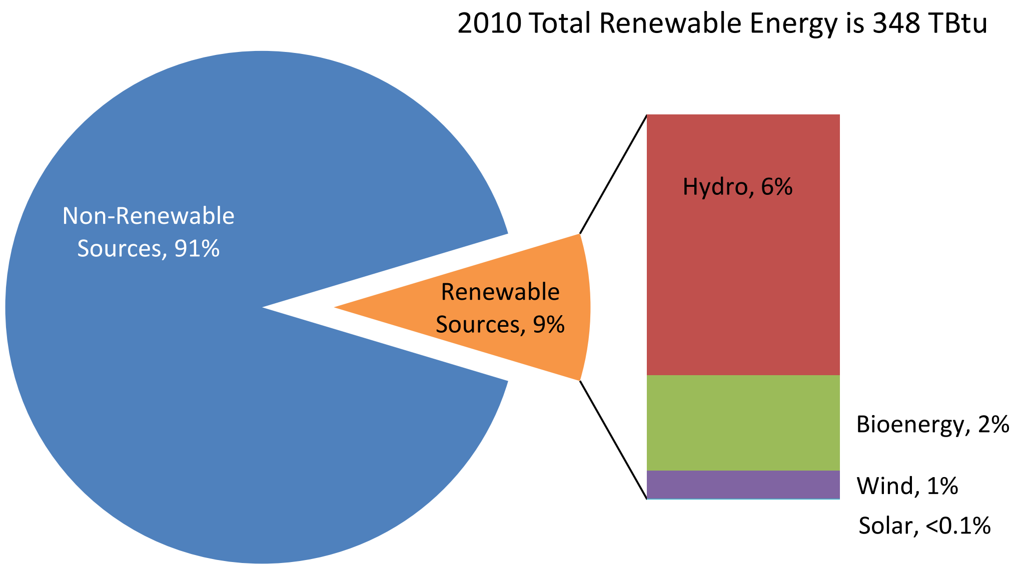
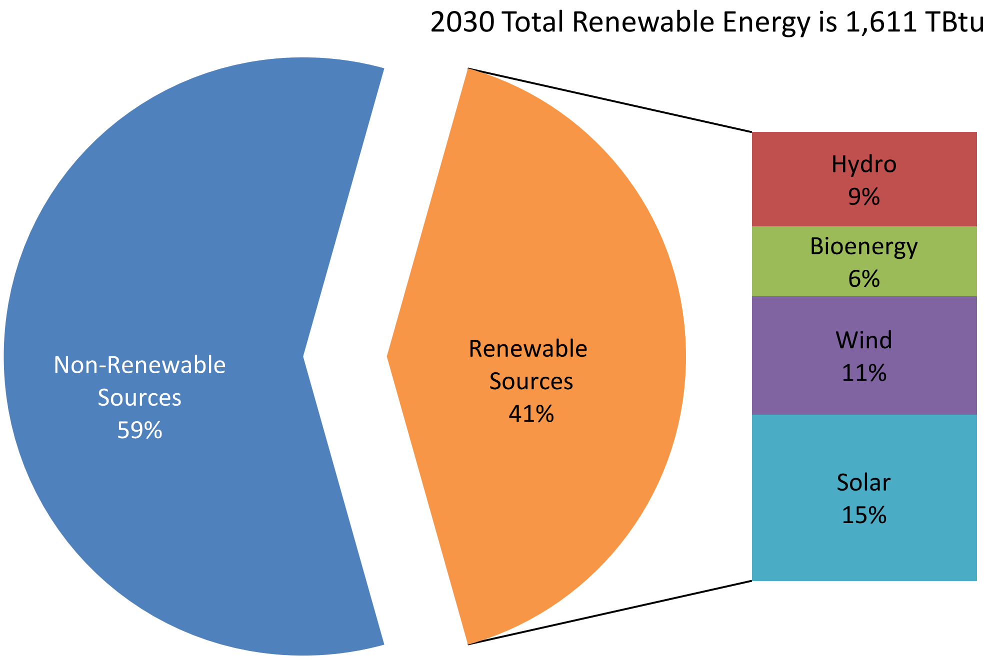


Figure 15. Bounded Technical Potential 2030, Renewable Share of Total Primary Energy.



The following table shows that renewable resources could theoretically provide one third of projected electric use by 2020 and over two thirds of projected use by 2030 if they were unconstrained by real world fiscal and market constraints.

Table 9. Renewable Energy Bounded Technical Potential Electric Generation (GWh).

Resource		2010		2020		2030	
		In-State Electricity Generation (GWh)	% of Projected Electricity Generation	Projected BTP Electricity Generation (GWh)	% of Projected Electricity Generation	Projected BTP Electricity Generation (GWh)	% of Projected Electricity Generation
Hydro	*Conventional*	24,214	15%	26,176	15%	34,021	17%
	Hydro Kinetic	3.5	n/a	427	0%	2,118	1%
Bioenergy	*Biomass*	315	0%	795	0%	1,396	1%
	Biogas	708	0%	1,320	1%	2,219	1%
Wind	*Onshore*	2,596	2%	8,911	5%	19,169	10%
	Offshore	0	n/a	2,042	1%	25,025	13%
Solar	*Solar PV*	61	n/a	18,700	11%	54,100	27%
	Solar Thermal	0	0%	194	0%	928	0%
Total		**27,898**	**17%**	**58,565**	**33%**	**138,975**	**70%**

Table notes:

1. Wave energy is not included in the BTP for hydro due to the early stages of technical and commercial development. If wave energy becomes feasible it could add significant resource of about 17,000 GWh by 2030, which is equivalent to an additional 8% of projected use in that year.

2. 2010 in-state use data is derived from the 2014 Draft New York State Energy Plan.

4.2 Economic Potential

Economic potential results indicate that a significant share – 53% – of the identified BTP is found to be cost effective. Statewide thermal and electric economic potential compared to the BTP are presented in Tables 10, 11 and 12 and in Figure 16. Zonal results are presented in Volume 3.

A relatively high share of the BTP is economic for several reasons. First of all, the BTP is much lower than a typical unbounded technical potential estimate, and therefore the relative share of economic potential to BTP is higher than it would be if the potential was compared directly to an unbounded technical potential. Second, some technologies, most importantly PV, are projected to have cost declines during the study period and much of the deployment occurs in years when these technologies have become cost effective.

Table 10. Renewable Energy Economic Potential (TBtu of Primary Energy).

Resource		2010		2020		2030	
		In-State Use (TBtu)	% of Total Primary Energy Use	Projected In-State Economic Potential (TBtu)	% of Projected Total Primary Energy Use	Projected In-State Economic Potential (TBtu)	% of Projected Total Primary Energy Use
Hydro	*Conventional*	236	6%	241	6%	303	8%
	Hydro Kinetic	0	0%	0	0%	0	0%
Bioenergy	*Biomass*	75	2%	132	3%	201	5%
	Biogas	11	0%	65	2%	15	0%
Wind	*Onshore*	25	1%	39	1%	99	2%
	Offshore	0	0%	0	0%	25	1%
Solar	*Solar PV*	0.6	0%	33	1%	125	3%
	Solar Thermal	0	0%	12	0%	78	2%
Total		**348**	**9%**	**522**	**14%**	**847**	**21%**

Figure 16. 2030 Economic Potential, Renewable Share of Total Primary Energy.

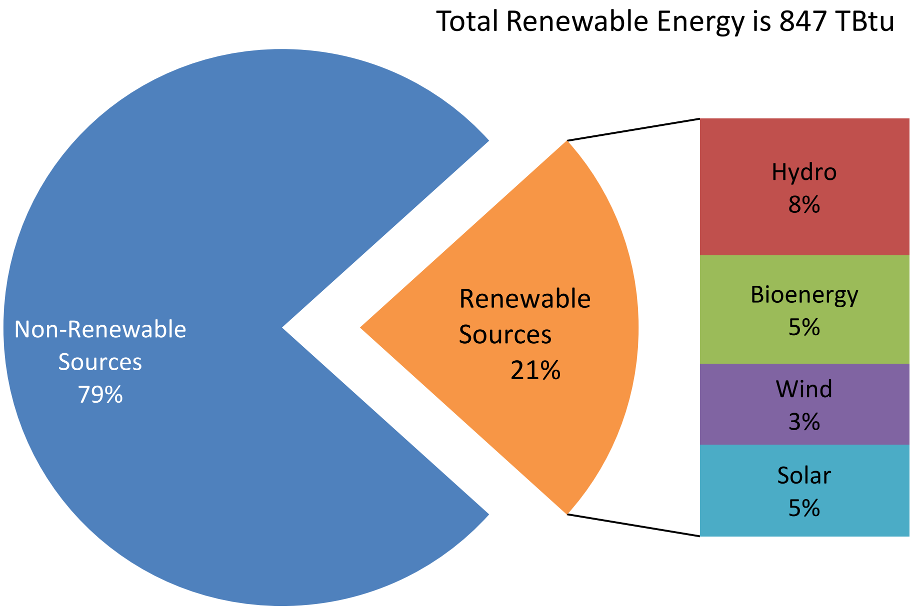


Table 11. BTP and Economic Potential, New Renewable Thermal End Uses (TBtu).

	Total TBtu			
	2020		2030	
Resource	BTP	Economic	BTP	Economic
Bioenergy	53	52	119	117
Solar Thermal	18	11	88	70
Total	**71**	**62**	**208**	**186**

Table 12. BTP and Economic Potential, New Renewable Electric Generation (GWh).

		Total GWh			
		2020		2030	
Resource		BTP	Economic	BTP	Economic
Hydro	*Conventional*	1,962	560	9,807	7,454
	Hydro Kinetic	423	0	2,114	0
Bioenergy	*Biomass*	480	399	1,081	898
	Biogas	612	133	1511	473
Wind	*Onshore*	6,315	1,403	16,573	7,517
	Offshore	2,042	0	25,025	2,571
Solar	*Solar PV*	18,639	3,421	54,039	13,259
	Solar Thermal	194	194	928	928
Total		**30,667**	**6,110**	**111,08**	**33,100**

5 Conclusions

The study found that large reservoirs of clean energy potential exist in New York State. The economic potential for efficiency is large relative to forecasted electricity requirements, with the cumulative savings amounting to nearly 45% of electric sales by 2030. The achievable potential is still significant with cumulative savings of about 18% of electric sales by 2030. The analysis shows the highest electric efficiency potential in the commercial sector, which is also where electric load growth is greatest. Similarly, the analysis finds that efficiency potential is greatest in New York City and Upstate New York, which is largely a function of greater electric sales.

The potential savings for natural gas and petroleum fuels are similarly large, though less so than the electric potential. Cumulative economic potential for natural gas amount to roughly 32% of sales in 2030, while the achievable potential is lower at about 11% of sales in 2030. Cumulative economic potential for petroleum fuels amounts to roughly 53% of sales by 2030, while the cumulative achievable potential is roughly 20% of sales by 2030.

Capture of the achievable efficiency potential would result in nearly $30 billion dollars of net benefits to the state in present value 2012 dollars, and return about $1.88 for every dollar invested. About two thirds of the net benefits would accrue from the commercial sector, with the balance coming mostly from residential and about 6% of the net benefits coming from the industrial sector. The potential associated with the achievable scenario – which assumes a set of comprehensive efficiency programs that pay, on average, 50% of incremental costs – is considerably higher than the savings targets for New York's current programs. This finding suggests current programs will have ample opportunity for continued cost-effective efficiency savings, and could be expanded to generate greater energy savings and greater economic benefits for the state while remaining cost-effective.

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.[13] 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 on- and off-shore wind by 2030.

These findings, when viewed in light of the State's established pursuit of aggressive clean energy initiatives, reflect the fact that new resource opportunities continue to grow as efficient and renewable technologies improve and their decline. The State will continue to have substantial opportunities to reap the benefits of cost-effective clean energy for its citizens and businesses well into the future.

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[13] Total energy supply includes energy for transportation.

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Energy Efficiency and Renewable Energy Potential Study of New York State

Volume 1: Study Overview

Final Report
April 2014

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