ENERGY EFFICIENCY AND RENEWABLE ENERGY RESOURCE DEVELOPMENT POTENTIAL IN NEW YORK STATE

Final Report

VOLUME TWO:

TECHNICAL REPORT

ANALYSIS APPROACH AND CONSOLIDATED RESULTS

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Section 1:
OVERVIEW

The New York State Research and Development Authority (NYSERDA) commissioned this assessment of the technical and economic potential for electricity from energy efficiency and renewable resources over the next five, 10, and 20 years both statewide and within each of five control-area load zones: The five zones analyzed in this study are:

- Zone A: West, containing Buffalo and surrounding areas
- Zone F: Capital, consisting of the greater Albany area
- Zone G: Hudson, including Dutchess and Putnam counties
- Zone J: New York City
- Zone K: Long Island

Figure 1.1 of Volume 1 shows these locations on a New York State map.

This technical and economic potential analysis estimates and compares the costs and performance of efficiency improvements in the end-use of electricity in the residential, commercial, and industrial sectors, and of renewable-electricity generation using biomass, fuel cells, hydropower, landfill gas, municipal solid waste, solar, and wind technologies. The analysis encompasses thousands of efficiency and renewable-technology applications, and spans horizons of five, 10, and 20 years.

Building on the statewide technical potential analysis, this study also examines two achievable potential scenarios for energy efficiency and renewable resources. The first achievable scenario assesses the potential for efficiency and renewable resources to contribute toward a least-cost solution for meeting New York's greenhouse gas (GHG) targets for 2010 and 2020. The second achievable scenario estimates the likely electricity contributions from efficiency and renewable resources under currently planned initiatives (CPI) in the State Energy Plan to promote them.

The technical potential for efficiency savings and renewable supply represents the amount of energy and peak capacity theoretically available from each resource in the State or load zone, applied as if all the technically feasible opportunities for the technologies were universally developed in the marketplace. This analysis is limited solely by practical or physical constraints, without regard to cost or market acceptability.

How much of this technically feasible efficiency and renewable resources to consider economic depends both on their costs and their value. The study estimates the economic potential for efficiency and renewable

resources as the portion of technical potential costing less than the conventional electricity supply it would displace. This assessment values efficiency and renewable resources according to NYSERDA's estimates of the electric supply costs they avoid in the long run.

The achievable potential analysis introduced two modifications to the technical potential analysis: achievable market-penetration rates predicated on aggressive market-intervention strategies; and achievable cost "adders" reflecting the costs to support the intervention strategies that would achieve higher efficiency and renewable market penetration.

For the GHG analysis, the study produced a consolidated efficiency and renewable supply function, indicating in order of increasing achievable cost the size of the achievable contribution from each set of efficiency and renewable resources. The analysis selected efficiency and renewable resources in increasing order of life-cycle cost per kWh of electric energy until the GHG target would be reached. The study finds that efficiency and renewable technologies could achieve New York's GHG-reduction targets at costs well below the conventional electric supply they would displace. In projecting and comparing the benefits and costs of least-cost combination of efficiency and renewables for meeting the GHG targets, the study finds that New York would benefit substantially if the State pursued such a least-cost approach to deploying efficiency and renewables to meet GHG targets.

The study also developed independent estimates of expected achievements from market-intervention strategies included in currently planned initiatives in the State Energy Plan. It analyzes the benefits and costs of the electricity from efficiency and renewable investments expected to result under currently planned initiatives. These expected contributions from both efficiency and renewable technologies will benefit New York's economy substantially.

Section 2:
APPROACH

This study had two main objectives:

- to assess the technical and economic potential for energy-efficiency measures and renewable-energy resources in New York and five key New York "control area load zones" (West, Capital, Hudson Valley, New York City, Long Island); and
- to estimate the statewide contributions from efficiency and renewables (1) toward meeting the State's greenhouse-gas targets, and (2) likely to result from currently planned initiatives.

The study periods of interest are 2007, 2012, and 2022. Estimates presented in this study should be interpreted as expected values of the potential magnitudes and costs of available and achievable efficiency and renewable resources.

The scope of analysis includes efficiency technologies applicable to all major end uses of electricity in the residential, commercial, and industrial sectors. Each sector's analysis considers efficiency technologies applicable to New York's wide range of buildings and markets. The renewable analysis deals with electricity generation from biomass, fuel cells, hydropower, landfill gas, municipal solid waste, photovoltaic, solar thermal, and wind technologies. The analysis examines potential from a variety of application types for each of these renewable technologies and explicitly addresses expected changes in electricity usage and technological performance during the 20-year study period.

TECHNICAL AND ECONOMIC POTENTIAL ANALYSIS

Technical Potential

As defined for this assessment, technical potential represents the upper limit for capacity and energy that is theoretically possible, without regard to cost, market barriers, or market acceptability. This technically feasible potential includes efficiency and renewable-technology applications that are plausible and practical within pragmatic physical constraints.

This study examines energy-efficiency technologies for all major end uses in the residential, commercial, and industrial sectors. The efficiency potential analysis for each sector was developed on the basis of information on the size of the electricity-consuming population. NYSERDA's own electricity forecast and underlying data were the principal source for this information, which the study supplemented with other publicly available data. NYSERDA's zonal electricity forecasts provided the basis for estimating efficiency market size. The study relied on information from other public and private sources where possible to develop zonal technical potential estimates for each sector (e.g., distribution of industry by county). In general, the statewide technical potential analysis is

more reliable than the zonal analyses because the quality of the underlying market population data is higher than for the zonal analyses. The efficiency technical report and appendix (Volumes 3 and 5) contain details on efficiency technologies analyzed and data sources used.[1] Deliberately excluded from the efficiency potential analysis were fuel-substitution technologies (e.g., conversion of electric-resistance space heating to gas-fired hydronic heat), as well as technologies and practices for shifting or curtailing electricity end uses (e.g., load control, interruptible rates, and demand-response strategies).

Renewable resources for the purposes of this study include electricity produced from the following sources: biomass; fuel cells; hydropower; landfill gas and municipal solid waste; solar (photovoltaic and solar thermal); and windpower.[2] Separate technical potential analyses were conducted for each technology.[3] Each technology assessment examined a variety of technology applications, primarily distinguishing between distributed and central-station deployment. These analyses are presented in the Renewables Technical Report (Volume 4), with supporting details provided in the Renewables Technical Appendix (Volume 6).

At the core of the technical potential analysis are detailed characterizations of the performance of efficiency and renewable technologies. The technical potential analysis applies these technology characterizations to statewide and zonal efficiency and renewable markets to produce statewide and zonal estimates of aggregate technical potential in 2007, 2012, and 2022. Technology characterizations for efficiency resources are detailed and documented in Volume 5, Appendix 5.1 for residential, Appendix 5.2 for commercial, and Appendix 5.3 for industrial. Renewable Technology characterizations appear in Volume 6, Appendix 6.3

Efficiency resources consist of reductions in end-use energy intensity from baseline levels implicit in forecasts of energy consumption and peak demand. The technical potential for efficiency savings derives from estimates of baseline efficiency conditions, since forecasts of future electricity consumption are predicated on some level of end-use efficiency absent future market intervention. Energy-efficiency technical potential represents the savings from universal application of efficiency technologies to a particular end-use. As such, the efficiency technical potential is ultimately limited by (a) the amount of electricity consumed by the full range end-uses in homes, businesses, and factories; (b) the degree of technical applicability and feasibility of potential efficiency technologies throughout the population; and (c) the performance of the full range of current and emerging efficiency technologies over time.

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1 Table 3.2.3 in Volume 3 provides a detailed listing of residential efficiency technologies analyzed; comparable information for commercial industrial technologies is found in Table 3.3.2. The industrial technologies examined are listed on pp. 3-85 of Volume 3.

2 Solar thermal could arguably be counted as an efficiency resource since no electricity is actually produced; rather, solar energy production displaces electrically-heated hot water.

3 Table 4.1.3 in Volume 4 provides details of the renewable technologies and scales examined in the study.

Energy-efficiency resource potential differs fundamentally from renewable potential in that the potential supply of renewable energy is not connected to underlying energy use at the site. It is limited rather by the presence of the underlying physical energy source and the efficiency with which available technology can convert it to electricity. The major constraints on renewable technical potential is ultimately the physical availability of the renewable resource throughout the State, coupled with the performance of the technologies converting each renewable resource into electricity. Whereas efficiency savings can never theoretically exceed electric energy requirements, the same is not necessarily true for renewable supply.

The study produced estimates of technical potential from efficiency and renewable resources in each of the five load zones and for the entire State in 2007, 2012, and 2022.

Economic Potential

The economic potential from efficiency and renewable technologies is that subset of technical potential which is cost-effective compared to the electric supply it would avoid. It is determined by removing from technical potential the efficiency savings and renewable supplies that are not found to be cost-effective under long-run estimates of avoided electricity costs. NYSERDA separately furnished projections of avoided electric generation energy and capacity costs for each load zone, which vary by year, and within each year according to season and time of day. This analysis used these estimates to value the economic benefits from technically feasible efficiency savings and renewable supply.

To complete these benefit-cost comparisons for the economic potential analysis, the study characterized energy efficiency and renewable technology costs over time. Technology costs consist of capital and labor costs and, where applicable, operation and maintenance costs. Also included in technology costs estimates were the values of additional non-electricity resource usage or savings (the latter were counted as negative costs). Among the non-electricity usage or savings included in the analysis were natural gas, fuel oil, and water.

The study compared efficiency and renewable technology benefits and costs over time by calculating the present worth of future values in 2002 using a real societal discount rate of 4%. It provides estimates of economic potential for each of the five zones using the zonal avoided costs provided by NYSERDA, the technology cost estimates developed for economic potential analysis, and the results of the study's zonal technical potential analysis. This study estimated statewide economic potential by valuing statewide technical potential under two sets of avoided costs: the highest (Long Island) and lowest (West Zone).

ACHIEVABLE POTENTIAL SCENARIO ANALYSES

Achievable Contributions toward New York's GHG Targets

The study extended the technical and economic potential analysis to determine which efficiency and renewable technologies would be expected to make economically achievable contributions toward meeting the State's GHG-reduction targets. It then assembled the results of this analysis to find out how large the aggregate contributions from these technologies would be, and how much they would be worth to the State's economy.

This analysis required the following further steps. Combining these additional estimates with the technical potential analysis, the study calculated the achievable electric energy contribution and the net life-cycle energy cost per kilowatt-hour (kWh) from specific efficiency and renewable technologies. This net cost calculation subtracted all non-energy benefits from the achievable technology costs (including the added administrative costs) to arrive at the net cost of electric energy. The analysis then selected technologies in order of increasing achievable cost per kWh to establish the total achievable contribution from economical efficiency and renewable technologies.

The study presents these results graphically in the form of "supply curves", and in tabular form. It also compares the benefits and costs of the least-cost combination of efficiency resources achievable from each sector and the renewable resources achievable from each technology. The report performs these benefit-cost comparisons using the same sets of high and low zonal avoided costs employed in the economic potential analysis. The report presents all these results for 2012 and 2022.

The study estimated the achievable supply of GHG contributions from efficiency and renewable resources by applying the GHG market-penetration rates. Aggressive market-intervention strategies underlying the market penetration rates for the GHG analysis are described in the efficiency and renewable technical appendices (Volumes 5 and 6, respectively).[4] The achievable contribution from each resource can be represented as a supply "block". The "width" of the block is the size of the achievable electric energy supply. The achievable technology cost represents the height of the supply cost. Costs and quantities of achievable GHG contributions were developed for 2012 and 2022. When sorted in order of increasing costs, these supply blocks produce a GHG supply function. The least-cost GHG solution is found by including progressively more costly technologies until the target for the particular year is met. The study then projects and compares the total costs and benefits that would result from achieving the least-cost mix of efficiency and renewable contributions toward the GHG targets, valued at both the lowest and highest zonal avoided costs.

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4 See Volume 5, Appendix 5.4 for descriptions of aggressive market-intervention strategies that have succeeded in achieving high market penetration of efficiency technologies. See Table 6.4.3 in Volume 6 for information on renewable market-intervention strategies.

This analysis of achievable potential for GHG reductions is subject to several important limitations on its use. First, the present analysis cannot reasonably be used to project and plan outcomes from specific market-intervention initiatives either at the state or zonal level. A program potential analysis would be the proper approach for making such projections or plans. Program potential analysis estimates savings and costs that could be achieved by applying a specific set of market-intervention strategies to promote increased market penetration of particular technologies in a particular market. In such an analysis, technologies are characterized, then subjected to cost-effectiveness to determine which to include in program planning. Program potential analysis separately estimates the costs of planned market-intervention strategies, which are relatively fixed and thus do not vary directly with the technologies included in the program or the amount of efficiency and renewable supply they produce. Program administration costs are added to technology costs to determine total program costs. A second-stage cost-effectiveness analysis compares the total program costs with total benefits.

Thus, program potential analysis more accurately reflects the true economics of a particular set of market-intervention strategies. Although the achievable potential analysis in this study is not well suited to assessing program potential, the technology characterizations developed for this study are appropriate for use in conducting such analysis.

Similarly, it would not be appropriate to use the GHG analysis in this study to plan efficiency and/or renewable alternatives to specific electricity supply resources. Such an undertaking would require a program potential analysis configured to provide the higher confidence levels required for planning the electricity resource in question. For example, transmission capacity investment is usually analyzed in terms of its ability to reduce the probability of electricity outages to an acceptable level. Meeting the reliability standards associated with transmission planning therefore would require estimates of achievable contributions with a low likelihood of falling short.[5] With basically a 50/50 chance of being too high or too low, the estimates of achievable market penetration in this study are not intended to provide such a high confidence level in projected resource contributions.

Finally, the portfolio of greenhouse-gas resources assembled for this analysis is derived solely on the basis of cost. Consequently, the composition of these resources is not balanced in the sense that it would not reflect how resources would be allocated to meet other policy objectives of the State Energy Plan, such as market transformation, distributional equity, or portfolio diversity.

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5 For example, a recent analysis of economically achievable transmission capacity from energy-efficiency resources in Vermont applied a 90% confidence standard, i.e., demand-side transmission capacity levels were projected with 90% confidence that actual results would equal or exceed predicted values. J. Plunkett, C. Neme, and P. Mosenthal, Assessment Of Economically Deliverable Transmission Capacity From Targeted Energy-Efficiency Investments In The Inner And Metro-Area And Northwest And Northwest/Central Load Zones, prepared for The Vermont Electric Power Company, April 2003.

Expected Achievements from Currently Planned Initiatives

Consistent with the State Enery Plan, the analysis assumed that programmatic funding extends through:

- June 2004 for LIPA and NYPA initiatives
- June 2006 for NYSERDA efficiency and renewable initiatives, except
- 2022 for draft state purchasing regulations which NYSERDA has promulgated as of September 3, 2002
- 2020 for Executive Order 111.

The study estimates market-penetration rates expected to result from currently planned initiatives contained in the State Energy Plan. Estimated outcomes from these initiatives were developed independently using professional judgment of the study's authors and thus differ somewhat from outcomes projected in the State Energy Plan by NYSERDA. The study also applied efficiency and renewable technology performance and cost estimates developed for the technical and economic potential analysis. This analysis also relied on information provided by NYSERDA concerning historical activity levels, stated design intent, and quantitative expectations for currently planned initiatives in its STATE ENERGY PLAN estimates. Since currently planned initiatives interact in their impacts on efficiency and renewable technology markets, this study estimated expected achievements associated with the technologies analyzed in the technical and economic potential, rather than by individual initiative as is usually the case in reporting program results.

Achievable Market Penetration Rates and Achievable Technology Costs

The achievable potential analysis introduced two additional factors to the technical potential analysis: achievable market penetration, and additional costs associated with market-intervention strategies to achieve higher market penetration than would be expected absent such intervention.

Market Penetration Scenarios

The study developed independent estimates of achievable statewide market penetration rates for efficiency and renewable technologies by 2007, 2012, and 2022 for efficiency and renewable technologies under three scenarios:

- Achievable market penetration assuming highly aggressive market-intervention strategies designed to secure major contributions by efficiency and renewable resources toward New York's GHG targets;
- Expected market penetration under currently planned market-intervention strategies throughout New York; and
- Base-case market penetration assuming no future market intervention beyond 2002.

The estimated contributions toward greenhouse-gas targets and from currently planned initiatives are calculated as the difference between these two respective sets of market penetration projections and the base case market penetrations. These deviations from the base case market penetrations yield the achievable increase in efficiency

savings and renewable supply to meet New York's electricity requirements. Detailed efficiency market penetration rates are provided for efficiency technologies in Volume 3, Table 3.2.12 for residential, Table 3.3.11 for commercial, and Table 3.4.5 for industrial. Renewables market penetration projections are provided in Volume 6, Appendix 6.3.

The development of base case market penetrations for efficiency and renewable technologies over the study period was an essential step in the achievable potential analysis. The study estimates current and future market penetration assuming no further market intervention of any kind beyond 2002 for each technology or technology set. Base-case market penetrations posit counter-factual trajectories of technology diffusion in the absence of any market intervention beyond 2002 ("counter-factual" because actual market outcomes will presumably reflect the influence at the very least of currently planned initiatives). While the base case market penetrations of efficiency and renewable technologies reflects market forces and the absence of further market intervention, they do recognize future market effects of past market interventions (e.g. future efficiency codes and standards anticipated now as the result of past market penetration from previous market intervention). For renewables the base case represents the impact of renewable electricity projects already on-line, already permitted, or well along in planning as of 2002. Base case conditions were estimated statewide for 2007, 2012, and 2022. Statewide conditions were applied in the zonal technical potential analysis. These were adjusted for known zonal variations in efficiency markets or in existing or planned renewable electricity projects as of 2002.

Achievable Technology Costs

This study estimated the costs to achieve the efficiency and renewable technology market penetrations in the GHG and the currently planned initiatives, above and beyond the costs of the technologies themselves. For the GHG analysis, these additional costs were developed as achievable cost "adders" to estimates of efficiency and renewable technology costs.[6] These achievable-cost adders reflect only the costs of additional societal resources, such as marketing and administration. Specifically excluded from these estimates are any financial incentives paid as part of market-intervention strategies, since such expenditures reflect transfers between electricity users and do not utilize any additional societal resources. For currently planned initiatives, the study relied heavily on NYSERDA's own estimates of program delivery costs.

The analysis combined the achievable cost adders with the technology costs developed for the economic potential analysis to develop achievable technology costs of GHG reductions. The study applied these achievable technology costs to construct the efficiency and renewable supply function for meeting GHG targets. One final analytical step

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6 See Volume 3 for the administrative cost adders developed for energy-efficiency resources, in particular Table 3.2.13 for residential efficiency, and Table 3.3.12 for commercial and industrial efficiency. See Volume 6 for renewable administrative cost adders, Table 6.4.5.

was required: development of the net costs of electric energy supplied by efficiency and renewable resources to meet GHG targets.

Electric energy resources from efficiency and renewables provide New York with the means to reduce GHG emissions by avoiding the electric energy generation that produces them in the first place. The analytical difficulty is that efficiency and renewables produce more than just electric energy. To varying degrees, efficiency and renewable resources each produce joint output in the form of energy and capacity. The net cost of electric energy therefore must reflect a credit for the market value of capacity. The converse is also true: the net cost of capacity from efficiency and renewables must subtract the market value of energy from the "gross" life-cycle cost of the resource. This approach to assessing net resource costs is not uncommon in transmission capacity planning. When calculating the net cost of obtaining transmission capacity from generation resource alternatives, planners assume that energy output can be sold, the proceeds of which (net of fuel and O&M costs) are deducted from the capital cost of the generation resource.

Accordingly, this study subtracts the present worth of estimated generation capacity benefits from the achievable technology cost for each set of efficiency and renewable resources. The study also subtracts the value of other non-electric cost savings from achievable technology costs to compute the net achievable cost of electric energy contributions from efficiency and renewable resources toward meeting New York's GHG targets.

ECONOMIC ANALYSIS METHODOLOGY

Economic Perspective

This study assesses economic merit by estimating and comparing the total costs of the resources employed to provide electricity from efficiency and renewable technologies, with total benefits of conventional energy resources they avoid. Total resource costs consist of the capital, operation, maintenance, and fuel costs of efficiency and renewable technologies. The study values the economic benefits of electricity from efficiency and renewable technologies at the marginal costs of electric energy generation and capacity resources displaced. Also included in the analysis are costs of direct fossil fuel either incurred (e.g. for certain renewable resources like municipal solid waste) or avoided (e.g. by efficiency resources that save heating fuel and cooling electricity) by efficiency and renewable resources. The value of water savings is also included in the total resource benefits of efficiency and renewable technologies.

This total resource perspective on benefits and costs provides an accurate representation of the value of efficiency and renewable technologies to New York's economy.[7] Omitting non-electric benefits or costs would distort and bias the economic assessment of efficiency and renewable potential. For example, confining benefits to avoided electricity costs would understate the true economic savings provided by efficiency technologies that also save gas, oil, or water (e.g., high-efficiency clothes washers). By contrast, counting only those technology costs paid by programs to promote efficiency and renewable resources would understate their true costs (by ignoring substantial capital or operating costs).[8]

This study did not use retail electricity rates to value electricity savings, which are based on average, historical costs (as opposed to avoided marginal costs to value electric energy and capacity). Such an approach would have overstated true economic benefits to New York from efficiency and renewable resources, since retail rates throughnout New York substantially exceed the long-run marginal costs these resources would avoid. Embedded in retail rates are significant fixed costs which must be recovered even if efficiency and renewable resources were to supply much of New York's total electricity requirements. This is how benefits are valued in the widely-used Participant Test., which compares the expected bill savings for a single participant with the individual's contribution toward the efficiency or renewable cost. While valid for gauging the likely acceptability of a particular project, the Participant Test cannot be used to assess the true economic value of efficiency and renewable resources to New York.

This study also did not examine the potential effects on electricity rates from realizing efficiency and renewable potential. Such analysis would have to account for two additional factors beyond the scope of this study. The first would be the total expenditures supported by New York's electricity ratepayers, which this study did not attempt to estimate.[9] The other key factor in asessing potential rate impacts from realizing efficiency and renewable potential are future fixed costs that would still be recovered through reduced electricity sales volumes, something that was

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7 This economic perspective is known as the Total Resource Cost (TRC) cost-effectiveness test, widely used by utility regulators to judge the merits of energy-efficiency investments. This is the cost-effectiveness test used by the Massachusetts Department of Telecommunications and Energy (DTE) to judge energy-efficiency programs administered by that state's electricity and gas utilities. See MDTE Decision in Docket 98-100, Investigation by the Department of Telecommunications and Energy on Its Own Motion to Establish Methods and Procedures to Evaluate and Approve Energy Efficiency Programs, November, 1999.

8 The perspective represented by this example is known as the Energy System Test (EST) or the Utility Cost Test. The EST compares the direct electric benefits that accrue to electricity customers from the funds they provide to support efficiency or renewable programs. Although it is a poor measure of economic efficiency, the EST does provide a valid representation of distributional equity.

9 The study did estimate administrative costs for the GHG scenario, but did not project budgets for financial incentives payable to consumers or other market participants. For the CPI analysis, the study applied NYSERDA's budgets.

well beyond the scope of this study. Both these factors would need to be considered in addition to the avoided costs this study used to analyze the economic impacts of efficiency and renewable resources.[10]

The one shortcoming of the total resource cost perspective used in this study is that it ignores the value of external environmental costs avoided by reduced electric energy generation. This more expansive perspective is known as the Societal Test.[11] The omission of environmental externalities from this study's economic analysis is discussed further in the following section.

Avoided Electricity and Other Resource Costs

NYSERDA developed static estimates of period avoided electric energy and generating capacity costs through 2020. These estimates are static in the sense that they do not reflect the fact that large amounts of efficiency and/or renewable resources would tend to back down progressively lower-cost energy generation and thus lower market-clearing wholesale energy and capacity prices. A dynamic analysis of specific resource portfolio options would simulate the total costs of meeting lower electricity requirements and compare this with the total generation costs under forecast conditions (which implicitly include the effects of currently planned initiatives). Because efficiency and renewable resources last longer than the twenty years for which NYSERDA projected avoided costs, this study extrapolated these values another thirty years into the future. Tables 2.43 through 2.46 at the end of this volume present avoided electric energy and capacity costs through 2020 for Zones A, F, G, J, and K (with Zone A serving as the low range of statewide avoided costs and Zone K used for high statewide avoided costs).[12]

Also listed below in Table 2.47 are avoided fossil fuel costs developed by NYSERDA, which are consistent with NYSERDA's estimates of avoided electricity costs. These values apply to the direct fossil fuel savings in addition to electricity avoided by efficiency and renewable resources. The study also used avoided water costs, which NYSERDA developed in consultation with the Water Department of the New York Department of Public Service. This resource value averaged 0.4 cents/gallon, and was applied to water-saving technologies such as high-efficiency clothes washers.

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[10] For a comprehensive treatment of alternative cost-effectiveness tests, see P. Chernick and J. Plunkett, From Here to Efficiency: Securing Demand Managmenet Rsources, Volume 4: Screening Demand Management Options, prepared for the Pennsylvania Energy Office, Jannuary 1993.

[11] California, Vermont, New Jersey, and the Long Island Power Authority are among the jurisdictions and utilities that apply the Societal Test to assess the economics of efficiency and renewable resources.

[12] Zonal avoided costs are used in the benefit calculations underlying the economic potential estimates presented in Tables 2.6, 2.10, 2.14, 2.18, and 2.22 in Section 2.3.2. The low and high statewide avoided costs in Tables 2.42 and 2.46 are applied to electricity provided by efficiency and renewables in the statewide results for economic potential in Tables 2.2 and 2.3, as well as the benefit-cost analysis of statewide achievable potential in Tables 2.25 through 2.28.

Not counted in the economic benefits of technical and achievable potential are the following sources of resource value that have been reflected in other potential analyses:

- Avoided transmission and distribution capacity costs resulting from peak demand reductions leading to deferral or alteration of planned investments to increase capacity;
- Environmental externalities, i.e., the economic value of reducing pollutants with societal costs not monetized in market prices paid in the production or use of electricity;
- Reduced market-clearing wholesale electricity prices resulting from lower demand due to pursuit of efficiency and renewable resources; and
- Economic stimulus resulting from aggregate energy cost reductions resulting from the pursuit of cost-effective efficiency and renewable resources.

Avoided Transmission and Distribution Capacity. Efficiency savings, and to a lesser extent renewable supply, can defer the need to invest in transmission and distribution (T&D) capacity by lowering future peak demand on existing facilities. On a dollar-per-kilowatt basis, these avoided T&D costs have been found in other jurisdictions to be worth anywhere from half the value of avoided generation capacity to four times that amount.[13] Indeed, most of New York's investor-owned utilities are subject to regulatory requirements to examine distributed alternatives, including efficiency resources, to proposed T&D investments above certain magnitudes, which vary by utility.

Avoided environmental externalities. Efficiency savings and renewable supply avoid emissions of key pollutants associated with electricity generation. It is generally recognized that the economic costs of pollution are not fully reflected in the market prices paid to generate and sell electricity. In the past, monetizing these avoided external costs has added between 0.5 cents/kWh and 2.0 cents/kWh to avoided energy costs. Indeed, the long-run avoided costs (LRACs) routinely approved by the Public Service Commission reflected externality values on the order of one cent per kWh, roughly a third of NYSERDA's current estimates of avoided energy costs.

Lower market-clearing electric energy prices. By reducing overall demand for conventional wholesale supply, efficiency and renewables will tend to lower market-clearing wholesale prices paid for all electricity sold in New York or within particular load zones. This is especially true during high-demand, high-price hours. Even a very small effect on the overall wholesale price can translate into a relatively high premium on the efficiency and renewable demand reductions that produce them. Other jurisdictions, particularly California, have assigned a high value to avoided energy costs to account for this demand-induced price effect. There, regulators have adopted

[13] Other jurisdictions include avoided T&D costs of two to four times the value of avoided generating capacity costs reflected in this analysis. For example, NSTAR's 2003 Plan Update filing used T&D avoided costs of $154/kW.

multipliers to on-peak avoided costs ranging from 2.0 to 4.0 to reflect this broadly-distributed economic benefit from energy-efficiency savings. [14]

Economic stimulus. Reductions in total resource costs due to cost-effective efficiency and renewable investments stimulate economic activity in two ways. First and foremost, electricity cost reductions put more money at the disposal of households and businesses. Consumers and businesses then can reinvest tbese additional funds. That portion spent or invested in New York stimulates economic activity and creates jobs. This economic development value was recently estimated to be worth an extra $1.53 per dollar of efficiency investment in Vermont in 2002.[15]

Excluding these significant sources of economic value will systematically understate the benefits of efficiency and renewable savings. Conversely, reflecting any one of these additional sources of electric resource value from efficiency and/or renewable resources would likely exert a significant effect on the amount of technical potential found to be economic in New York and any of the five load zones.

Counting avoided T&D capacity costs would lower the estimated net cost of electric energy from efficiency and renewables to meet GHG targets. Expanding the scope of benefits included in the economic analysis would also raise the estimated benefits reported for the economically achievable contributions toward GHG targets, and for the assessment of currently planned initiatives.

Global Assumptions

This study applied a relatively small set of economic assumptions to the economic analysis. These include the discount rate for computing present worths of future benefits and costs; the base year for discounting; the loss factor for converting electricity at the end-use to generation; the capacity reserve requirement avoided by displacing peak demand; and the market value of avoided resources. The first four elements are listed immediately below. Avoided electricity costs span many years and costing periods for the five zones; these values are presented in Tables 2.42 through 2.46. Avoided fossil fuel costs are presented in Table 2.47. All avoided cost tables are at the end of this Volume.

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[14] For example, the California Public Utilities Commission adopted multipliers for avoided energy costs during peak periods ranging from 200% to 400%. See CPUC Ruling On Cost-Effectiveness Issues For PY 2001 Programs, October 25, 2000, pp. 13-16.

[15] Efficiency Vermont 2002 Annual Report, pp. 2, 5, available at efficiencyvermont.org. The Long Island Power Authority estimates this economic development value from efficiency and renewable resources. P. Kamer, The Economic Impact of LIPA's Clean Energy Initiative Program, 2001, 2002, undated. Neither organization apply this additional economic value in avoided cost estimates used to value electricity from efficiency and renewables, however.

Discount rate:	4% real (i.e., net of inflation)
Base year for discounting:	2003
Loss factor:	11.5% for converting electric energy and peak demand from the end use to generation voltage.
Required capacity reserves:	18% — i.e., one kW of peak demand reduction is worth 1.18 kW of installed capacity requirement in the determination of electric capacity value

Information Sources

The study relied on many sources of information for assessing technical and economic potential and achievable contributions toward New York's GHG targets. Basic market data, such as forecasts of electricity and market populations, were obtained from NYSERDA and other public and private sources. NYSERDA also supplied avoided electric energy and capacity costs for valuing efficiency and renewable resources. The study also relied on a variety of specialized information sources for developing estimates of technology costs and performance to assess efficiency and renewable technical and economic potential. The study's technical reports and appendices describe and cite these extensive additional sources. Particularly notable is the use of hourly end-use load shapes, developed by RER, Inc., to estimate efficiency savings in the residential and commercial sectors for each of the energy and demand costing periods defined for NYSERDA's avoided costs. These and the numerous other information sources are detailed in the study's efficiency and renewable technical reports (Volumes 3 and 4) and their associated appendices (Volumes 5 and 6).

The primary basis for the study's estimates of economically achievable GHG contributions was the professional judgment of its authors. This collective judgment was the source for projecting achievable technology market penetration. These judgments were informed by the successful experience to date with the most aggressive intervention strategies in efficiency and renewable technology markets.

Analytical Sequence

This study approached the economics of technical potential and of achievable greenhouse-gas contributions as two analytically distinct but related exercises. Economic potential represents the portion of technical potential that is available at costs below their benefits. To assess economic potential, the study first compared the present worth of lifetime benefits and costs of each efficiency and renewable technology application, and then eliminated those technologies whose resource benefits fell short of their resource costs. Likewise, the study derived achievable greenhouse-gas contributions by applying achievable market penetration rates to the technical potential estimates. The analysis then subjects both the greenhouse-gas and currently-planned scenarios to benefit-cost analysis, in both

cases indicating the economically achievable potential for electricity from efficiency and renewable resources. Figure 1.6 in Volume 1 of this report presents a schematic diagram depicting the analytical flow of this study.

Deriving achievable potential from technical potential rather than from economic potential was contrary to the approach taken by other studies.[16] This analytical sequence was necessitated by the particular purpose of the achievable potential assessment, which was to estimate how much efficiency and renewable technologies could be expected to contribute to statewide GHG targets in order of increasing *achievable* cost. Interposing economic value would have needlessly limited and complicated the rank ordering of efficiency and renewable resources by achievable technology cost. Had this study used such an alternative approach, routine or unexpected changes in avoided energy cost estimates to reflect current market realities and expectations would invalidate the study's achievable potential assessment.

This study avoids these problems by estimating achievable potential directly from technical potential analysis, and then subjecting their projected costs and electricity savings to benefit-cost analysis. Incorporating other economic benefits such as avoided environmental externalities would not require re-estimation of this study's estimates of achievable potential since it is predicated directly on technical potential.[17] Ultimately, economic value is not the binding constraint on the amount of electricity that efficiency and renewable resources can achieve; market-intervention strategies can effectively spur market penetration no matter how valuable these resources would be on New York's electricity markets. This study recognizes this reality by assessing the economics of achievable potential, rather than assessing the achievability of economic potential.

The structure of New York's electricity markets is such that no single statewide electric energy and capacity market can be said to exist, since no single set of transactions results in a single set of market clearing prices paid by and to a single set of buyers and sellers. This study's analytical sequence therefore facilitates future independent assessment of zonal achievable potential — which was beyond the scope of this study — by allowing the independent development and application of achievable market penetration and achievable technology costs.

The study used the Optimal cost-effectivness screening tool developed in Microsoft Excel for this project, which was loaded with New York's avoided costs. Versions of the Optimal screening tool have been used by the Long Island Power Authority, utilities in New Jersey and Massachusetts, and the states of Vermont and Maine for

16 Rufo, M. and Coito, F., California Statewide Commercial Sector Energy Efficiency Potential Study, Final Report, XENERGY, Inc., Oakland, CA, July 2002.

17 Since the GHG analysis nets out capacity value to estimate achievable electric energy costs, incorporating avoided T&D costs would require re-analysis. The result would be lower net achievable costs of electric energy from any efficiency or renewable technology that saves peak demand or provides peak capacity. This would then change the composition of the least-cost efficiency and renewable resource mix selected to meet GHG targets, as well as the relative positions of individual technologies within the mix.

program planning, implementation, and potential analyses. This tool is equipped to handle the many types and variations in efficiency and renewable technology costs and benefits over time for the three analysis horizons in the study.

Not only do avoided electricity and fossil fuel costs vary by year, but technology costs are expected to decline over time. For instance, at their current state of market maturity, renewable technology costs in particular are strongly correlated with production scale and thus market penetration. This analysis projects that they will decline significantly over the study horizon as market penetration, and thus production volume, increase. Changes in other capital costs resulting from efficiency and renewable technologies are credited against the direct costs of efficiency and renewable technologies. For example, some efficiency retrofits retire existing inefficient equipment before the end of their anticipated economic life, permanently postponing future replacement investments. The Optimal screening tool properly accounts for all the aforementioned cost and timing effects associated with efficiency and renewable technologies.

Limitations of This Study

Two distinct types of analysis were beyond the scope of this study: program potential analysis and resource planning. Program potential analysis projects the impacts from a particular set of program strategies directed at specific target markets to promote certain technologies. Efficiency and renewable resource plans contain specific targets for acquiring energy efficiency or developing renewable energy resources to meet specific electricity resource requirements. The technical and economic potential analyses in this study provide building blocks for conducting both program potential analysis and resource planning. Neither the technical, economic, or achievable potential analysis in this study can directly serve either purpose by itself.

In practice, program potential analysis involves a two-stage cost-effectiveness analysis. The first stage is the economic potential analysis presented here for whatever set of technologies are consider technically feasible and potentially acceptable in a specific market under pre-specified market-intervention strategies. The second stage of program potential analysis incorporates separate budgeting for marketing, business development, information and technical support, and management functions over multi-year horizons. These functions are largely fixed with respect to the market penetration achieved, as compared with incentive payments to customers and third parties. The second-stage economic analysis projects market penetration rates given the planned program design, and includes the non-technology budget. In this study, these fixed costs have been made artificially variable for purposes of assigning non-technology costs to each group of technologies. Consequently, the achievable cost estimates are not suitable for program potential analysis or for resource planning.

Program potential analysis also explicitly considers program incentive expenditures to compare electric system benefits with expenditures supported by electricity consumers. Which members pay how much for technology costs is not relevant to this study's comparison of total resource costs and benefits, since they represent transfers between consumers. The potential impacts of expenditures on financial incentives can raise valid policy concerns regarding distributional equity and overall rate levels.

Future analysis of efficiency and renewable program potential and specific resource plans should explicitly and separately estimate and incorporate the costs associated with achieving higher technology market penetration

This study does not develop or reach any conclusions on the specific efficiency and renewable program strategies that New York could or should rely on to achieve maximum contributions from efficiency and/or renewable resources. Consequently, the least-cost combination of efficiency and renewable contributions toward a greenhouse-gas solution do not necessarily reflect a balanced portfolio that addresses all the State's multiple energy, economic, and environmental policy objectives. A program potential analysis would be necessary for constructing and comparing potential efficiency and resource portfolios. Such an analysis would involve conceptual program designs employing aggressive combinations of intervention strategies to maximize market penetration of efficiency and renewable technologies in target markets.

The technical and economic potential analyses in this study provide a strong theoretical foundation for formulating policy and for assessing the potential role of efficiency and renewables in meeting the long-range electricity resource needs, both statewide and by load zone. Individual technology descriptions and characterizations of costs and performance should serve as a reference for detailed efficiency and renewable investment and initiative planning. In order to develop future statewide or zonal resource investment plans containing efficiency and resource options, program potential analysis is the next logical analytical step. Using the technology characterizations developed for this study, program potential analysis should develop specific sets of program strategies, market penetration projections that such strategies would achieve, and program budgets for realizing them. Such analysis should project and compare the achievable savings, costs, and benefits from efficiency and renewable programs. Future cost-effectiveness analysis of efficiency and renewable resource options should include estimates of avoided T&D costs, environmental externalities, and the effects of demand-induced price effects. This will ensure that the full range of benefits from efficiency and renewable resources are reflected on economic comparisons between competing alternatives

Finally, the static avoided costs used in this study would be appropriate for use in program potential analysis but not for large-scale resource planning. Since estimates of avoided transmission and distribution capacity costs are not included in this study, however, using these avoided costs alone would understate the total resource benefits from

specific efficiency or renewables initiatives. The static avoided costs used in this study may or may not be adequate for resource planning analysis, depending on the scale of the resource investments for which efficiency and renewables are being considered as alternatives. For example, the static zonal avoided generation costs probably would be adequate for assessing the economics of targeted deployment of efficiency and renewables for meeting localized distribution capacity needs. The study of specific initiative plans to meet GHG targets should probably consider a more dynamic estimate of avoided electric generation resources from a much larger displacement of conventional generation than that underlying NYSERDA's static avoided-cost estimates.

STUDY ORGANIZATION

NYSERDA Efficiency and Renewable-Energy Potential Study Team

The NYSERDA study team consisted of many individuals and organizations, all selected for their specialized expertise in efficiency and renewable energy technologies and markets. The multi-disciplinary effort was led by the study integration team headed by Optimal Energy Inc., the prime contractor for the study. The chart below and on the following page lists the affiliation and responsibility of each member of the study's integration team.

Team Member	Responsibility	Affiliation
John Plunkett	Overall Project Leader	Optimal Energy, Inc.
Francis Wyatt	Overall Project Analytical Support	Optimal Energy, Inc.
Steven Nadel	Efficiency Leader	American Council for an Energy-Efficient Economy
Chris Neme	Residential Efficiency Leader	Vermont Energy Investment Corporation
Chris Granda	Residential Lighting and Appliance Efficiency Support	Vermont Energy Investment Corporation
Richard Faesy	Residential New Construction Efficiency Support	Vermont Energy Investment Corporation
Ken Tohinaka	Residential Efficiency Retrofit Measures and General Analytical Support	Vermont Energy Investment Corporation
David Scenna	Residential Measures Market Characterization	Vermont Energy Investment Corporation
Philip Mosenthal	Commercial Efficiency Leader	Optimal Energy, Inc.
Eric Belliveau	Commercial Efficiency Support	Optimal Energy, Inc.
Harvey Sachs	Commercial and Residential Efficiency Support	American Council for an Energy-Efficient Economy
R. Neal Elliott	Industrial Efficiency Leader	American Council for an Energy-Efficient Economy
Jennifer Thorne	Industrial Efficiency Support	American Council for an Energy-Efficient Economy
Anna Shipley	Industrial Efficiency Support and Fuel Cell Resource Expert	American Council for an Energy-Efficient Economy
Nakhil Ganhdi	Industrial Efficiency Measure Identification & Characterization Support	Strategic Energy Technologies

N. Richard Friedman	Industrial Efficiency Sector and Measure Characterization Support	Resource Dynamics Corp.
E.J. Honton	Industrial Efficiency Sector and Measure Characterization Support	Resource Dynamics Corp.
Paul Sheaffer	Industrial Efficiency Sector and Measure Characterization Support	Resource Dynamics Corp.
John O'Brien	Industrial Efficiency Analysis Support	Resource Dynamics Corp.
Elizabeth Kime	Industrial Efficiency Analysis Support	Resource Dynamics Corp.
David Hill	Renewables Co-Leader	Vermont Energy Investment Corporation
Christine Donovan	Renewables Co-Leader	Christine T. Donovan Associates
Barclay Gibbs	Biopower Analysis Resource Expert	Antares Group, Inc.
Kevin Comer	Biopower Analysis Resource Expert	Antares Group, Inc.
George Lagassa	Hydropower Analysis Resource Expert	Mainstream Associates
Peter Kuniholm	Landfill Gas and Municipal Solid Waste Analysis Resource Expert	SCS Engineers, PC
Richard Perez	Photovoltaics and Solar Thermal Analysis Resource Expert	Consultant
Andy Shapiro	Photovoltaics and Solar Thermal Analysis Resource Expert	Energy Balance
Scott Sklar	Photovoltaics and Solar Thermal Analysis Resource Expert	The Stella Group
Jamie Chapman	Wind Energy Analysis Resource Expert	OEM Development Corporation
Greg Strong	Wind Energy Analysis Resource Expert	OEM Development Corporation
Paul Chernick	Develop Avoided Costs	Resource Insight, Inc.

Organization of the Study

This study is presented in seven volumes. The remaining volumes are:

- *Volume 1:* The Summary Report, which provides an overview of the study's methods and assumptions and highlights of its findings.
- *Volume 3:* The Energy Efficiency Technical Report, which consists of a detailed presentation of the analysis and results of residential, commercial and industrial efficiency potential.
- *Volume 4:* The Renewable Potential Technical Report, which presents comparable details for electricity potential from the seven renewable energy technologies studies.
- *Volumes 5-6:* Technical Appendices accompanying the efficiency and renewable energy reports. These appendices contain detailed information on the costs and performance of efficiency and renewable energy technologies underlying the technical, economic, and achievable potential analysis.
- *Volume 7:* Details of an analysis of the potential least-cost solutions for meeting New York's GHG emission targets using efficiency and renewable energy resources.

Section 3:
FINDINGS AND CONCLUSIONS

Study results are presented in two main sections. Presented first are the results of the technical and economic potential analyses, followed by analysis results for the two achievable potential scenarios. Results for the technical and economic potential analyses are presented first at the statewide level and then by zone (in alphabetical order). Electricity potential is expressed as GWh for electric energy and summer MW of peak capacity at generation voltage. Monetary values of costs and benefits are expressed at their 2003 present worth.

TECHNICAL AND ECONOMIC EFFICIENCY AND RENEWABLE ELECTRICITY POTENTIAL

Technical and economic potential analysis results for the State as a whole are portrayed in Figures 2.1 through 2.19, which depict the detailed results shown in Tables 2.1 though 2.4. Zonal technical and economic potential results are presented in Tables 2.5 through 2.25.

Table 2.1 presents statewide technical potential for efficiency by sector and for renewable supply by technology for 2007, 2012, and 2022. Figures 2.1, 2.2, and 2.3 show the breakdown of efficiency technical potential by sector and of renewable potential by technology for 2007, 2012, and 2022, respectively. Zonal technical potential estimates are shown in Tables 2.5, 2.9, 2.13, 2.17, and 2.21.

The technical potential for energy-efficiency in New York is greater in the residential and commercial sectors than in the industrial sector. This is due primarily to the absence of feasible efficiency retrofit opportunities in the industrial sector. In the near term, the greatest source of renewable technical potential is from biomass, hydropower, and solar thermal technologies. In the intermediate term, roughly comparable amounts of electric energy resources are technically feasible from the foregoing technologies as well as fuel cells, photovoltaics, and windpower. By 2022, photovoltaic technology represents the single largest source of statewide technical potential for renewable electric energy, followed by windpower and fuel cells.

Tables 2.2 and 2.3 present economic potential estimates for New York under low and high avoided costs, respectively. Figures 2.4, 2.5, and 2.6 illustrate the breakdown of statewide economic potential in Table 2.2 under low avoided costs by efficiency sector and renewable technology in 2007, 2012, and 2022, respectively. Figures 2.7, 2.8, and 2.9 provide comparable information for 2007, 2012, and 2022 under

high avoided costs, using results listed in Table 2.3. For illustrative comparison purposes only, Table 2.4 provides the forecast of statewide electric energy requirements.[18]

The study concludes that a large fraction of the efficiency technical potential is likely to be economic in all three sectors in all five load zones. The same is true on a statewide basis under either low or high avoided costs. The difference between high and low avoided costs has a significant influence on the amount of statewide efficiency technical potential that would be economic compared to conventional electricity supply.

The study concludes that, compared to energy-efficiency, a relatively small share of technically feasible renewable resources is expected to be economic at current estimates of long-run avoided electricity supply costs. In the near term, practically all the biomass technical potential is economic at the state and zonal levels. Almost all the hydroelectric technical potential is also found to be cost-effective. On the other hand, hardly any of the solar thermal technical potential was found to be economic in 2007. By 2012, the state's technical potential for municipal solid waste was found to be cost-effective under either low or high avoided costs. The study found that under 10% of photovoltaic technical potential would be economic by 2012 for the State as a whole, for New York City, or for Long Island.

By 2022, the study found that most of the state's technical potential for windpower would be economic under either set of avoided costs. This finding varied significantly by zone, however, with 100% of available wind potential being economic in Zone K (Long Island). By contrast, no technical wind potential was found to be economic at avoided costs for Zones G or H. No photovoltaic technical potential was found to represent economic potential in 2022.

The study found that economic potential as a percentage of technical potential varies signicantly by zone, due primarily to the variation in zonal avoided costs. It finds that the economic potential for energy-efficiency ranges between 82% of the technical potential in the West zone and 94% in the Long Island zone. On a statewide basis, between two thirds and three quarters of technical potential would be economically viable over the low and high range of zonal avoided costs.

Figures 2.10 through 2.19 provide further breakdowns of the statewide economic potential for efficiency and renewables under high avoided costs, separately for 2012 and 2022.

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[18] Any comparison between technical or economic potential and the forecast of electricity requirements should be done with extreme caution. Direct comparisons are not valid for policy or planning purposes because technical potential is estimated without regard to achievable market acceptance. Only achievable potential should be directly compared with electricity requirements forecasts.

Figures 2.10 and 2.11 break down economic efficiency potential in the residential sector by end use in 2012 and 2022, respectively. This figure demonstrates that lighting is clearly the largest source of economic potential in this sector. Much of the balance comes from cooling, refrigeration, space heating and water heating.

Figures 2.12 through 2.15 provide more detailed views of the potentially economical efficiency savings in the commercial sector. Figures 2.12 and 2.13 break down commercial economic potential by end-use in 2012 and 2022. Figures 2.14 and 2.15 show economic potential by building type for 2012 and 2022, respectively. They show that the greatest potential for economical efficiency savings in the commercial sector comes from lighting in office buildings.

Figures 2.16 and 2.17 provides a breakdown of industrial economic potential by industry for 2012 and 2022, respectively. This shows, for example, that in the industrial sector, chemical manufacturing is the single largest source of economic efficiency potential in 2012.

Figures 2.18 and 2.19 present the breakdown of renewable economic potential by generating technology in 2012 and 2022, respectively. Biomass, hydropower, and wind energy together comprise the bulk of renewable economic potential.

Statewide Potential

Figure 2.1 2007 Statewide Technical Potential for Electric Energy from Efficiency by Sector and from Renewables by Technology: Cumulative Annual GWh/Year

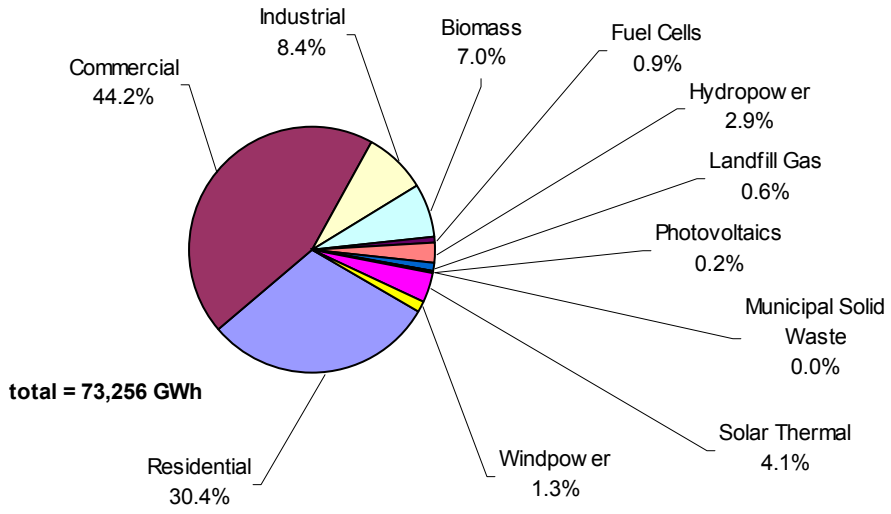


Figure 2.2 2012 Statewide Technical Potential for Electric Energy from Efficiency by Sector and from Renewables by Technology: Cumulative Annual GWh/Year

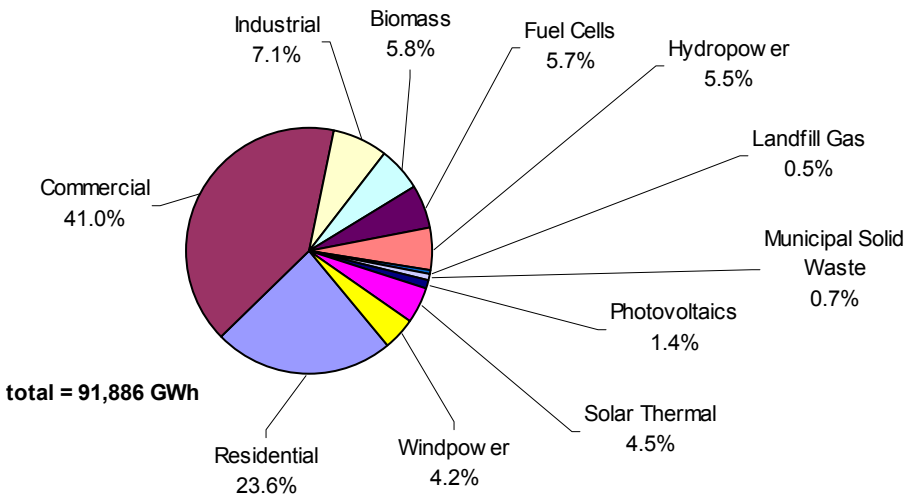


Figure 2.3 2022 Statewide Technical Potential for Electric Energy from Efficiency by Sector and from Renewables by Technology: Cumulative Annual GWh/Year

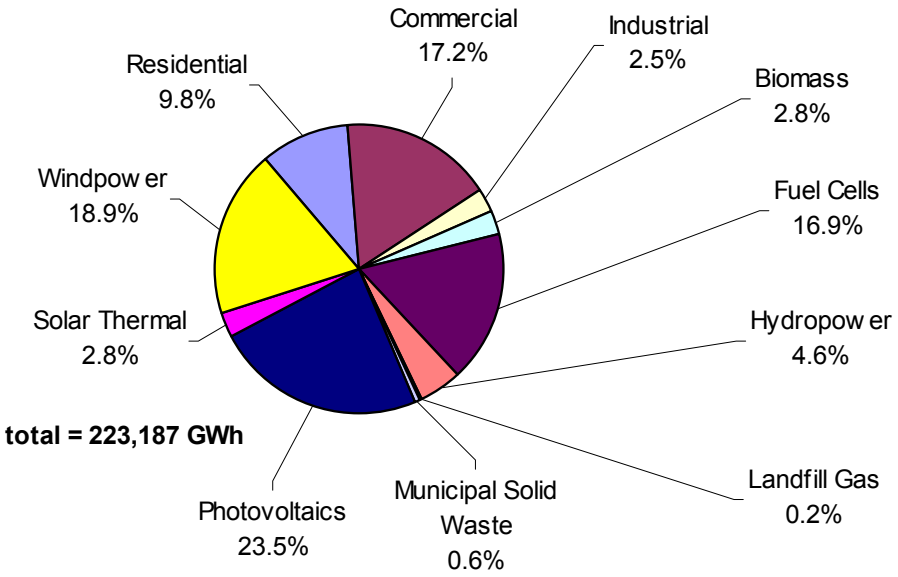


Table 2.1 Statewide Technical Potential for Electricity from Efficiency Savings and Renewable Supply: 2007, 2012, and 2022

	2007								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	1,229	7,272	1,864	1,591	8,525	1,756	22,236	5,011	4,058
Commercial	3,000	12,861	4,031	1,845	9,010	1,655	32,402	8,564	3,864
Industrial	393	2,233	469	484	2,201	351	6,131	905	905
Total Efficiency	**4,623**	**22,366**	**6,364**	**3,920**	**19,735**	**3,762**	**60,769**	**14,480**	**8,828**
Renewable Supply									
Biomass	233	1,973	386	305	1,942	303	5,141	833	846
Fuel Cells	33	243	50	40	243	43	651	79	80
Hydropower	83	677	128	148	932	147	2,115	257	336
Landfill Gas	20	177	34	27	174	27	460	62	62
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	22	58	14	9	43	9	155	44	10
Solar Thermal	553	1,222	351	133	628	127	3,014	1,422	392
Windpower	107	87	105	216	212	224	951	75	175
Total Renewable	**1,051**	**4,438**	**1,067**	**877**	**4,173**	**880**	**12,487**	**2,772**	**1,901**
Total Efficiency Savings & Renewable Supply	**5,674**	**26,804**	**7,431**	**4,797**	**23,909**	**4,642**	**73,256**	**17,252**	**10,728**

	2012								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	1,239	6,977	1,823	1,558	8,305	1,741	21,642	5,255	4,065
Commercial	3,636	14,932	4,805	2,098	10,310	1,888	37,670	10,655	4,473
Industrial	422	2,373	501	519	2,339	376	6,530	973	973
Total Efficiency	**5,297**	**24,282**	**7,129**	**4,176**	**20,954**	**4,005**	**65,842**	**16,883**	**9,511**
Renewable Supply									
Biomass	242	2,042	400	317	2,010	314	5,325	861	875
Fuel Cells	270	1,969	402	322	1,971	346	5,279	641	645
Hydropower	199	1,613	304	352	2,219	351	5,038	555	725
Landfill Gas	19	166	32	25	164	25	432	58	58
Municipal Solid Waste	30	263	51	40	258	40	682	91	91
Photovoltaics	179	468	111	73	342	70	1,244	355	78
Solar Thermal	873	1,794	559	141	670	135	4,173	2,315	423
Windpower	439	355	431	880	856	911	3,872	304	714
Total Renewable	**2,252**	**8,671**	**2,289**	**2,150**	**8,490**	**2,193**	**26,045**	**5,180**	**3,609**
Total Efficiency Savings & Renewable Supply	**7,549**	**32,953**	**9,418**	**6,326**	**29,444**	**6,198**	**91,886**	**22,063**	**13,121**

	2022								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	1,364	6,989	1,862	1,578	8,391	1,781	21,964	6,067	4,262
Commercial	3,813	14,870	4,855	2,221	10,573	1,951	38,282	11,145	4,748
Industrial	367	2,029	432	450	1,999	328	5,605	849	849
Total Efficiency	**5,543**	**23,888**	**7,148**	**4,249**	**20,964**	**4,059**	**65,852**	**18,061**	**9,859**
Renewable Supply									
Biomass	290	2,431	476	380	2,393	374	6,344	1,022	1,038
Fuel Cells	2,018	13,929	2,883	2,344	14,014	2,589	37,777	4,596	4,633
Hydropower	409	3,301	621	721	4,540	719	10,311	1,095	1,429
Landfill Gas	20	174	34	26	171	26	452	61	61
Municipal Solid Waste	63	547	105	83	538	83	1,421	190	190
Photovoltaics	7,586	19,767	4,716	3,096	14,437	2,955	52,556	15,052	3,277
Solar Thermal	1,492	2,880	960	151	716	144	6,343	4,041	455
Windpower	5,183	3,650	4,905	9,694	8,863	9,838	42,133	3,280	7,757
Total Renewable	**17,061**	**46,679**	**14,700**	**16,494**	**45,673**	**16,729**	**157,336**	**29,336**	**18,839**
Total Efficiency Savings & Renewable Supply	**22,604**	**70,567**	**21,849**	**20,743**	**66,636**	**20,788**	**223,187**	**47,398**	**28,699**

Table 2.2 Statewide Economic Potential for Electricity from Efficiency Savings and Renewable Supply: 2007, 2012, and 2022 (Low Avoided Costs)

	2007								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	402	3,349	881	736	3,915	840	10,124	1,475	1,678
Commercial	2,310	11,059	3,274	1,600	7,828	1,419	27,490	6,173	3,179
Industrial	365	2,085	436	450	2,055	327	5,718	840	840
Total Efficiency	**3,078**	**16,494**	**4,590**	**2,787**	**13,798**	**2,585**	**43,332**	**8,489**	**5,698**
Renewable Supply									
Biomass	233	1,973	386	305	1,942	303	5,141	833	846
Fuel Cells	-	-	-	-	-	-	-	-	-
Hydropower	60	484	91	106	665	106	1,512	109	143
Landfill Gas	-	-	-	-	-	-	-	-	-
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	-	-	-	-	-	-	-	-	-
Solar Thermal	-	-	-	32	111	32	175	-	30
Windpower	-	-	-	-	-	-	-	-	-
Total Renewable	**293**	**2,457**	**476**	**442**	**2,719**	**441**	**6,828**	**942**	**1,019**
Total Efficiency Savings & Renewable Supply	**3,371**	**18,951**	**5,067**	**3,229**	**16,516**	**3,026**	**50,159**	**9,431**	**6,717**

	2012								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	525	3,924	1,018	913	4,800	1,026	12,205	1,981	2,231
Commercial	2,870	12,909	3,962	1,818	8,949	1,616	32,124	8,009	3,696
Industrial	389	2,200	462	479	2,168	347	6,045	896	896
Total Efficiency	**3,783**	**19,033**	**5,443**	**3,209**	**15,917**	**2,989**	**50,374**	**10,886**	**6,823**
Renewable Supply									
Biomass	242	2,042	400	317	2,010	314	5,325	861	875
Fuel Cells	-	-	-	-	-	-	-	-	-
Hydropower	173	1,388	260	304	1,908	304	4,336	375	489
Landfill Gas	-	-	-	-	-	-	-	-	-
Municipal Solid Waste	30	263	51	40	258	40	682	91	91
Photovoltaics	-	-	-	-	-	-	-	-	-
Solar Thermal	-	-	-	33	115	33	181	-	31
Windpower	87	149	112	262	336	299	1,245	100	237
Total Renewable	**533**	**3,842**	**822**	**954**	**4,628**	**989**	**11,769**	**1,427**	**1,724**
Total Efficiency Savings & Renewable Supply	**4,316**	**22,875**	**6,265**	**4,164**	**20,545**	**3,978**	**62,143**	**12,313**	**8,546**

	2022								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	676	4,793	1,224	1,207	6,343	1,367	15,610	2,646	3,212
Commercial	3,230	13,006	4,204	1,903	9,008	1,643	32,994	9,266	3,961
Industrial	325	1,813	384	399	1,787	291	4,999	752	752
Total Efficiency	**4,230**	**19,611**	**5,812**	**3,510**	**17,138**	**3,301**	**53,603**	**12,664**	**7,925**
Renewable Supply									
Biomass	290	2,431	476	380	2,393	374	6,344	1,022	1,038
Fuel Cells	-	-	-	-	-	-	-	-	-
Hydropower	365	2,919	547	639	4,014	639	9,123	816	1,065
Landfill Gas	-	-	-	-	-	-	-	-	-
Municipal Solid Waste	63	547	105	83	538	83	1,421	190	190
Photovoltaics	-	-	-	-	-	-	-	-	-
Solar Thermal	-	-	-	34	121	34	189	-	33
Windpower	5,142	3,634	4,871	9,612	8,800	9,760	41,818	3,255	7,709
Total Renewable	**5,860**	**9,531**	**6,000**	**10,748**	**15,866**	**10,889**	**58,894**	**5,283**	**10,035**
Total Efficiency Savings & Renewable Supply	**10,091**	**29,143**	**11,811**	**14,257**	**33,004**	**14,191**	**112,497**	**17,947**	**17,960**

Table 2.3 Statewide Economic Potential for Electricity from Efficiency Savings and Renewable Supply: 2007, 2012, and 2022 (High Avoided Costs)

	2007								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	611	4,165	1,090	900	4,814	1,014	12,593	2,433	2,144
Commercial	2,584	12,068	3,584	1,775	8,675	1,586	30,273	7,021	3,600
Industrial	365	2,085	436	450	2,055	327	5,718	840	840
Total Efficiency	**3,560**	**18,318**	**5,111**	**3,125**	**15,544**	**2,927**	**48,584**	**10,294**	**6,584**
Renewable Supply									
Biomass	233	1,973	386	305	1,942	303	5,141	833	846
Fuel Cells	-	-	-	-	-	-	-	-	-
Hydropower	83	677	128	148	932	147	2,115	257	336
Landfill Gas	20	169	33	26	166	26	439	59	59
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	-	-	-	-	-	-	-	-	-
Solar Thermal	-	-	-	32	111	32	175	-	30
Windpower	99	84	99	201	200	210	893	70	166
Total Renewable	**435**	**2,903**	**645**	**711**	**3,352**	**717**	**8,762**	**1,219**	**1,437**
Total Efficiency Savings & Renewable Supply	**3,994**	**21,221**	**5,755**	**3,836**	**18,896**	**3,644**	**57,347**	**11,513**	**8,021**

	2012								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	809	5,203	1,354	1,162	6,159	1,296	15,982	3,267	2,870
Commercial	3,185	14,066	4,321	2,020	9,938	1,811	35,340	8,988	4,183
Industrial	389	2,200	462	479	2,168	347	6,045	896	896
Total Efficiency	**4,382**	**21,469**	**6,137**	**3,661**	**18,265**	**3,455**	**57,367**	**13,151**	**7,949**
Renewable Supply									
Biomass	242	2,042	400	317	2,010	314	5,325	861	875
Fuel Cells	-	-	-	-	-	-	-	-	-
Hydropower	199	1,613	304	352	2,219	351	5,038	555	725
Landfill Gas	18	157	30	24	154	24	407	54	54
Municipal Solid Waste	30	263	51	40	258	40	682	91	91
Photovoltaics	-	-	-	-	-	-	-	-	-
Solar Thermal	-	-	-	33	115	33	181	-	31
Windpower	423	349	417	846	830	879	3,744	293	695
Total Renewable	**913**	**4,423**	**1,201**	**1,612**	**5,587**	**1,640**	**15,376**	**1,855**	**2,472**
Total Efficiency Savings & Renewable Supply	**5,295**	**25,892**	**7,338**	**5,272**	**23,852**	**5,095**	**72,744**	**15,006**	**10,420**

	2022								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	1,055	6,181	1,602	1,458	7,723	1,641	19,660	4,480	3,883
Commercial	3,565	14,371	4,587	2,158	10,277	1,888	36,847	10,225	4,524
Industrial	325	1,813	384	399	1,787	291	4,999	752	752
Total Efficiency	**4,946**	**22,366**	**6,572**	**4,015**	**19,787**	**3,821**	**61,506**	**15,457**	**9,159**
Renewable Supply									
Biomass	290	2,431	476	380	2,393	374	6,344	1,022	1,038
Fuel Cells	-	-	-	-	-	-	-	-	-
Hydropower	409	3,301	621	721	4,540	719	10,311	1,095	1,429
Landfill Gas	19	161	31	24	159	24	419	56	56
Municipal Solid Waste	63	547	105	83	538	83	1,421	190	190
Photovoltaics	-	-	-	-	-	-	-	-	-
Solar Thermal	-	-	-	34	121	34	189	-	33
Windpower	5,142	3,634	4,871	9,612	8,800	9,760	41,818	3,255	7,709
Total Renewable	**5,923**	**10,074**	**6,105**	**10,854**	**16,551**	**10,995**	**60,501**	**5,618**	**10,455**
Total Efficiency Savings & Renewable Supply	**10,869**	**32,440**	**12,677**	**14,869**	**36,337**	**14,815**	**122,007**	**21,074**	**19,614**

Table 2.4 NYSERDA Statewide Forecast of Electric Energy Requirements by Sector: 2007, 2012, and 2022 (GWh at Generation)

	GWh at Generation		
	2007	2012	2022
Residential	54,136	56,091	61,046
Commercial	84,042	89,395	94,754
Industrial	27,405	29,917	33,123
Total (not including transportation)	165,583	175,404	188,923

Source: NYSERDA forecast sales with effects of post-2002 DSM removed.
Sales are multiplied by 1.115 to derive generation requirements in this table.

Figure 2.4 2007 Statewide Economic Potential for Electric Energy from Efficiency by Sector and from Renewables by Technology: Cumulative Annual GWh/Year under Low Avoided Costs

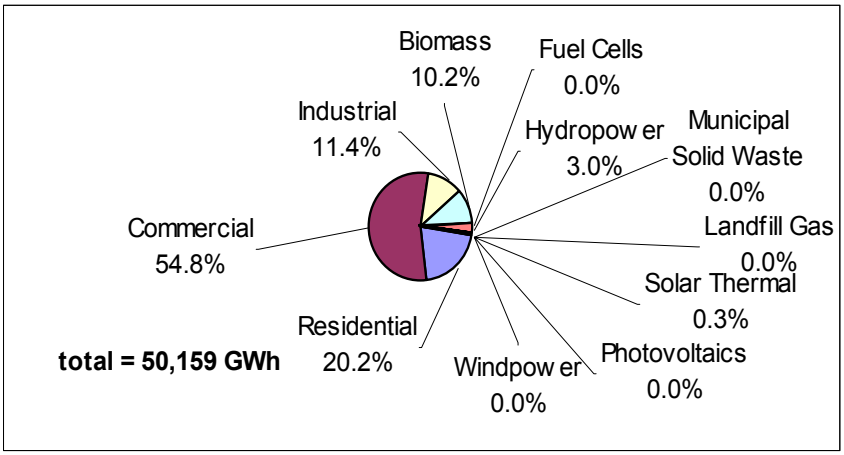


Figure 2.5 2012 Statewide Economic Potential for Electric Energy from Efficiency by Sector and from Renewables by Technology: Cumulative Annual GWh/Year under Low Avoided Costs

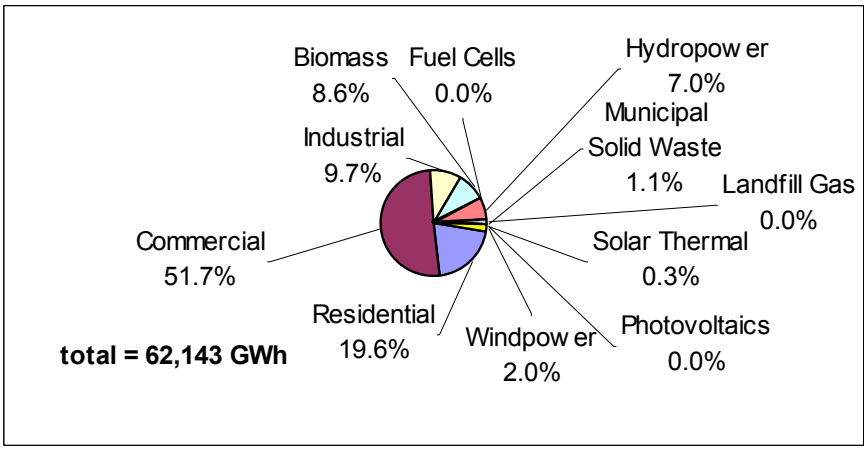


Figure 2.6 **2022 Statewide Economic Potential for Electric Energy from Efficiency by Sector and from Renewables by Technology: Cumulative Annual GWh/Year under Low Avoided Costs**

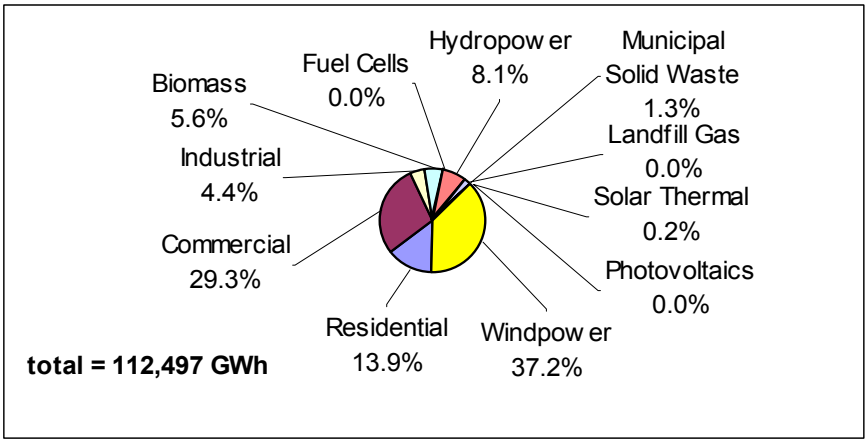


Figure 2.7 **2007 Statewide Economic Potential for Electric Energy from Efficiency by Sector and from Renewables by Technology: Cumulative Annual GWh/Year under High Avoided Costs**

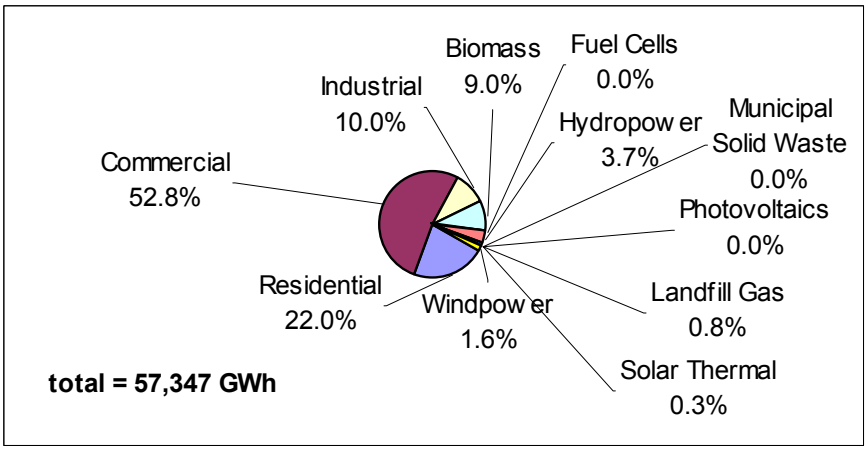


Figure 2.8 **2012 Statewide Economic Potential for Electric Energy from Efficiency by Sector and from Renewables by Technology: Cumulative Annual GWh/Year under High Avoided Costs**

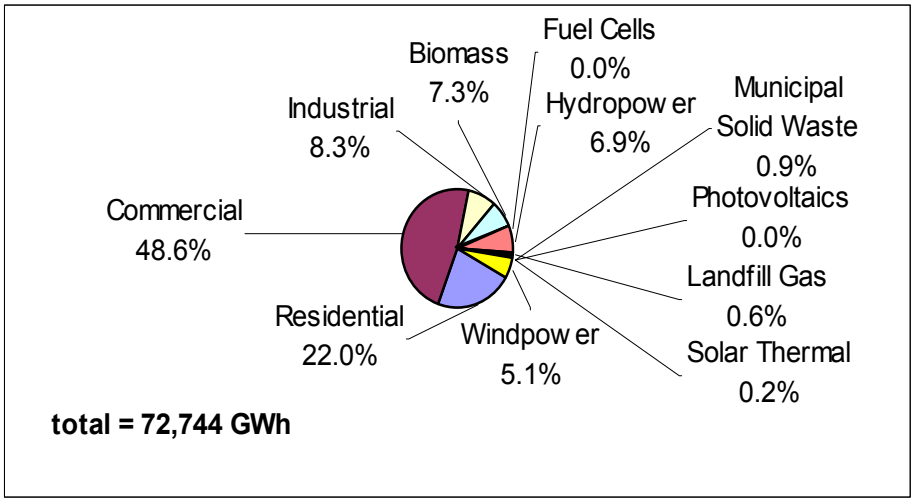


Figure 2.9 **2022 Statewide Economic Potential for Electric Energy from Efficiency by Sector and from Renewables by Technology: Cumulative Annual GWh/Year under High Avoided Costs**

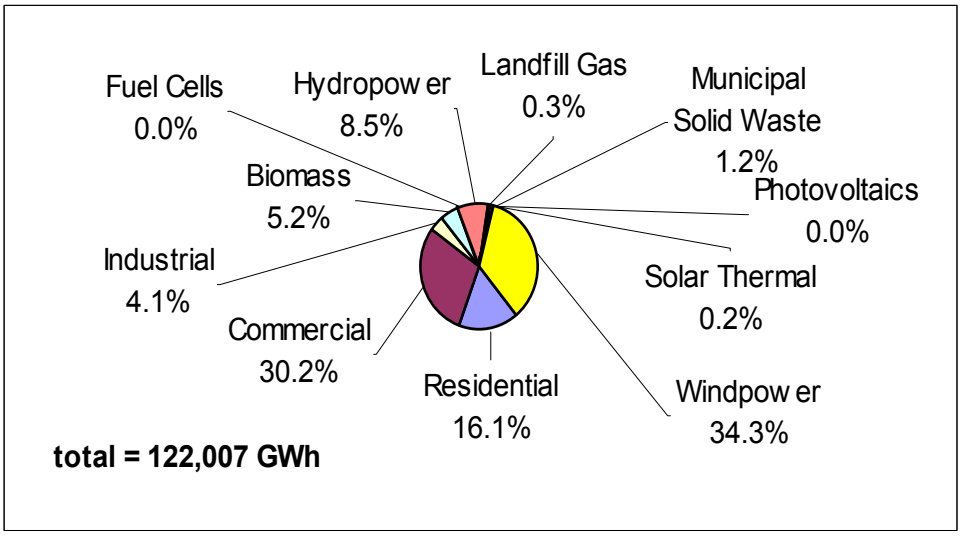


Figure 2.10 2012 Statewide Residential Economic Efficiency Potential by End Use (High Avoided Costs)

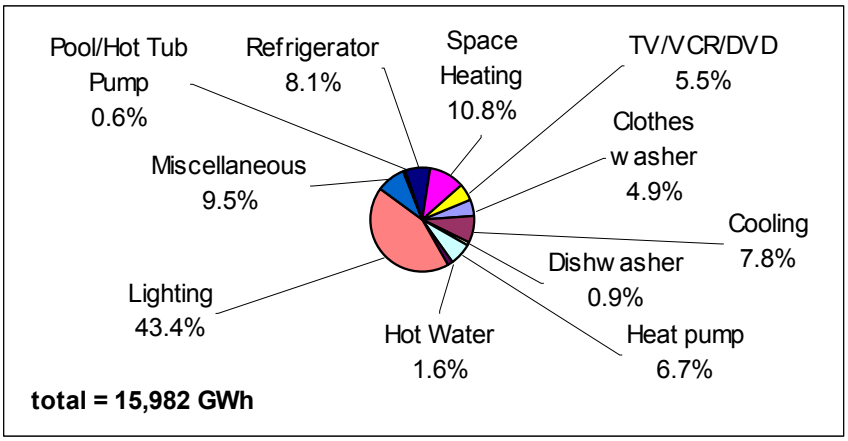


Figure 2.11 2022 Statewide Residential Economic Efficiency Potential by End Use (High Avoided Costs)

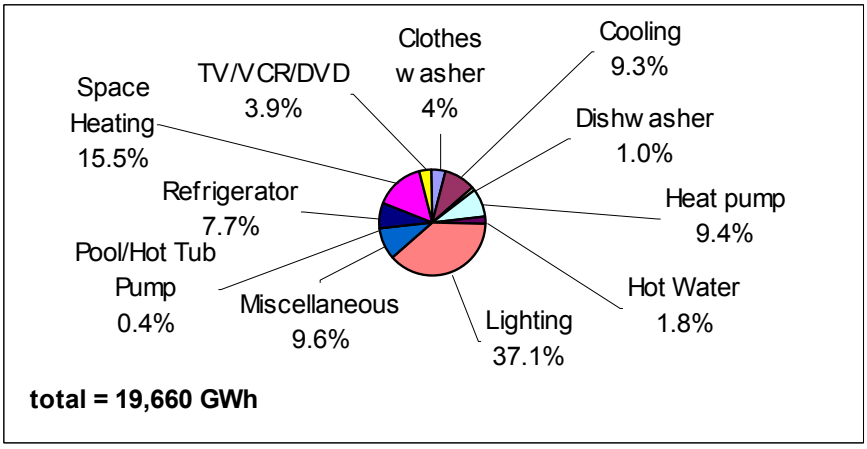


Figure 2.12 2012 Statewide Commercial Economic Efficiency Potential by End Use (High Avoided Costs)

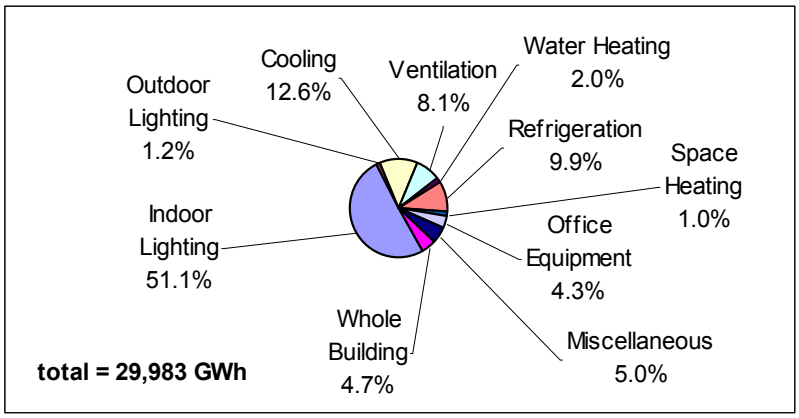


Figure 2.13 2022 Statewide Commercial Economic Efficiency Potential by End Use (High Avoided Costs)

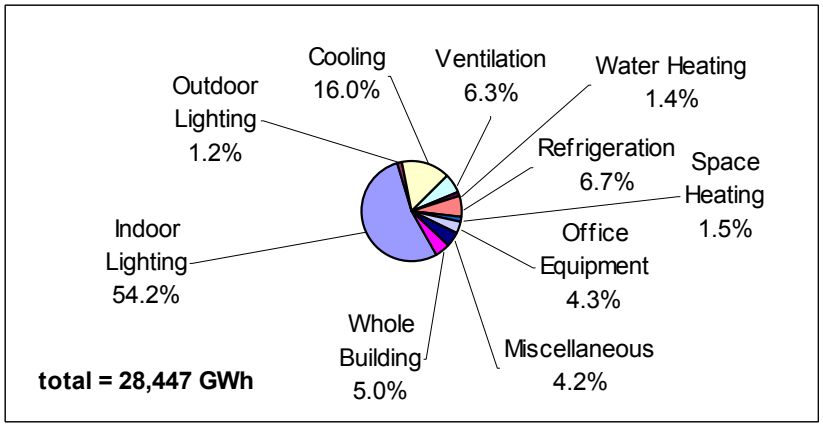


Figure 2.14 2012 Statewide Commercial Economic Efficiency Potential by Building Type (High Avoided Costs)

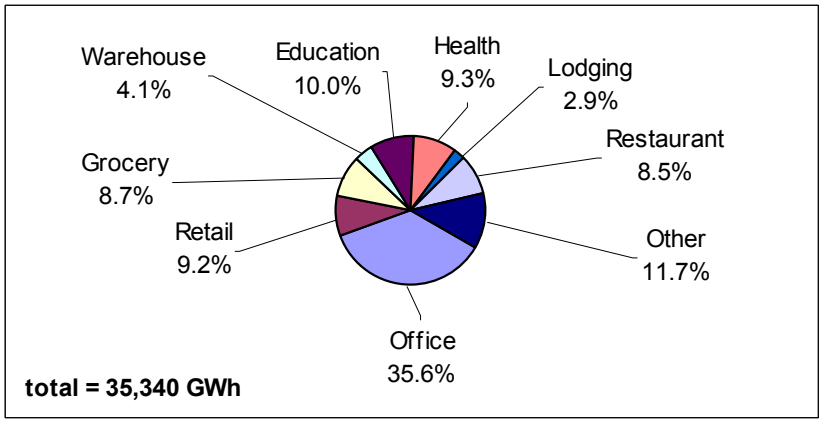


Figure 2.15 2022 Statewide Commercial Economic Efficiency Potential by Building Type (High Avoided Costs)

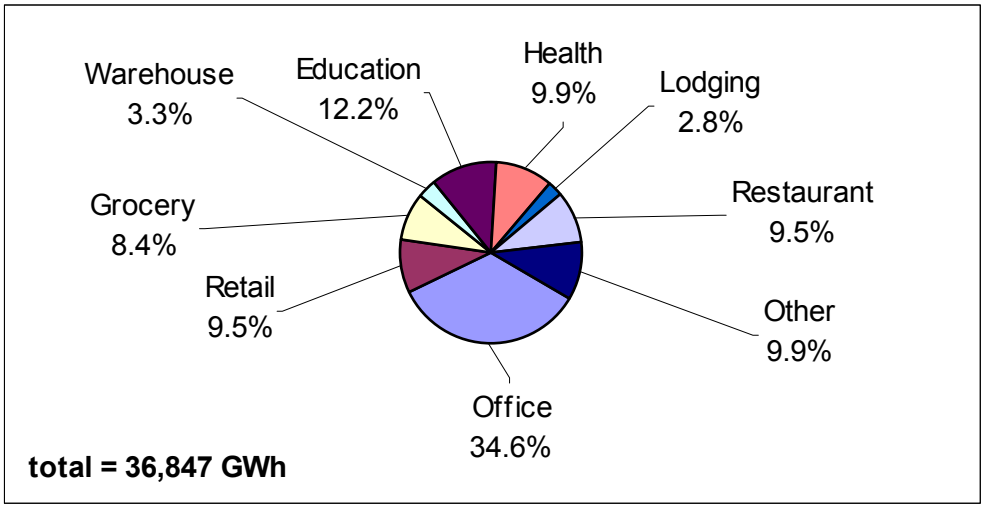


Figure 2.16 2012 Statewide Industrial Economic Efficiency Potential by Industry (High Avoided Costs)

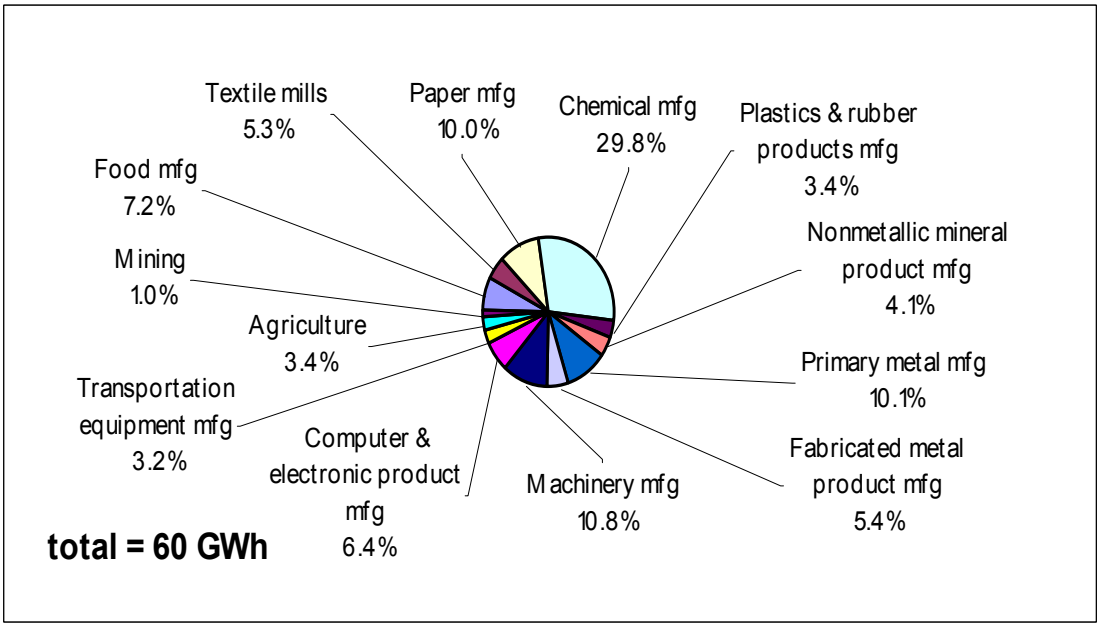


Figure 2.17 2022 Statewide Industrial Economic Efficiency Potential by Industry (High Avoided Costs)

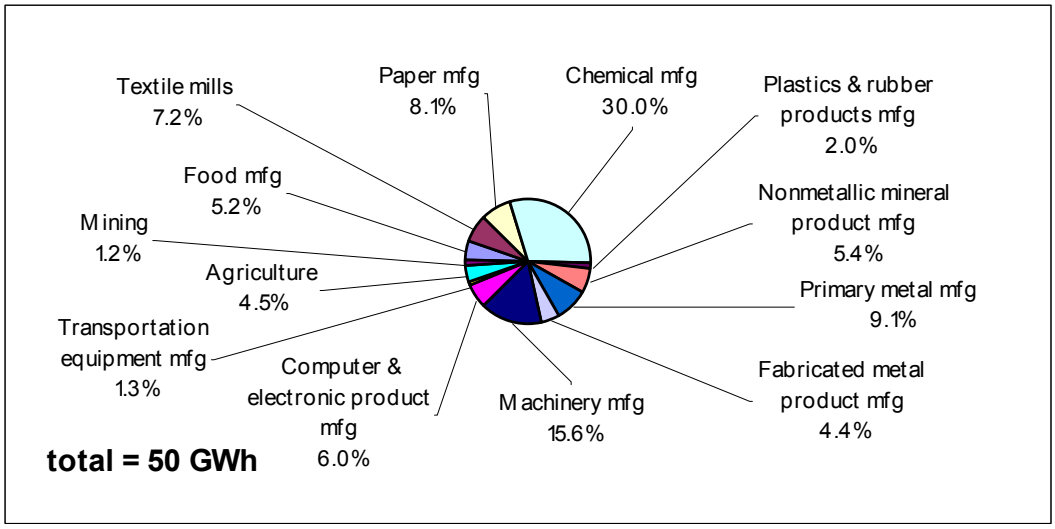


Figure 2.18 2012 Statewide Renewable Economic Potential by Technology (High Avoided Costs)

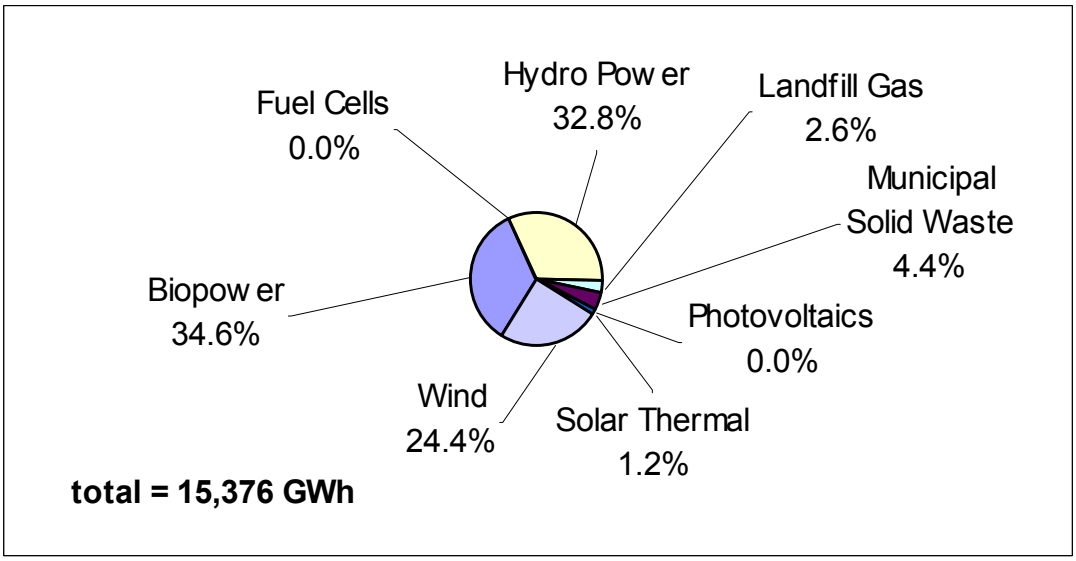
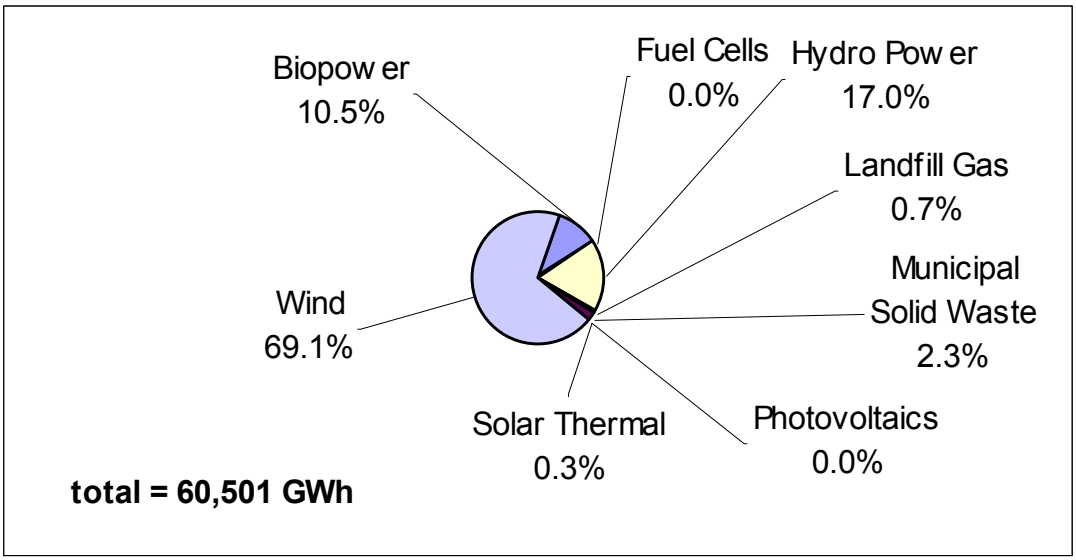


Figure 2.19 2022 Statewide Renewable Economic Potential by Technology (High Avoided Costs)



Zonal potential

Tables 2.5 through 2.24 provide the following information for Zones A, F, G, J, and K:

- Technical potential for efficiency and renewable resources
- Economic potential
- Economic potential as share of technical potential
- NYSERDA forecasted electricity requirements

These tables demonstrate that economic potential for efficiency and renewables varies substantially between zones as a share of technical potential. For example, the residential efficiency economic potential as a percent of technical potential in 2012 is only 43% in Zone A, but 75% in Zone K. In several zones, windpower economic potential as a percent of technical potential is 0%, whereas in Zone K it is 98%. Most of this variation is attributable to differences in avoided costs. The exceptions are industrial efficiency and renewable supply. Industrial potential depends heavily on the presence of particular industries within a given zone. Renewable potential, particularly wind and hydro, depend to a great extent on the physical availability of the resource in any particulary part of the State.

Table 2.5 Zone A Technical Potential for Electricity from Efficiency Savings and Renewable Supply: 2007, 2012, and 2022 (West)

	2007								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	93	587	147	133	710	146	1,816	368	338
Commercial	231	950	306	145	697	131	2,460	588	289
Industrial	71	403	84	87	397	62	1,105	164	164
Total Efficiency	**395**	**1,940**	**537**	**366**	**1,804**	**339**	**5,381**	**1,121**	**791**
Renewable Supply									
Biomass	107	914	178	141	899	140	2,380	389	395
Fuel Cells	6	16	22	5	17	22	88	11	11
Hydropower	28	225	42	49	309	49	702	50	66
Landfill Gas	2	22	4	3	21	3	56	7	7
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	3	7	2	1	5	1	17	4	1
Solar Thermal	36	84	23	15	67	15	241	94	40
Windpower	59	67	64	140	157	152	639	51	120
Total Renewable	**241**	**1,334**	**336**	**355**	**1,475**	**382**	**4,123**	**607**	**640**
Total Efficiency Savings & Renewable Supply	**636**	**3,274**	**873**	**721**	**3,279**	**722**	**9,503**	**1,728**	**1,431**

	2012								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	92	554	141	129	683	143	1,743	382	335
Commercial	278	1,099	362	166	803	150	2,857	724	338
Industrial	77	432	91	95	426	68	1,188	178	178
Total Efficiency	**447**	**2,084**	**594**	**390**	**1,912**	**361**	**5,787**	**1,284**	**851**
Renewable Supply									
Biomass	110	932	182	144	917	143	2,428	397	403
Fuel Cells	47	141	173	45	148	170	724	88	88
Hydropower	60	482	90	106	663	106	1,507	114	149
Landfill Gas	3	26	5	4	25	4	66	9	9
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	22	54	13	8	39	6	142	36	9
Solar Thermal	51	112	33	16	72	16	300	131	43
Windpower	182	174	187	393	410	416	1,763	139	328
Total Renewable	**475**	**1,920**	**684**	**715**	**2,274**	**861**	**6,930**	**914**	**1,030**
Total Efficiency Savings & Renewable Supply	**922**	**4,005**	**1,278**	**1,105**	**4,186**	**1,222**	**12,717**	**2,198**	**1,880**

	2022								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	101	555	144	131	693	147	1,772	439	351
Commercial	285	1,055	355	172	796	151	2,814	745	354
Industrial	65	361	77	80	356	58	996	152	152
Total Efficiency	**451**	**1,971**	**576**	**383**	**1,845**	**355**	**5,582**	**1,335**	**856**
Renewable Supply									
Biomass	129	1,097	214	169	1,080	169	2,858	467	474
Fuel Cells	410	886	1,641	367	961	1,634	5,898	715	719
Hydropower	118	947	177	207	1,301	207	2,958	229	299
Landfill Gas	4	38	7	6	38	6	99	13	13
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	953	2,281	553	335	1,643	271	6,036	1,541	382
Solar Thermal	79	162	51	17	76	17	402	198	46
Windpower	1,876	1,404	1,803	3,601	3,384	3,686	15,754	1,230	2,909
Total Renewable	**3,569**	**6,815**	**4,447**	**4,703**	**8,483**	**5,989**	**34,005**	**4,393**	**4,843**
Total Efficiency Savings & Renewable Supply	**4,021**	**8,786**	**5,023**	**5,086**	**10,328**	**6,344**	**39,587**	**5,728**	**5,699**

Table 2.6 Zone A Economic Potential for Electricity from Efficiency Savings and Renewable Supply: 2007, 2012, and 2022 (West)

	2007								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	28	223	57	50	265	56	679	103	117
Commercial	180	822	251	124	599	111	2,086	430	234
Industrial	66	375	78	81	369	58	1,027	152	152
Total Efficiency	**274**	**1,420**	**386**	**255**	**1,233**	**225**	**3,793**	**684**	**502**
Renewable Supply									
Biomass	107	914	178	141	899	140	2,380	389	395
Fuel Cells	-	-	-	-	-	-	-	-	-
Hydropower	28	224	42	49	308	49	701	50	66
Landfill Gas	-	-	-	-	-	-	-	-	-
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	-	-	-	-	-	-	-	-	-
Solar Thermal	-	-	-	-	-	-	-	-	-
Windpower	-	-	-	-	-	-	-	-	-
Total Renewable	**135**	**1,138**	**221**	**190**	**1,208**	**189**	**3,080**	**439**	**461**
Total Efficiency Savings & Renewable Supply	**409**	**2,558**	**607**	**445**	**2,441**	**414**	**6,873**	**1,124**	**963**

	2012								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	33	245	65	56	292	63	754	128	132
Commercial	222	957	302	142	693	128	2,444	551	276
Industrial	71	399	84	87	394	62	1,097	164	164
Total Efficiency	**325**	**1,602**	**450**	**285**	**1,379**	**253**	**4,294**	**842**	**572**
Renewable Supply									
Biomass	110	932	182	144	917	143	2,428	397	403
Fuel Cells	-	-	-	-	-	-	-	-	-
Hydropower	60	481	90	105	661	105	1,502	113	148
Landfill Gas	-	-	-	-	-	-	-	-	-
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	-	-	-	-	-	-	-	-	-
Solar Thermal	-	-	-	-	-	-	-	-	-
Windpower	-	-	-	-	-	-	-	-	-
Total Renewable	**170**	**1,412**	**272**	**249**	**1,578**	**248**	**3,930**	**510**	**551**
Total Efficiency Savings & Renewable Supply	**495**	**3,014**	**723**	**534**	**2,957**	**501**	**8,224**	**1,352**	**1,123**

	2022								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	51	392	99	100	523	113	1,279	192	260
Commercial	242	918	309	145	667	125	2,406	618	289
Industrial	57	320	67	70	315	51	881	133	133
Total Efficiency	**351**	**1,630**	**476**	**315**	**1,506**	**288**	**4,566**	**943**	**682**
Renewable Supply									
Biomass	129	1,097	214	169	1,080	169	2,858	467	474
Fuel Cells	-	-	-	-	-	-	-	-	-
Hydropower	118	942	177	206	1,295	206	2,944	227	296
Landfill Gas	-	-	-	-	-	-	-	-	-
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	-	-	-	-	-	-	-	-	-
Solar Thermal	-	-	-	-	-	-	-	-	-
Windpower	223	382	287	669	860	764	3,185	256	607
Total Renewable	**470**	**2,421**	**678**	**1,044**	**3,235**	**1,139**	**8,987**	**950**	**1,377**
Total Efficiency Savings & Renewable Supply	**821**	**4,051**	**1,153**	**1,360**	**4,741**	**1,428**	**13,553**	**1,893**	**2,059**

Table 2.7 Zone A Economic Potential as Share of Technical Potential

	2007	2012	2022
Energy Efficiency Savings			
Residential	37%	43%	72%
Commercial	85%	86%	85%
Industrial	93%	92%	88%
Total Efficiency	70%	74%	82%
Renewable Supply			
Biomass	100%	100%	100%
Fuel Cells	0%	0%	0%
Hydropower	100%	100%	100%
Landfill Gas	0%	0%	0%
Municipal Solid Waste	NA	NA	NA
Photovoltaics	0%	0%	0%
Solar Thermal	0%	0%	0%
Windpower	0%	0%	20%
Total Renewable	75%	57%	26%
Total Efficiency Savings & Renewable Supply	72%	65%	34%

Table 2.8 NYSERDA Forecast of Zone A Sector Electric Energy Requirements: 2007, 2012, and 2022 (GWH at Generation)

	GWh at Generation		
	2007	2012	2022
Residential	4,874	5,050	5,497
Commercial	6,682	7,012	7,202
Industrial	5,057	5,506	5,863
Total (not including transportation)	16,613	17,569	18,561

Source: NYSERDA forecast sales with effects of post-2002 DSM removed.
Sales are multiplied by 1.115 to derive generation requirements in this table.

Table 2.9 Zone F Technical Potential for Electricity from Efficiency Savings and Renewable Supply: 2007, 2012, and 2022 (Capital)

	2007								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	76	419	108	91	485	100	1,279	317	231
Commercial	160	655	211	100	481	90	1,697	406	199
Industrial	48	271	57	59	267	43	746	109	109
Total Efficiency	**283**	**1,346**	**376**	**250**	**1,233**	**233**	**3,722**	**833**	**539**
Renewable Supply									
Biomass	2	13	3	2	13	2	35	5	5
Fuel Cells	4	11	15	4	12	15	60	7	7
Hydropower	26	209	39	46	287	46	652	49	64
Landfill Gas	2	15	3	2	15	2	39	5	5
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	2	5	1	1	4	1	13	3	1
Solar Thermal	24	57	16	10	45	10	163	58	25
Windpower	1	1	1	3	3	3	11	1	2
Total Renewable	**61**	**311**	**78**	**67**	**378**	**78**	**973**	**129**	**109**
Total Efficiency Savings & Renewable Supply	**344**	**1,657**	**454**	**318**	**1,611**	**312**	**4,695**	**961**	**648**

	2012								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	77	399	105	88	468	98	1,235	335	229
Commercial	194	764	252	116	559	105	1,989	505	234
Industrial	51	286	61	63	282	46	789	116	116
Total Efficiency	**321**	**1,450**	**418**	**267**	**1,309**	**248**	**4,013**	**956**	**580**
Renewable Supply									
Biomass	2	14	3	2	14	2	37	6	6
Fuel Cells	32	97	118	30	101	116	493	60	60
Hydropower	46	368	69	80	506	80	1,150	103	134
Landfill Gas	2	14	3	2	14	2	36	5	5
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	14	38	9	6	27	6	100	22	6
Solar Thermal	35	76	22	11	48	11	203	81	27
Windpower	2	2	2	6	6	6	24	2	4
Total Renewable	**132**	**608**	**226**	**137**	**716**	**223**	**2,042**	**278**	**242**
Total Efficiency Savings & Renewable Supply	**454**	**2,058**	**644**	**404**	**2,025**	**471**	**6,055**	**1,234**	**821**

	2022								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	86	406	109	90	475	100	1,266	393	240
Commercial	206	759	256	124	576	109	2,029	536	254
Industrial	46	253	54	56	249	41	699	105	105
Total Efficiency	**338**	**1,417**	**419**	**270**	**1,300**	**251**	**3,995**	**1,034**	**599**
Renewable Supply									
Biomass	2	18	4	3	18	3	47	7	7
Fuel Cells	279	604	1,115	250	655	1,111	4,014	487	489
Hydropower	81	655	123	143	900	143	2,045	200	262
Landfill Gas	2	14	3	2	14	2	36	5	5
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	590	1,586	382	249	1,157	252	4,217	927	250
Solar Thermal	54	111	34	11	50	11	272	123	28
Windpower	9	10	10	22	25	24	99	8	18
Total Renewable	**1,017**	**2,998**	**1,670**	**681**	**2,819**	**1,545**	**10,730**	**1,758**	**1,059**
Total Efficiency Savings & Renewable Supply	**1,354**	**4,415**	**2,089**	**951**	**4,119**	**1,796**	**14,724**	**2,792**	**1,658**

Table 2.10 Zone F Economic Potential for Electricity from Efficiency Savings and Renewable Supply: 2007, 2012, and 2022 (Capital)

	2007								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	24	186	49	41	215	46	560	91	93
Commercial	126	570	175	86	417	77	1,451	301	163
Industrial	45	255	54	55	251	41	700	102	102
Total Efficiency	**194**	**1,010**	**277**	**182**	**883**	**164**	**2,710**	**494**	**357**
Renewable Supply									
Biomass	2	13	3	2	13	2	35	5	5
Fuel Cells	-	-	-	-	-	-	-	-	-
Hydropower	24	195	36	43	268	43	608	43	56
Landfill Gas	-	-	-	-	-	-	-	-	-
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	-	-	-	-	-	-	-	-	-
Solar Thermal	-	-	-	-	-	-	-	-	-
Windpower	-	-	-	-	-	-	-	-	-
Total Renewable	**26**	**208**	**39**	**45**	**281**	**45**	**643**	**48**	**61**
Total Efficiency Savings & Renewable Supply	**220**	**1,218**	**316**	**227**	**1,163**	**208**	**3,353**	**542**	**419**

	2012								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	32	227	59	52	271	58	698	123	124
Commercial	157	669	212	100	487	90	1,715	390	195
Industrial	47	267	56	58	263	43	734	108	108
Total Efficiency	**235**	**1,163**	**328**	**210**	**1,020**	**190**	**3,147**	**620**	**426**
Renewable Supply									
Biomass	2	14	3	2	14	2	37	6	6
Fuel Cells	-	-	-	-	-	-	-	-	-
Hydropower	43	347	65	76	477	76	1,085	92	120
Landfill Gas	-	-	-	-	-	-	-	-	-
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	-	-	-	-	-	-	-	-	-
Solar Thermal	-	-	-	-	-	-	-	-	-
Windpower	1	1	1	2	3	2	9	1	2
Total Renewable	**46**	**362**	**69**	**80**	**494**	**80**	**1,131**	**98**	**127**
Total Efficiency Savings & Renewable Supply	**281**	**1,525**	**396**	**290**	**1,514**	**271**	**4,278**	**718**	**553**

	2022								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	41	277	72	68	357	77	892	166	178
Commercial	176	662	223	105	485	91	1,742	449	209
Industrial	41	228	49	51	225	37	631	94	94
Total Efficiency	**259**	**1,167**	**344**	**224**	**1,067**	**205**	**3,266**	**709**	**481**
Renewable Supply									
Biomass	2	18	4	3	18	3	47	7	7
Fuel Cells	-	-	-	-	-	-	-	-	-
Hydropower	75	602	113	132	827	132	1,880	171	224
Landfill Gas	-	-	-	-	-	-	-	-	-
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	-	-	-	-	-	-	-	-	-
Solar Thermal	-	-	-	-	-	-	-	-	-
Windpower	5	8	6	15	19	17	71	6	13
Total Renewable	**82**	**628**	**123**	**149**	**864**	**151**	**1,998**	**184**	**244**
Total Efficiency Savings & Renewable Supply	**341**	**1,795**	**466**	**374**	**1,931**	**356**	**5,263**	**893**	**726**

Table 2.11 Zone F Economic Potential as Share of Technical Potential

	2007	2012	2022
Energy Efficiency Savings			
Residential	44%	57%	71%
Commercial	85%	86%	86%
Industrial	94%	93%	90%
Total Efficiency	73%	78%	82%
Renewable Supply			
Biomass	100%	100%	100%
Fuel Cells	0%	0%	0%
Hydropower	93%	94%	92%
Landfill Gas	0%	0%	0%
Municipal Solid Waste	NA	NA	NA
Photovoltaics	0%	0%	0%
Solar Thermal	0%	0%	0%
Windpower	0%	40%	71%
Total Renewable	66%	55%	19%
Total Efficiency Savings & Renewable Supply	71%	71%	36%

Table 2.12 NYSERDA Forecast of Zone F Sector Electric Energy Requirements: 2007, 2012, and 2022 (GWH at Generation)

	GWh at Generation		
	2007	2012	2022
Residential	3,311	3,430	3,733
Commercial	4,587	4,864	4,976
Industrial	3,344	3,600	3,743
Total (not including transportation)	11,243	11,894	12,453

Source: NYSERDA forecast sales with effects of post-2002 DSM removed.
Sales are multiplied by 1.115 to derive generation requirements in this table.

Table 2.13 Zone G Technical Potential for Electricity from Efficiency Savings and Renewable Supply: 2007, 2012, and 2022 (Hudson)

	2007								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	87	498	128	108	576	118	1,516	361	272
Commercial	148	717	211	96	499	89	1,760	457	207
Industrial	33	200	41	41	197	31	543	77	77
Total Efficiency	**269**	**1,415**	**379**	**245**	**1,272**	**238**	**3,818**	**895**	**555**
Renewable Supply									
Biomass	30	255	50	39	252	39	665	109	111
Fuel Cells	3	9	11	3	10	10	46	6	6
Hydropower	1	6	1	1	8	1	19	2	2
Landfill Gas	1	8	2	1	8	1	21	3	3
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	2	5	1	1	4	1	13	4	1
Solar Thermal	33	76	21	9	43	9	192	84	29
Windpower	0	0	0	1	1	1	3	0	0
Total Renewable	**70**	**360**	**86**	**56**	**325**	**63**	**959**	**208**	**152**
Total Efficiency Savings & Renewable Supply	**339**	**1,775**	**465**	**301**	**1,597**	**301**	**4,777**	**1,103**	**708**

	2012								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	88	474	124	105	555	116	1,461	380	269
Commercial	182	844	254	111	579	103	2,072	575	242
Industrial	35	208	43	44	205	33	568	81	81
Total Efficiency	**305**	**1,526**	**421**	**259**	**1,339**	**251**	**4,100**	**1,036**	**592**
Renewable Supply									
Biomass	34	287	56	44	282	44	747	123	125
Fuel Cells	24	86	85	24	89	82	390	47	48
Hydropower	9	73	14	16	100	16	228	19	25
Landfill Gas	1	5	1	1	5	1	12	2	2
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	15	42	10	7	31	7	111	29	5
Solar Thermal	49	106	31	10	47	10	252	127	32
Windpower	1	0	1	2	1	2	6	1	1
Total Renewable	**133**	**598**	**197**	**103**	**555**	**161**	**1,747**	**348**	**238**
Total Efficiency Savings & Renewable Supply	**438**	**2,124**	**617**	**362**	**1,894**	**412**	**5,847**	**1,384**	**830**

	2022								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	98	479	128	106	562	119	1,493	443	281
Commercial	191	834	256	116	584	105	2,087	603	254
Industrial	32	183	38	39	180	29	500	73	73
Total Efficiency	**321**	**1,497**	**422**	**261**	**1,327**	**252**	**4,079**	**1,119**	**609**
Renewable Supply									
Biomass	38	328	64	50	323	50	854	141	143
Fuel Cells	206	526	788	190	561	780	3,051	371	374
Hydropower	23	185	35	40	254	40	577	49	64
Landfill Gas	0	1	0	0	1	0	4	0	0
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	660	1,775	420	283	1,300	283	4,720	1,253	216
Solar Thermal	79	160	50	11	50	10	361	207	35
Windpower	2	1	2	4	3	4	16	1	2
Total Renewable	**1,008**	**2,976**	**1,359**	**579**	**2,492**	**1,168**	**9,583**	**2,022**	**834**
Total Efficiency Savings & Renewable Supply	**1,329**	**4,472**	**1,781**	**840**	**3,819**	**1,421**	**13,663**	**3,141**	**1,443**

Table 2.14 Zone G Economic Potential for Electricity from Efficiency Savings and Renewable Supply: 2007, 2012, and 2022 (Hudson)

	2007								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	26	196	51	43	228	48	593	100	99
Commercial	112	612	170	82	433	76	1,485	324	171
Industrial	31	188	38	39	185	29	510	72	72
Total Efficiency	**170**	**996**	**260**	**164**	**846**	**153**	**2,588**	**496**	**342**
Renewable Supply									
Biomass	30	255	50	39	252	39	665	109	111
Fuel Cells	-	-	-	-	-	-	-	-	-
Hydropower	1	6	1	1	8	1	19	2	2
Landfill Gas	-	-	-	-	-	-	-	-	-
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	-	-	-	-	-	-	-	-	-
Solar Thermal	-	-	-	-	-	-	-	-	-
Windpower	-	-	-	-	-	-	-	-	-
Total Renewable	**31**	**262**	**51**	**41**	**260**	**41**	**684**	**111**	**113**
Total Efficiency Savings & Renewable Supply	**201**	**1,257**	**311**	**205**	**1,105**	**194**	**3,272**	**607**	**456**

	2012								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	37	271	71	62	323	69	831	141	147
Commercial	142	726	209	95	503	88	1,764	428	201
Industrial	33	194	40	40	191	30	529	75	75
Total Efficiency	**212**	**1,191**	**319**	**198**	**1,017**	**187**	**3,124**	**644**	**423**
Renewable Supply									
Biomass	34	287	56	44	282	44	747	123	125
Fuel Cells	-	-	-	-	-	-	-	-	-
Hydropower	9	73	14	16	100	16	228	19	25
Landfill Gas	-	-	-	-	-	-	-	-	-
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	-	-	-	-	-	-	-	-	-
Solar Thermal	-	-	-	-	-	-	-	-	-
Windpower	-	-	-	-	-	-	-	-	-
Total Renewable	**43**	**360**	**70**	**60**	**383**	**60**	**975**	**142**	**150**
Total Efficiency Savings & Renewable Supply	**255**	**1,551**	**389**	**258**	**1,400**	**247**	**4,099**	**787**	**574**

	2022								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	52	400	105	97	506	110	1,270	201	240
Commercial	160	725	221	98	494	87	1,785	498	211
Industrial	28	165	34	35	163	26	450	65	65
Total Efficiency	**240**	**1,290**	**359**	**230**	**1,163**	**223**	**3,506**	**764**	**516**
Renewable Supply									
Biomass	38	328	64	50	323	50	854	141	143
Fuel Cells	-	-	-	-	-	-	-	-	-
Hydropower	23	185	35	40	254	40	577	49	64
Landfill Gas	-	-	-	-	-	-	-	-	-
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	-	-	-	-	-	-	-	-	-
Solar Thermal	-	-	-	-	-	-	-	-	-
Windpower	-	-	-	-	-	-	-	-	-
Total Renewable	**62**	**513**	**99**	**91**	**577**	**91**	**1,432**	**190**	**207**
Total Efficiency Savings & Renewable Supply	**302**	**1,803**	**458**	**321**	**1,740**	**313**	**4,937**	**953**	**723**

Table 2.15 Zone G Economic Potential as Share of Technical Potential

	2007	2012	2022
Energy Efficiency Savings			
Residential	39%	57%	85%
Commercial	84%	85%	86%
Industrial	94%	93%	90%
Total Efficiency	68%	76%	86%
Renewable Supply			
Biomass	100%	100%	100%
Fuel Cells	0%	0%	0%
Hydropower	100%	100%	100%
Landfill Gas	0%	0%	0%
Municipal Solid Waste	NA	NA	NA
Photovoltaics	0%	0%	0%
Solar Thermal	0%	0%	0%
Windpower	0%	0%	0%
Total Renewable	71%	56%	15%
Total Efficiency Savings & Renewable Supply	69%	70%	36%

Table 2.16 NYSERDA Forecast of Zone G Sector Electric Energy Requirements: 2007, 2012, and 2022 (GWh at Generation)

	GWh at Generation		
	2007	2012	2022
Residential	3,976	4,120	4,484
Commercial	4,611	4,907	5,169
Industrial	2,367	2,577	2,732
Total (not including transportation)	10,955	11,604	12,384

Source: NYSERDA forecast sales with effects of post-2002 DSM removed.
Sales are multiplied by 1.115 to derive generation requirements in this table.

Table 2.17 Zone J Technical Potential for Electricity from Efficiency Savings and Renewable Supply: 2007, 2012, and 2022 (New York City)

	2007								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	467	2,439	669	457	2,496	509	7,037	1,973	1,111
Commercial	1,392	6,124	1,882	845	4,185	754	15,182	4,285	1,861
Industrial	14	80	17	18	79	13	221	32	32
Total Efficiency	**1,873**	**8,643**	**2,568**	**1,320**	**6,760**	**1,276**	**22,440**	**6,290**	**3,004**
Renewable Supply									
Biomass	30	253	49	39	249	39	659	103	105
Fuel Cells	7	56	15	9	56	12	156	19	19
Hydropower	0	0	0	0	0	0	1	0	0
Landfill Gas	1	5	1	1	5	1	13	2	2
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	5	14	3	2	10	2	38	12	3
Solar Thermal	176	334	111	13	61	13	708	554	33
Windpower	0	0	0	1	1	1	3	0	0
Total Renewable	**220**	**663**	**180**	**65**	**382**	**68**	**1,578**	**689**	**162**
Total Efficiency Savings & Renewable Supply	**2,093**	**9,306**	**2,748**	**1,385**	**7,142**	**1,344**	**24,018**	**6,979**	**3,167**

	2012								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	478	2,385	668	450	2,447	508	6,935	2,084	1,115
Commercial	1,690	7,107	2,245	955	4,750	854	17,601	5,347	2,144
Industrial	15	82	17	18	81	13	227	33	33
Total Efficiency	**2,182**	**9,574**	**2,930**	**1,422**	**7,278**	**1,375**	**24,762**	**7,464**	**3,292**
Renewable Supply									
Biomass	28	242	47	37	239	37	631	99	100
Fuel Cells	65	490	126	81	488	105	1,355	165	166
Hydropower	0	1	0	0	2	0	4	0	0
Landfill Gas	0	3	1	0	3	0	7	1	1
Municipal Solid Waste	30	263	51	40	258	40	682	91	91
Photovoltaics	42	114	27	19	84	18	304	94	28
Solar Thermal	368	680	232	14	65	14	1,373	1,175	36
Windpower	1	0	1	2	1	2	7	1	1
Total Renewable	**536**	**1,794**	**484**	**193**	**1,140**	**216**	**4,363**	**1,625**	**423**
Total Efficiency Savings & Renewable Supply	**2,718**	**11,368**	**3,414**	**1,616**	**8,418**	**1,592**	**29,125**	**9,090**	**3,716**

	2022								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	527	2,385	684	446	2,422	508	6,972	2,390	1,148
Commercial	1,805	7,277	2,322	1,034	5,026	907	18,371	5,668	2,310
Industrial	13	70	15	16	69	11	193	29	29
Total Efficiency	**2,344**	**9,732**	**3,022**	**1,495**	**7,516**	**1,426**	**25,536**	**8,087**	**3,487**
Renewable Supply									
Biomass	31	265	52	41	261	41	691	108	110
Fuel Cells	366	2,466	783	436	2,468	679	7,198	878	888
Hydropower	0	3	1	1	5	1	11	1	1
Landfill Gas	0	1	0	0	1	0	1	0	0
Municipal Solid Waste	63	548	105	83	538	83	1,421	190	190
Photovoltaics	1,794	4,835	1,125	783	3,553	775	12,866	4,004	1,177
Solar Thermal	750	1,365	473	15	70	15	2,689	2,410	39
Windpower	2	1	2	4	3	4	17	1	3
Total Renewable	**3,007**	**9,484**	**2,541**	**1,363**	**6,900**	**1,598**	**24,893**	**7,593**	**2,408**
Total Efficiency Savings & Renewable Supply	**5,351**	**19,216**	**5,563**	**2,859**	**14,416**	**3,024**	**50,429**	**15,680**	**5,895**

Table 2.18 Zone J Economic Potential for Electricity from Efficiency Savings and Renewable Supply: 2007, 2012, and 2022 (New York City)

	2007								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	243	1,337	380	237	1,303	275	3,774	1,051	524
Commercial	1,178	5,637	1,645	811	4,001	719	13,991	3,429	1,721
Industrial	13	75	16	16	74	12	207	30	30
Total Efficiency	**1,434**	**7,049**	**2,041**	**1,065**	**5,378**	**1,006**	**17,973**	**4,510**	**2,276**
Renewable Supply									
Biomass	30	253	49	39	249	39	659	103	105
Fuel Cells	-	-	-	-	-	-	-	-	-
Hydropower	0	0	0	0	0	0	1	0	0
Landfill Gas	-	-	-	-	-	-	-	-	-
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	-	-	-	-	-	-	-	-	-
Solar Thermal	-	-	-	5	19	5	30	-	3
Windpower	-	-	-	-	-	-	-	-	-
Total Renewable	**30**	**253**	**49**	**44**	**268**	**44**	**689**	**103**	**108**
Total Efficiency Savings & Renewable Supply	**1,463**	**7,302**	**2,090**	**1,109**	**5,647**	**1,050**	**18,662**	**4,613**	**2,384**

	2012								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	362	1,627	488	270	1,475	310	4,532	1,637	626
Commercial	1,456	6,566	1,986	915	4,537	814	16,275	4,419	1,988
Industrial	14	77	16	17	76	12	211	31	31
Total Efficiency	**1,832**	**8,270**	**2,490**	**1,202**	**6,087**	**1,136**	**21,018**	**6,087**	**2,645**
Renewable Supply									
Biomass	28	242	47	37	239	37	631	99	100
Fuel Cells	-	-	-	-	-	-	-	-	-
Hydropower	0	1	0	0	2	0	4	0	0
Landfill Gas	-	-	-	-	-	-	-	-	-
Municipal Solid Waste	28	244	47	37	240	37	633	85	85
Photovoltaics	-	-	-	-	-	-	-	-	-
Solar Thermal	-	-	-	6	20	6	31	-	4
Windpower	-	-	-	-	-	-	-	-	-
Total Renewable	**57**	**488**	**95**	**80**	**500**	**80**	**1,299**	**184**	**189**
Total Efficiency Savings & Renewable Supply	**1,888**	**8,758**	**2,585**	**1,282**	**6,587**	**1,216**	**22,317**	**6,271**	**2,834**

	2022								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	487	2,158	630	390	2,115	443	6,224	2,217	984
Commercial	1,652	6,870	2,148	986	4,774	860	17,291	5,099	2,168
Industrial	12	63	14	14	62	10	175	26	26
Total Efficiency	**2,151**	**9,092**	**2,792**	**1,391**	**6,951**	**1,314**	**23,690**	**7,342**	**3,179**
Renewable Supply									
Biomass	31	265	52	41	261	41	691	108	110
Fuel Cells	-	-	-	-	-	-	-	-	-
Hydropower	0	3	1	1	5	1	11	1	1
Landfill Gas	-	-	-	-	-	-	-	-	-
Municipal Solid Waste	63	548	105	83	538	83	1,421	190	190
Photovoltaics	-	-	-	-	-	-	-	-	-
Solar Thermal	-	-	-	6	21	6	32	-	4
Windpower	-	-	-	-	-	-	-	-	-
Total Renewable	**95**	**816**	**158**	**130**	**825**	**130**	**2,155**	**299**	**305**
Total Efficiency Savings & Renewable Supply	**2,246**	**9,908**	**2,949**	**1,521**	**7,776**	**1,444**	**25,844**	**7,641**	**3,484**

Table 2.19 Zone J Economic Potential as Share of Technical Potential

	2007	2012	2022
Energy Efficiency Savings			
Residential	54%	65%	89%
Commercial	92%	92%	94%
Industrial	94%	93%	91%
Total Efficiency	80%	85%	93%
Renewable Supply			
Biomass	100%	100%	100%
Fuel Cells	0%	0%	0%
Hydropower	100%	100%	100%
Landfill Gas	0%	0%	0%
Municipal Solid Waste	NA	93%	100%
Photovoltaics	0%	0%	0%
Solar Thermal	4%	2%	1%
Windpower	0%	0%	0%
Total Renewable	44%	30%	9%
Total Efficiency Savings & Renewable Supply	78%	77%	51%

Table 2.20 NYSERDA Forecast of Zone J Sector Electric Energy Requirements: 2007, 2012, and 2022 (GWH at Generation)

	GWh at Generation		
	2007	2012	2022
Residential	15,207	15,756	17,147
Commercial	38,148	40,994	44,954
Industrial	934	989	988
Total (not including transportation)	54,288	57,739	63,089

Source: NYSERDA forecast sales with effects of post-2002 DSM removed.
Sales are multiplied by 1.115 to derive generation requirements in this table.

Table 2.21 Zone K Technical Potential for Electricity from Efficiency Savings and Renewable Supply: 2007, 2012, and 2022 (Long Island)

	2007								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	216	1,082	285	220	1,169	238	3,209	942	541
Commercial	343	1,661	488	223	1,158	206	4,080	1,060	481
Industrial	27	152	32	33	150	24	417	61	61
Total Efficiency	**586**	**2,895**	**805**	**475**	**2,478**	**468**	**7,707**	**2,063**	**1,083**
Renewable Supply									
Biomass	0	0	0	0	0	0	1	0	0
Fuel Cells	3	17	10	4	17	9	61	7	7
Hydropower	-	-	-	-	-	-	-	-	-
Landfill Gas	2	18	3	3	17	3	46	-	-
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	5	12	3	2	9	2	33	10	1
Solar Thermal	88	199	56	25	116	24	507	235	71
Windpower	35	24	29	108	91	103	390	30	71
Total Renewable	**133**	**271**	**102**	**142**	**251**	**141**	**1,039**	**282**	**151**
Total Efficiency Savings & Renewable Supply	**719**	**3,166**	**906**	**617**	**2,728**	**609**	**8,746**	**2,345**	**1,234**

	2012								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	222	1,034	278	212	1,119	232	3,096	1,004	532
Commercial	421	1,954	588	257	1,344	238	4,804	1,333	562
Industrial	28	159	34	35	157	25	438	65	65
Total Efficiency	**671**	**3,147**	**901**	**503**	**2,619**	**496**	**8,337**	**2,402**	**1,159**
Renewable Supply									
Biomass	0	0	0	0	0	0	1	0	0
Fuel Cells	31	164	84	34	166	78	556	68	68
Hydropower	-	-	-	-	-	-	-	-	-
Landfill Gas	1	9	2	1	9	1	23	-	-
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	36	96	22	16	71	15	256	77	10
Solar Thermal	134	282	85	27	125	26	679	372	77
Windpower	129	92	110	421	356	402	1,511	116	274
Total Renewable	**331**	**644**	**304**	**498**	**727**	**522**	**3,026**	**633**	**430**
Total Efficiency Savings & Renewable Supply	**1,002**	**3,791**	**1,204**	**1,002**	**3,346**	**1,018**	**11,363**	**3,035**	**1,589**

	2022								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	253	1,062	294	214	1,131	237	3,191	1,195	553
Commercial	444	1,936	593	270	1,358	243	4,844	1,399	591
Industrial	24	134	29	30	132	22	370	56	56
Total Efficiency	**721**	**3,132**	**916**	**514**	**2,620**	**502**	**8,404**	**2,650**	**1,201**
Renewable Supply									
Biomass	0	0	0	0	0	0	1	0	0
Fuel Cells	223	919	700	228	945	670	3,684	450	456
Hydropower	-	-	-	-	-	-	-	-	-
Landfill Gas	0	2	0	0	2	0	5	-	-
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	1,507	4,062	946	658	2,985	651	10,808	3,250	403
Solar Thermal	221	437	142	29	134	28	990	636	84
Windpower	1,585	1,164	1,371	5,374	4,581	5,160	19,235	1,473	3,487
Total Renewable	**3,536**	**6,585**	**3,158**	**6,289**	**8,648**	**6,508**	**34,724**	**5,809**	**4,429**
Total Efficiency Savings & Renewable Supply	**4,257**	**9,716**	**4,074**	**6,802**	**11,268**	**7,010**	**43,128**	**8,459**	**5,630**

Table 2.22 Zone K Economic Potential for Electricity from Efficiency Savings and Renewable Supply: 2007, 2012, and 2022 (Long Island)

	2007								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	112	608	165	117	621	128	1,751	485	261
Commercial	295	1,550	433	215	1,118	199	3,809	861	453
Industrial	25	141	30	30	139	22	387	57	57
Total Efficiency	**431**	**2,300**	**627**	**363**	**1,878**	**349**	**5,947**	**1,402**	**771**
Renewable Supply									
Biomass	0	0	0	0	0	0	1	0	0
Fuel Cells	-	-	-	-	-	-	-	-	-
Hydropower	-	-	-	-	-	-	-	-	-
Landfill Gas	-	-	-	-	-	-	-	-	-
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	-	-	-	-	-	-	-	-	-
Solar Thermal	-	-	-	7	25	7	40	-	7
Windpower	34	24	28	105	89	100	379	29	69
Total Renewable	**34**	**24**	**28**	**113**	**114**	**107**	**420**	**29**	**76**
Total Efficiency Savings & Renewable Supply	**465**	**2,324**	**655**	**476**	**1,992**	**456**	**6,367**	**1,431**	**848**

	2012								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	158	802	217	157	827	171	2,332	696	363
Commercial	369	1,834	528	249	1,299	230	4,509	1,119	531
Industrial	26	147	31	32	144	23	403	59	59
Total Efficiency	**552**	**2,783**	**777**	**438**	**2,271**	**424**	**7,244**	**1,874**	**954**
Renewable Supply									
Biomass	0	0	0	0	0	0	1	0	0
Fuel Cells	-	-	-	-	-	-	-	-	-
Hydropower	-	-	-	-	-	-	-	-	-
Landfill Gas	-	-	-	-	-	-	-	-	-
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	-	-	-	-	-	-	-	-	-
Solar Thermal	-	-	-	7	26	7	41	-	7
Windpower	126	91	108	414	351	396	1,487	114	271
Total Renewable	**126**	**91**	**108**	**422**	**378**	**403**	**1,529**	**114**	**278**
Total Efficiency Savings & Renewable Supply	**678**	**2,874**	**884**	**860**	**2,648**	**827**	**8,773**	**1,988**	**1,231**

	2022								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	213	978	267	202	1,066	224	2,950	980	513
Commercial	414	1,863	559	263	1,321	236	4,656	1,277	568
Industrial	21	118	25	26	117	19	326	49	49
Total Efficiency	**648**	**2,960**	**851**	**491**	**2,504**	**479**	**7,932**	**2,306**	**1,129**
Renewable Supply									
Biomass	0	0	0	0	0	0	1	0	0
Fuel Cells	-	-	-	-	-	-	-	-	-
Hydropower	-	-	-	-	-	-	-	-	-
Landfill Gas	-	-	-	-	-	-	-	-	-
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	-	-	-	-	-	-	-	-	-
Solar Thermal	-	-	-	8	27	8	43	-	7
Windpower	1,577	1,161	1,364	5,358	4,569	5,145	19,175	1,468	3,477
Total Renewable	**1,577**	**1,162**	**1,364**	**5,366**	**4,597**	**5,152**	**19,219**	**1,468**	**3,485**
Total Efficiency Savings & Renewable Supply	**2,226**	**4,122**	**2,215**	**5,857**	**7,101**	**5,631**	**27,152**	**3,774**	**4,614**

Table 2.23 Zone K Economic Potential as Share of Technical Potential

	2007	2012	2022
Energy Efficiency Savings			
Residential	55%	75%	92%
Commercial	93%	94%	96%
Industrial	93%	92%	88%
Total Efficiency	77%	87%	94%
Renewable Supply			
Biomass	100%	100%	100%
Fuel Cells	0%	0%	0%
Hydropower	NA	NA	NA
Landfill Gas	0%	0%	0%
Municipal Solid Waste	NA	NA	NA
Photovoltaics	0%	0%	0%
Solar Thermal	8%	6%	4%
Windpower	97%	98%	100%
Total Renewable	40%	51%	55%
Total Efficiency Savings & Renewable Supply	73%	77%	63%

Table 2.24 NYSERDA Forecast of Zone K Sector Electric Energy Requirements: 2007, 2012, and 2022 (GWH at Generation)

	GWh at Generation		
	2007	2012	2022
Residential	8,452	8,757	9,530
Commercial	10,669	11,353	11,958
Industrial	1,725	1,859	1,936
Total (not including transportation)	20,845	21,969	23,424

Source: NYSERDA forecast sales with effects of post-2002 DSM removed.
Sales are multiplied by 1.115 to derive generation requirements in this table.

ACHIEVABLE EFFICIENCY AND RENEWABLE CONTRIBUTIONS TOWARD NEW YORK'S GHG REDUCTIONS

Consolidated results for the achievable potential analyses of the GHG scenarios appear in Tables 2.25 through 2.36. Tables 2.25 and 2.26 provide results for the efficiency and renewable resources that would comprise a least-cost portfolio for meeting GHG targets in 2012, under low and high avoided costs, respectively. Tables 2.27 and 2.28 provide comparable information for 2022. Table 2.29 shows these achievable contributions as a share of forecasted electric energy requirements for 2012 and 2022.

The supply curves resulting from the GHG analysis are presented in Volume 1, Figures 1.10 and 1.11. Volume 7 is devoted entirely to detailed results of the GHG analysis underlying these curves, providing the achievable costs and quantitites of efficiency and renewable resources selected in order of increasing cost to meet both 2012 and 2022 GHG targets.

The study concludes that New York could achieve its GHG-reduction targets for electricity entirely through a combination of efficiency savings and renewable supply.[19] New York could choose the least-cost combination of achievable efficiency and renewable resources by starting with the least expensive and adding progressively more expensive resources.

The analysis concludes that in many cases the net cost of electric energy from efficiency and renewable resources is negative. This is because in those instances, the value of the generating capacity benefit exceeds the unadjusted estimates of achievable technology cost (shown in the fourth column of Tables 2.25 through 2.28). Moreover, many industrial efficiency technologies reduce other customer resource costs, such as waste disposal or capital. The combined value of these other benefits can exceed the entire direct costs of the technologies, even after adding administrative costs to technology costs.

For example, Table 2.26 shows the composition of the least-cost portfolio selected for 2012 under high avoided costs. It indicates that the least-cost efficiency savings all have negative net lifetime costs of saved energy. This is primarily due to the value of peak capacity savings. In the case of the least-cost industrial efficiency technologies, non-electric resource savings are so substantial that they surpass the direct costs of the technologies, even after adding program administration costs, which yields negative resource costs in the amount of minus $3.3 million (2003 present worth).[20] This is the reason for the negative benefit/cost ratio shown in the last column of Table 2.26. The average net lifetime cost of the efficiency resources

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[19] The analysis interpolated linearly between 2010 and 2020 to determine a 2012 target, in order to match the time horizon of the study. Likewise, the analysis extrapolated the 2022 target. The total Annual GWh shown at the bottom in Tables 2.25 through 2.28 slightly exceed the study GHG targets for 2012 and 2022. This is because the size of the last resource block chosen exceeded the deficit remaining after including all other efficiency and rewewables up to that point.

[20] The costs shown in the fourth column have not been reduced by capacity value; as in the rest of the study, these savings are included as resource benefits.

included in the least-cost mix is *minus* 0.88 cents/kWh. Three of the renewable technologies in the least-cost GHG portfolio for 2012 under high avoided costs also show negative net lifetime costs of saved energy: biomass, municipal solid waste, and solar thermal. Indeed, because of their high non-electric resource savings, biomass and MSW both show negative resource costs (and thus negative benefit/cost ratios). For all the renewable resources included in the least-cost GHG mix for 2012 under high avoided costs, the net lifetime energy cost averages minus 1.52 cents/kWh. Thus, electric energy from the entire efficiency and renewable GHG portfolio would cost on average minus 0.99 cents/kWh.[21]

The study further concludes that there would be substantial net economic benefits to New York from pursuing such a least-cost approach to meeting greenhouse-gas reduction targets, under the lowest and the highest zonal avoided costs. For example, Table 2.27 shows that even under low avoided costs, New York's economy would reap $9.1 billion in net resource benefits if it were to pursue a strictly least-cost combination of achievable efficiency and renewable resources to meet the 2022 GHG target for the electricity sector.

[21] This result calls to mind the notion of the economist's supposedly non-existent free lunch. From the standpoint of the State's greenhouse-gas targets, the study suggests that efficiency and renewables offer a lunch New Yorkers collectively would be paid to eat.

Table 2.25 Least-Cost Efficiency and Renewable Achievements Toward Greenhouse-Gas Targets, 2012 (Calculated at Low Avoided Costs)

				Present Worth in 2003 Millions of Dollars			
				Total Resource			
	Annual GWh		Lifetime net cost per kWh saved ($/kWh)	Benefits ($Millions)	Costs ($Millions)	Net Benefits ($Millions)	BCR
Energy Efficiency Savings							
Residential	3,105	$	(0.0224)	1,281.4	(26.1)	1,307.5	-49.08
Commercial	12,454	$	0.0160	4,068.6	2,555.3	1,513.2	1.59
Industrial	538	$	(0.0164)	139.6	(3.3)	142.9	-41.98
Total Efficiency	16,096	$	0.0084	5,489.5	2,525.9	2,963.6	2.17
Renewable Supply							
Biomass	2,520	$	(0.0122)	728.5	(162.8)	891.3	-4.48
Fuel Cells	-		NA	-	-	-	NA
Hydropower	859	$	0.0075	440.4	135.8	304.6	3.24
Landfill Gas	-		NA	-	-	-	NA
Municipal Solid Waste	633	$	(0.0093)	329.6	(46.0)	375.6	-7.16
Photovoltaics	-		NA	-	-	-	NA
Solar Thermal	7	$	0.0039	2.6	0.4	2.2	7.30
Windpower	-		NA	-	-	-	NA
Total Renewable	4,019	$	(0.0055)	1,501.2	(72.6)	1,573.8	-20.67
Total Efficiency Savings & Renewable Supply	20,115	$	0.0050	6,990.7	2,453.3	4,537.4	2.85

Table 2.26 Least-Cost Efficiency and Renewable Achievements Toward Greenhouse-Gas Targets, 2012 (Calculated at High Avoided Costs)

				Present Worth in 2003 Millions of Dollars			
				Total Resource			
	Annual GWh		Lifetime net cost per kWh saved ($/kWh)	Benefits ($Millions)	Costs ($Millions)	Net Benefits ($Millions)	BCR
Energy Efficiency Savings							
Residential	3,271	$	(0.0407)	2,366.6	233.0	2,133.6	10.16
Commercial	12,307	$	(0.0002)	7,481.0	2,916.2	4,564.8	2.57
Industrial	538	$	(0.0296)	213.0	(3.3)	216.3	-64.06
Total Efficiency	16,116	$	(0.0082)	10,060.6	3,145.8	6,914.8	3.20
Renewable Supply							
Biomass	2,520	$	(0.0241)	1,208.1	(162.8)	1,370.8	-7.42
Fuel Cells	-		NA	-	-	-	NA
Hydropower	859	$	0.0015	678.8	135.8	543.0	5.00
Landfill Gas	-		NA	-	-	-	NA
Municipal Solid Waste	633	$	(0.0194)	548.2	(46.0)	594.2	-11.91
Photovoltaics	-		NA	-	-	-	NA
Solar Thermal	7	$	(0.0036)	4.1	0.4	3.7	11.57
Windpower	-		NA	-	-	-	NA
Total Renewable	4,019	$	(0.0152)	2,439.2	(72.6)	2,511.8	-33.58
Total Efficiency Savings & Renewable Supply	20,135	$	(0.0099)	12,499.8	3,073.2	9,426.6	4.07

Table 2.27 Least-Cost Efficiency and Renewable Achievements Toward Greenhouse-Gas Targets, 2022 (Calculated at Low Avoided Costs)

				Present Worth in 2003 Millions of Dollars			
				Total Resource			
	Annual GWh		Lifetime net cost per kWh saved ($/kWh)	Benefits ($Millions)	Costs ($Millions)	Net Benefits ($Millions)	BCR
Energy Efficiency Savings							
Residential	6,818	$	(0.0286)	2,711.4	(369.8)	3,081.2	-7.33
Commercial	12,846	$	0.0121	5,263.7	2,751.6	2,512.1	1.91
Industrial	2,381	$	(0.0175)	659.6	(42.6)	702.2	-15.50
Total Efficiency	22,045	$	(0.0002)	8,634.8	2,339.3	6,295.5	3.69
Renewable Supply							
Biomass	1,717	$	(0.0236)	870.5	(483.3)	1,353.8	-1.80
Fuel Cells	-		NA	-	-	-	NA
Hydropower	859	$	0.0075	440.4	135.8	304.6	3.24
Landfill Gas	-		NA	-	-	-	NA
Municipal Solid Waste	1,325	$	(0.0093)	627.7	(83.7)	711.4	-7.50
Photovoltaics	-		NA	-	-	-	NA
Solar Thermal	9	$	0.0029	3.4	0.4	3.1	9.62
Windpower	6,049	$	0.0264	1,888.9	1,456.4	432.5	1.30
Total Renewable	9,959	$	0.0067	3,831.0	1,025.6	2,805.4	3.74
Total Efficiency Savings & Renewable Supply	32,003	$	0.0022	12,465.7	3,364.8	9,100.9	3.70

Table 2.28 Least-Cost Efficiency and Renewable Achievements Toward Greenhouse-Gas Targets, 2022 (Calculated at High Avoided Costs)

				Present Worth in 2003 Millions of Dollars			
				Total Resource			
	Annual GWh	Lifetime net cost per kWh saved ($/kWh)		Benefits ($Millions)	Costs ($Millions)	Net Benefits ($Millions)	BCR
Energy Efficiency Savings							
Residential	6,132	$	(0.0596)	4,743.2	(15.6)	4,758.8	-303.97
Commercial	15,066	$	(0.0041)	11,149.5	3,997.6	7,151.9	2.79
Industrial	2,381	$	(0.0310)	1,033.2	(42.6)	1,075.8	-24.27
Total Efficiency	23,580	$	(0.0176)	16,925.9	3,939.4	12,986.5	4.30
Renewable Supply							
Biomass	1,717	$	(0.0356)	1,448.5	(483.3)	1,931.9	-3.00
Fuel Cells	-		NA	-	-	-	NA
Hydropower	859	$	0.0015	678.8	135.8	543.0	5.00
Landfill Gas	-		NA	-	-	-	NA
Municipal Solid Waste	1,325	$	(0.0196)	1,055.3	(83.7)	1,138.9	-12.62
Photovoltaics	-		NA	-	-	-	NA
Solar Thermal	9	$	(0.0047)	5.5	0.4	5.1	15.49
Windpower	-		NA	-	-	-	NA
Total Renewable	3,910	$	(0.0217)	3,188.1	(430.8)	3,619.0	-7.40
Total Efficiency Savings & Renewable Supply	27,490	$	(0.0185)	20,114.0	3,508.5	16,605.5	5.73

Table 2.29 reports on the share of forecasted electric energy requirements that would be met by the selected efficiency resources by sector and renewable reources by technology. Results range from a low of 1.8% for industrial efficiency in both 2012 and 2022, to 15.9% for commercial efficiency in 2022 under high avoided costs. Note that using high avoided costs involves higher capacity costs, which lower net lifetime energy costs calculated for those technologies providing relatively high peak kW per kWh of energy. Such resources end up being selected first, displacing other resources that were favored in the low avoided-cost scenario. This is why residential efficiency and renewables end up meeting a lower fraction of forecasted electricity requirements under high avoided costs in 2020, as shown Table 2.29, for example.

Table 2.29 Achievable Greenhouse Gas Contributions vs. Forecast Energy Requirements, 2012 and 2022

	2012		2022	
	Low Avoided Cost	High Avoided Cost	Low Avoided Cost	High Avoided Cost
	GWh	GWh	GWh	GWh
Residential efficiency	3,105	3,271	6,818	6,132
Forecast Requirements	56,091	56,091	61,046	61,046
Achievable share of forecast requirements	5.5%	5.8%	11.2%	10.0%
Commercial efficiency	12,454	12,307	12,846	15,066
Forecast Requirements	89,395	89,395	94,754	94,754
Achievable share of forecast requirements	13.9%	13.8%	13.6%	15.9%
Industrial efficiency	538	538	2,381	2,381
Forecast Requirements	29,917	29,917	33,123	33,123
Achievable share of forecast requirements	1.8%	1.8%	7.2%	7.2%
Total efficiency	16,096	16,116	22,045	23,580
Forecast Requirements (not including transportation)	175,404	175,404	188,923	188,923
Achievable share of forecast requirements	9.2%	9.2%	11.7%	12.5%
Renewables	4,019	4,019	9,959	3,910
Forecast Requirements (not including transportation)	175,404	175,404	188,923	188,923
Achievable share of forecast requirements	2.3%	2.3%	5.3%	2.1%
Efficiency and renewables	20,115	20,135	32,003	27,490
Forecast Requirements (not including transportation)	175,404	175,404	188,923	188,923
Achievable share of forecast requirements	11.5%	11.5%	16.9%	14.6%

Note: Efficiency savings, renewable supply and forecast requirements are all shown at generation.

Tables 2.30 through 2.35 provide more detailed breakdowns of efficiency and renewable technologies included in the least-cost GHG solutions for 2012 and 2022 under low avoided costs. Tables 2.30 and 2.33 present a breakdown by end use of residential and commercial efficiency resources included in the least-cost GHG solutions for 2012 and 2022, respectively. Tables 2.31 and 2.34 provide comparable breakdowns by industrial efficiency technology. Tables 2.32 and 2.35 provide detailed breakdowns by technology of renewable resources.

Table 2.30 2012 Residential and Commercial Breakdown of Least-Cost Achievements Toward Greenhouse-Gas Targets, by End Use (Net Cost of Energy Calculated at Low Avoided Capacity Costs)

	Annual MWh	Lifetime net cost per kWh saved
Residential		
Cooling	261,859	$ (0.3046)
Dishwasher	88,094	$ (0.0014)
Refrigerator	114,931	$ 0.0214
Heat Pump	37,894	$ (0.0095)
Space Heating	344,727	$ 0.0172
Domestic Hot Water	111,110	$ 0.0088
Lighting	1,355,635	$ 0.0115
Miscellaneous	231,875	$ 0.0022
Pool/Hot Tub Pump	-	NA
TV/VCR/DVD	101,080	$ 0.0064
Clotheswasher	458,040	$ (0.0273)
TOTAL	3,105,245	$ (0.0224)
Commercial		
Indoor Lighting	6,088,178	$ 0.0203
Outdoor Lighting	228,281	$ 0.0135
Cooling	906,359	$ (0.0060)
Ventilation	1,640,650	$ 0.0153
Water Heating	292,213	$ 0.0111
Refrigeration	1,369,914	$ 0.0145
Space Heating	59,607	$ (0.0031)
Office Equipment	607,877	$ 0.0008
Miscellaneous	551,702	$ 0.0251
Whole Building	708,758	$ 0.0169
TOTAL	12,453,538	$ 0.0160

Table 2.31 2012 Industrial Breakdown of Least-Cost Achievements Toward Greenhouse-Gas Targets, by Technology (Net Cost of Energy Calculated at Low Avoided Capacity Costs)

Industrial			
Sensors and controls	10,954	$	(0.0057)
Energy Management systems	-		NA
membrane technology wastewater	720	$	(0.0050)
Advanced Industrial HVAC	-		NA
Energy Information Systems	43,417	$	0.0118
Efficient Transformers (Tier 1)	-		NA
Efficient Transformers (Tier 2)	3,717	$	0.0054
Duct/Pipe Insulation	126,939	$	0.0111
Heat recovery food industry - low temperature	-		NA
Cooling and storage	-		NA
electric supply system improments	31,439	$	(0.0112)
Microwave processing	-		NA
RF heating and drying	-		NA
Efficient lighting design -- Office	16,111	$	(0.0008)
Efficient lighting design -- Manuf	24,308	$	0.0029
Efficient lighting design -- Warehouse	18,326	$	(0.0009)
Efficient lighting fixtures and lamps -- Office	36	$	-
Efficient lighting fixtures and lamps -- Manuf	31,679	$	0.0097
Efficient lighting fixtures and lamps -- Warehous	9,827	$	0.0088
Advanced motor designs	30,373	$	(0.0024)
motor management	13,237	$	(0.0134)
Advanced lubricants	5,086	$	(0.0145)
Motor system optimization	3,047	$	(0.0414)
Compressed air system management	34,906	$	(0.0139)
Air Compressor Systems Advanced Controls	3,257	$	(0.0215)
Pump efficiency improvement	59,282	$	(0.0616)
Fan system efficiency	15,162	$	(0.0588)
Efficient cell retrofit designs	29,857	$	(0.0006)
Advanced forming/near net shape technology	3,020	$	(1.2395)
liquid mebrane technologies-chemicals	4,460	$	0.0091
gas membrane technologies-chemicals	5,645	$	(0.0021)
Advanced Cleanroom HVAC (Electronics)	1,773	$	0.0041
Advanced Cleanroom HVAC (pharm)	-		NA
membrane technology - food	-		NA
Freeze concentration	-		NA
Efficient refrigeration systems	8,434	$	0.0145
UV curing	791	$	(0.0776)
Electric IR heating and drying	-		NA
Optimization of aeration systems	1,765	$	0.0159
TOTAL	537,568	$	(0.0164)

Table 2.32 2012 Renewable Breakdown of Least-Cost Achievements Toward Greenhouse-Gas Targets, by Technology (Net Cost of Energy Calculated at Low Avoided Capacity Costs)

Renewables			
Biomass Direct-Fire	-		NA
Biomass Cofiring w/ Coal	1,508,595	$	0.0131
Biomass Gasification	834,242	$	0.0137
Biomass CHP	177,296	$	(0.2895)
Fuel Cell PEM	-		NA
Fuel Cell PAFC	-		NA
Fuel Cell SOFC	-		NA
Fuel Cell MCFC	-		NA
Hydro Relicense	858,900	$	0.0075
Hydro Repower	-		NA
Hydro Ex Capacity Ex Dam	-		NA
Hydro New Capacity Ex Dam	-		NA
Hydro New Dam sites	-		NA
LFG Large Systems	-		NA
LFG Engines	-		NA
LFG Microturbines	-		NA
WTE Large	633,304	$	(0.0093)
WTE Small	-		NA
Solid Waste Digestion	-		NA
PV Residential	-		NA
PV C&I with solar load control	-		NA
PV C&I no load control	-		NA
PV BIPV	-		NA
Res DHW	-		NA
Com DHW	-		NA
C&I Vent Pre Heat	6,519	$	0.0039
Solar Absorp Cool	-		NA
Wind Farm Installations	-		NA
Cluster Installations	-		NA
Small Wind Installations	-		NA
Offshore Wind Installations	-		NA
TOTAL	4,018,857	$	(0.0055)

Table 2.33 2022 Residential and Commercial Breakdown of Least-Cost Achievements Toward Greenhouse-Gas Targets, by End Use (Net Cost of Energy Calculated at Low Avoided Capacity Costs)

	Annual MWh	Lifetime net cost per kWh saved
Residential		
Cooling	789,035	$ (0.2968)
Dishwasher	158,840	$ (0.0017)
Refrigerator	209,235	$ 0.0216
Heat Pump	92,678	$ (0.0106)
Space Heating	935,551	$ 0.0171
Domestic Hot Water	167,649	$ 0.0086
Lighting	3,100,239	$ 0.0092
Miscellaneous	566,205	$ 0.0028
Pool/Hot Tub Pump	-	NA
TV/VCR/DVD	228,685	$ 0.0059
Clotheswasher	569,786	$ (0.0331)
TOTAL	6,817,904	$ (0.0286)
Commercial		
Indoor Lighting	6,227,948	$ 0.0170
Outdoor Lighting	173,918	$ 0.0133
Cooling	1,692,562	$ (0.0097)
Ventilation	1,715,563	$ 0.0147
Water Heating	378,942	$ 0.0080
Refrigeration	990,031	$ 0.0147
Space Heating	111,886	$ (0.0031)
Office Equipment	560,559	$ 0.0008
Miscellaneous	293,195	$ 0.0251
Whole Building	700,899	$ 0.0148
TOTAL	12,845,503	$ 0.0121

Table 2.34 2022 Industrial Breakdown of Least-Cost Achievements Toward Greenhouse-Gas Targets, by Technology (Net Cost of Energy Calculated at Low Avoided Capacity Costs)

Industrial			
Sensors and controls	48,310	$	(0.0059)
Energy Management systems	-		NA
membrane technology wastewater	2,945	$	(0.0050)
Advanced Industrial HVAC	-		NA
Energy Information Systems	355,953	$	0.0094
Efficient Transformers (Tier 1)	-		NA
Efficient Transformers (Tier 2)	23,143	$	0.0052
Duct/Pipe Insulation	408,269	$	0.0105
Heat recovery food industry - low temperature	-		NA
Cooling and storage	-		NA
electric supply system improments	100,985	$	(0.0113)
Microwave processing	-		NA
RF heating and drying	-		NA
Efficient lighting design -- Office	58,852	$	(0.0009)
Efficient lighting design -- Manuf	98,099	$	0.0026
Efficient lighting design -- Warehouse	73,539	$	(0.0011)
Efficient lighting fixtures and lamps -- Office	198	$	-
Efficient lighting fixtures and lamps -- Manuf	171,632	$	0.0095
Efficient lighting fixtures and lamps -- Warehous	54,433	$	0.0086
Advanced motor designs	159,048	$	(0.0025)
motor management	70,871	$	(0.0132)
Advanced lubricants	7,971	$	(0.0141)
Motor system optimization	15,562	$	(0.0399)
Compressed air system management	57,801	$	(0.0132)
Air Compressor Systems Advanced Controls	15,565	$	(0.0209)
Pump efficiency improvement	253,287	$	(0.0600)
Fan system efficiency	79,857	$	(0.0563)
Efficient cell retrofit designs	164,705	$	(0.0007)
Advanced forming/near net shape technology	20,987	$	(1.2397)
liquid mebrane technologies-chemicals	22,540	$	0.0090
gas membrane technologies-chemicals	36,562	$	(0.0023)
Advanced Cleanroom HVAC (Electronics)	10,358	$	0.0040
Advanced Cleanroom HVAC (pharm)	-		NA
membrane technology - food	-		NA
Freeze concentration	-		NA
Efficient refrigeration systems	56,847	$	0.0144
UV curing	4,740	$	(0.0777)
Electric IR heating and drying	-		NA
Optimization of aeration systems	8,248	$	0.0158
TOTAL	2,381,309	$	(0.0175)

Table 2.35 2022 Renewable Breakdown of Least-Cost Achievements Toward Greenhouse-Gas Targets, by Technology (Net Cost of Energy Calculated at Low Avoided Capacity Costs)

Renewables			
Biomass Direct-Fire	-		NA
Biomass Cofiring w/ Coal	526,935	$	0.0139
Biomass Gasification	834,242	$	0.0137
Biomass CHP	355,821	$	(0.2967)
Fuel Cell PEM	-		NA
Fuel Cell PAFC	-		NA
Fuel Cell SOFC	-		NA
Fuel Cell MCFC	-		NA
Hydro Relicense	858,900	$	0.0075
Hydro Repower	-		NA
Hydro Ex Capacity Ex Dam	-		NA
Hydro New Capacity Ex Dam	-		NA
Hydro New Dam sites	-		NA
LFG Large Systems	-		NA
LFG Engines	-		NA
LFG Microturbines	-		NA
WTE Large	1,324,862	$	(0.0093)
WTE Small	-		NA
Solid Waste Digestion	-		NA
PV Residential	-		NA
PV C&I with solar load control	-		NA
PV C&I no load control	-		NA
PV BIPV	-		NA
Res DHW	-		NA
Com DHW	-		NA
C&I Vent Pre Heat	9,234	$	0.0029
Solar Absorp Cool	-		NA
Wind Farm Installations	6,048,728	$	0.0264
Cluster Installations	-		NA
Small Wind Installations	-		NA
Offshore Wind Installations	-		NA
TOTAL	9,958,722	$	0.0067

Table 2.36 compares the least-cost contributions from achievable efficiency and renewable resources with their economic potential as estimated in this study, in 2012 and 2022, under low and high avoided costs. Least-cost contributions from efficiency resources represent between 28% of the estimated economic potential in 2012 under high avoided costs to 41% of economic potential under low avoided costs. For 2012, the least-cost portfolio includes 47% of biomass economic potential and 93% of MSW economic potential.

Table 2.36 Achievable Greenhouse Gas Contributions vs. Efficiency and Renewable Economic Potential

	2012		2022	
	Low Avoided Costs	High Avoided Costs	Low Avoided Costs	High Avoided Costs
Energy Efficiency Savings				
Residential	25%	20%	44%	31%
Commercial	39%	35%	39%	41%
Industrial	9%	9%	48%	48%
Total Efficiency	32%	28%	41%	38%
Renewable Supply				
Biomass	47%	47%	27%	27%
Fuel Cells	NA	NA	NA	NA
Hydropower	20%	17%	9%	8%
Landfill Gas	NA	0%	NA	0%
Municipal Solid Waste	93%	93%	93%	93%
Photovoltaics	NA	NA	NA	NA
Solar Thermal	4%	4%	5%	5%
Windpower	0%	0%	14%	0%
Total Renewable	34%	26%	17%	6%
Total Efficiency Savings & Renewable Supply	32%	28%	28%	23%

In conclusion, note that the least-cost greenhouse-gas solution indicated in this study is not balanced to reflect other important policy objectives stated in the State Energy Plan. Policy considerations not reflected in the strictly least-cost resource mix identified in this study include reliability, supply diversity, market transformation, or distributional equity. Future analysis and development of efficiency and renewable portfolios for the state or for individual load zones should take such additional policy objectives into account.

EXPECTED CONTRIBUTIONS FROM NEW YORK'S CURRENTLY PLANNED INITIATIVES

Finally, this study concludes that New York's currently planned initiatives will achieve significant cost-effective contributions toward meeting the State's greenhouse-gas targets. Tables 2.37 through 2.41 present the results of this study's estimates of expected contributions from New York's currently planned initiatives. Table 2.37 provides electric energy in annual GWh by peak vs. off-peak and seasonal costing periods, as well as summer and winter peak MW for 2007, 2012, and 2022. Table 2.38 compares annual

GWh with NYSERDA's statewide forecast of electric energy requirements This table shows that currently planned initiatives will produce small but significant fractions of New York's future electric energy needs. Overall, efficiency and renewables are expected to generate between 1.7% of total requirements in 2007 to 7.2% by 2022.

The smallest estimated contribution is from industrial efficiency, at 0.1% of forecast industrial sales through 2022. This result is due to the study's conclusion (in Volume 3, Section 4) that currently-planned initiatives are likely to produce only a modest amount of achievable savings from this hard-to-reach sector. By contrast, the study estimates that currently planned initatives will lead to commercial efficiency savings reaching 9.0% of forecast commecial electricity requirements by 2022. This is due to the substantial market transformation that the study projects will result from currently planned initiatives in the commercial sector.

Table 2.37 Expected Efficiency and Renewable Electric Energy Achievments Under Currently Planned Initiatives: 2007, 2012, and 2022 (at Generation)

	2007								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	21	117	35	21	110	24	328	96	43
Commercial	109	460	149	60	300	55	1,134	335	129
Industrial	2	11	2	2	10	2	29	4	4
Total Efficiency	**132**	**587**	**186**	**84**	**421**	**81**	**1,490**	**435**	**176**
Renewable Supply									
Biomass	32	262	51	42	258	40	684	108	109
Fuel Cells	3	21	4	3	21	4	57	7	7
Hydropower	-	-	-	-	-	-	-	-	-
Landfill Gas	5	45	9	7	45	7	118	16	16
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	2	6	1	1	4	1	16	5	1
Solar Thermal	1	2	1	0	2	0	7	2	1
Windpower	56	95	71	167	214	190	793	64	151
Total Renewable	**99**	**432**	**138**	**220**	**544**	**243**	**1,676**	**200**	**285**
Total Efficiency Savings & Renewable Supply	**231**	**1,019**	**324**	**304**	**965**	**323**	**3,166**	**636**	**461**

	2012								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	19	103	30	19	99	21	292	84	40
Commercial	263	1,103	355	152	742	136	2,751	798	319
Industrial	1	7	1	2	7	1	19	3	3
Total Efficiency	**283**	**1,213**	**387**	**173**	**848**	**159**	**3,063**	**886**	**362**
Renewable Supply									
Biomass	38	306	60	50	302	47	804	124	126
Fuel Cells	13	92	19	15	92	16	248	30	30
Hydropower	-	-	-	-	-	-	-	-	-
Landfill Gas	6	53	10	8	52	8	137	18	18
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	4	10	2	2	7	2	27	8	2
Solar Thermal	6	15	4	2	10	2	39	10	5
Windpower	126	176	149	334	401	372	1,558	124	295
Total Renewable	**193**	**652**	**244**	**411**	**865**	**447**	**2,812**	**315**	**476**
Total Efficiency Savings & Renewable Supply	**477**	**1,866**	**631**	**583**	**1,713**	**606**	**5,875**	**1,200**	**838**

	2022								
	Cumulative Annual GWh							Cumulative Annual MW	
	Summer On-Peak	Summer Off-Peak	Summer Shoulder	Winter On-Peak	Winter Off-peak	Winter Shoulder	Total Annual	Summer Peak	Winter Peak
Energy Efficiency Savings									
Residential	16	88	26	17	88	19	254	69	36
Commercial	890	3,412	1,152	464	2,228	409	8,555	2,835	991
Industrial	0	1	0	0	1	0	3	0	0
Total Efficiency	**906**	**3,502**	**1,178**	**481**	**2,317**	**428**	**8,812**	**2,904**	**1,028**
Renewable Supply									
Biomass	66	512	101	85	504	79	1,347	204	208
Fuel Cells	29	214	44	35	215	37	575	70	71
Hydropower	-	-	-	-	-	-	-	-	-
Landfill Gas	8	65	13	10	64	10	170	23	23
Municipal Solid Waste	-	-	-	-	-	-	-	-	-
Photovoltaics	16	41	10	6	30	6	108	31	7
Solar Thermal	10	26	6	4	18	3	67	18	9
Windpower	225	284	256	562	652	618	2,597	207	489
Total Renewable	**353**	**1,142**	**429**	**702**	**1,483**	**754**	**4,863**	**552**	**806**
Total Efficiency Savings & Renewable Supply	**1,260**	**4,644**	**1,607**	**1,183**	**3,800**	**1,182**	**13,675**	**3,456**	**1,834**

Table 2.38 Expected Efficiency and Renewable Electric Energy Achievments Under Currently Planned Initiatives vs. Forecast Requirements: 2007, 2012, and 2022 (at Generation)

	2007	2012	2022
	GWh	GWh	GWh
Residential efficiency	328	292	254
Forecast Requirements	54,136	56,091	61,046
Achievable share of forecast requirements	0.6%	0.5%	0.4%
Commercial efficiency	1,134	2,751	8,555
Forecast Requirements	84,042	89,395	94,754
Achievable share of forecast requirements	1.3%	3.1%	9.0%
Industrial efficiency	29	19	3
Forecast Requirements	27,405	29,917	33,123
Achievable share of forecast requirements	0.1%	0.1%	0.0%
Total efficiency	1,490	3,063	8,812
Forecast Requirements (not including transportation)	165,583	175,404	188,923
Achievable share of forecast requirements	0.9%	1.7%	4.7%
Renewables	1,676	2,812	4,863
Forecast Requirements (not including transportation)	165,583	175,404	188,923
Achievable share of forecast requirements	1.0%	1.6%	2.6%
Efficiency and renewables	3,166	5,875	13,675
Forecast Requirements (not including transportation)	165,583	175,404	188,923
Achievable share of forecast requirements	1.9%	3.3%	7.2%

Note: Efficiency savings, renewable supply and forecast requirements are all shown at generation.

Tables 2.39 and 2.40 present the results of the study's economic analysis of projected savings from currently planned initiatives, under low and high avoided costs, respectively. The study concludes that these initiatives will produce substantial net resource benefits for the State's economy. Net benefits (at their 2003 present worth) from all efficiency and renewable resources resulting from currently planned initiatives are estimated to range from $224 million in 2007 (under low avoided costs) to $5.4 billion by 2022 under high avoided costs.

These tables also indicate that efficiency savings in the residential sector are only marginally cost-effective under low avoided costs through 2007; however, the economics of residential efficiency under currently planned initiatives improve over time (see 2012, for example). Under high avoided costs, all efficiency savings provide positive net benefits during all periods. The economic picture for renewables is mixed. Some renewable technologies such as fuel cells and photovoltaics are not expected to make cost-effective contributions under NYSERDA's avoided cost projections. Nonetheless, the entire renewable contributions under both low and high avoided costs are estimated to be cost-effective over all periods under both low and high avoided costs.

Table 2.39 Benefit/Cost Analysis of Expected Efficiency and Renewable Achievements Under Currently Planned Initiatives: 2007, 2012, and 2022 (at Low Avoided Costs)

(Millons of $2003)												
	2007				2012				2022			
	PV Benefits	PV Costs	Net Benefits	BCR	PV Benefits	PV Costs	Net Benefits	BCR	PV Benefits	PV Costs	Net Benefits	BCR
Energy Efficiency												
Residential	175	197	(21)	0.89	232	197	35	1.18	359	180	180	2.00
Commercial	409	324	85	1.26	958	755	203	1.27	2,996	2,122	874	1.41
Industrial	9	2	7	3.92	9	2	7	3.92	9	2	7	3.92
Total Efficiency	594	523	71	1.13	1,199	954	245	1.26	3,364	2,304	1,060	1.46
Renewable Energy												
Biomass	224	(135)	360	-1.66	271	(356)	627	-0.76	480	(696)	1,176	-0.69
Fuel Cells	20	74	(54)	0.27	79	265	(186)	0.30	177	530	(353)	0.33
Hydropower	-	-	-		-	-	-		-	-	-	
Landfill Gas	47	74	(27)	0.64	54	84	(30)	0.64	63	96	(33)	0.66
Municipal Solid Waste	-	-	-		-	-	-		-	-	-	
Photovoltaics	9	76	(67)	0.12	14	105	(91)	0.14	47	232	(185)	0.20
Solar Thermal	3	11	(8)	0.29	16	34	(18)	0.47	26	49	(23)	0.53
Windpower	312	363	(50)	0.86	596	651	(55)	0.92	920	905	15	1.02
Total Renewable	616	462	154	1.33	1,030	783	247	1.32	1,713	1,115	598	1.54
Total Efficiency & Renewable	1,210	985	224	1.23	2,229	1,737	492	1.28	5,077	3,419	1,658	1.48

Table 2.40 Benefit/Cost Analysis of Expected Efficiency and Renewable Achievements Under Currently Planned Initiatives: 2007, 2012, and 2022 (at High Avoided Costs)

(Millons of $2003)												
	2007				2012				2022			
	PV Benefits	PV Costs	Net Benefits	BCR	PV Benefits	PV Costs	Net Benefits	BCR	PV Benefits	PV Costs	Net Benefits	BCR
Energy Efficiency												
Residential	292	197	96	1.49	384	197	187	1.95	606	180	426	3.37
Commercial	715	324	391	2.21	1,675	755	920	2.22	5,343	2,122	3,221	2.52
Industrial	14	2	11	5.85	14	2	11	5.85	14	2	11	5.85
Total Efficiency	1,021	523	498	1.95	2,073	954	1,119	2.17	5,962	2,304	3,658	2.59
Renewable Energy												
Biomass	371	(135)	506	-2.74	449	(356)	805	-1.26	804	(696)	1,500	-1.15
Fuel Cells	32	74	(42)	0.44	129	265	(136)	0.49	292	530	(237)	0.55
Hydropower	-	-	-		-	-	-		-	-	-	
Landfill Gas	76	74	2	1.03	87	84	3	1.04	103	96	7	1.07
Municipal Solid Waste	-	-	-		-	-	-		-	-	-	
Photovoltaics	15	76	(61)	0.20	24	105	(81)	0.23	80	232	(152)	0.35
Solar Thermal	6	11	(5)	0.51	28	34	(6)	0.83	46	49	(3)	0.94
Windpower	514	363	151	1.42	989	651	338	1.52	1,546	905	642	1.71
Total Renewable	1,014	462	552	2.19	1,707	783	924	2.18	2,871	1,115	1,756	2.57
Total Efficiency & Renewable	2,036	985	1,050	2.07	3,779	1,737	2,043	2.18	8,834	3,419	5,414	2.58

Table 2.41 compares the study's estimated electric energy contributions from currently planned initiatives with the study's estimates of economic potential, under low and high avoided costs, in 2007, 2012, and 2022. This table indicates that currently planned initiatives would yield between 3% and 16% of the study's estimated economic potential for efficiency resources between 2007 and 2022, respectively. Expected contributions from renewables represent 25% of renewable economic potential in 2007 under low avoided costs; they would be only 8% of economic potential in 2022. Note that wind energy expected to result from currently planned initiatives is estimated to reach 125% of wind's estimated economic potential.

This suggests that currently planned initiatives will succeed in encouraging some wind energy with costs in excess of benefits under NYSERDA's avoided costs.

Table 2.41 Currently Planned Initiative Contributions vs. Efficiency and Renewable Economic Potential

	2007		2012		2022	
	Low Avoided Costs	High Avoided Costs	Low Avoided Costs	High Avoided Costs	Low Avoided Costs	High Avoided Costs
Energy Efficiency Savings						
Residential	3%	3%	2%	2%	2%	1%
Commercial	4%	4%	9%	8%	26%	23%
Industrial	1%	1%	0%	0%	0%	0%
Total Efficiency	3%	3%	6%	5%	16%	14%
Renewable Supply						
Biomass	13%	13%	15%	15%	21%	21%
Fuel Cells	NA	NA	NA	NA	NA	NA
Hydropower	0%	0%	0%	0%	0%	0%
Landfill Gas	NA	27%	NA	34%	NA	40%
Municipal Solid Waste	NA	NA	0%	0%	0%	0%
Photovoltaics	NA	NA	NA	NA	NA	NA
Solar Thermal	4%	4%	21%	21%	36%	36%
Windpower	NA	89%	125%	42%	6%	6%
Total Renewable	25%	19%	24%	18%	8%	8%
Total Efficiency Savings & Renewable Supply	6%	6%	9%	8%	12%	11%

Readers are advised to bear in mind the study's caveats regarding NYSERDA's avoided costs when considering results indicating that wind, solar, and other renewable generation resulting from currently planned initiatives appears uneconomic. The tables that follow provide the projected avoided electricity costs through 2020 for each of the five load zones under analysis, as well as for avoided fossil fuel costs.

Table 2.42 NYSERDA Projections of Avoided Electricity Costs through 2020: Zone A (West)*

	2003$ without line losses							
	Energy						Capacity With 18% Reserve Margin	
	Summer On-Peak Energy	Summer Off-Peak Energy	Summer Shoulder Energy	Winter On-Peak Energy	Winter Off-Peak Energy	Winter Shoulder Energy	Summer Generation Capacity	Winter Generation Capacity
	$/kWh	$/kWh	$/kWh	$/kWh	$/kWh	$/kWh	$/kW	$/kW
2003	0.0299	0.0277	0.0297	0.0298	0.0256	0.0287	37.42	4.31
2004	0.0274	0.0256	0.0272	0.0279	0.0243	0.0274	37.60	4.33
2005	0.0287	0.0248	0.0274	0.0287	0.0244	0.0271	28.20	3.25
2006	0.0289	0.0249	0.0273	0.0286	0.0244	0.0271	28.31	3.26
2007	0.0291	0.0249	0.0272	0.0285	0.0243	0.0271	28.42	3.28
2008	0.0293	0.0250	0.0271	0.0283	0.0243	0.0272	28.53	3.29
2009	0.0294	0.0253	0.0273	0.0285	0.0244	0.0236	28.64	3.30
2010	0.0296	0.0255	0.0275	0.0286	0.0246	0.0200	28.76	3.31
2011	0.0302	0.0260	0.0282	0.0289	0.0248	0.0240	28.87	3.33
2012	0.0309	0.0266	0.0290	0.0291	0.0250	0.0280	28.98	3.34
2013	0.0318	0.0271	0.0296	0.0297	0.0254	0.0285	29.10	3.35
2014	0.0326	0.0276	0.0302	0.0303	0.0257	0.0291	29.21	3.37
2015	0.0335	0.0281	0.0308	0.0309	0.0261	0.0296	29.32	3.38
2016	0.0344	0.0286	0.0314	0.0315	0.0265	0.0302	29.44	3.39
2017	0.0348	0.0290	0.0320	0.0319	0.0269	0.0307	29.55	3.41
2018	0.0353	0.0293	0.0326	0.0323	0.0273	0.0312	29.67	3.42
2019	0.0357	0.0297	0.0331	0.0327	0.0277	0.0317	29.78	3.43
2020	0.0361	0.0301	0.0337	0.0330	0.0281	0.0321	29.90	3.45

Notes:

Summer On Peak Energy and Capacity is Jun - August, weekdays noon - 6 pm

Summer Off peak is June - August - midnight to 8am weekdays, all weekend hours June - August, and May, Sept and Oct all hours.

Summer Shoulder is weekdays June - August - 8am to noon and 6pm to midnight.

Winter On-Peak Energy and Capacity is Dec-Feb weekdays noon to 8 pm.

Winter Off peak is Dec-Feb - midnight to 8 am, all weekend hours, and March April, and November all hours.

Winter Shoulder is weekdays Dec- Feb - 8 am - noon and 8pm - midnight.

* Figures in Table 2.42 also are used as statewide low avoided costs.

Table 2.43 NYSERDA Projections of Avoided Electricity Costs through 2020: Zone F (Capital)

	2003$ without line losses							
	Energy						Capacity With 18% Reserve Margin	
	Summer On-Peak Energy	Summer Off-Peak Energy	Summer Shoulder Energy	Winter On-Peak Energy	Winter Off-Peak Energy	Winter Shoulder Energy	Summer Generation Capacity	Winter Generation Capacity
	$/kWh	$/kWh	$/kWh	$/kWh	$/kWh	$/kWh	$/kW	$/kW
2003	0.0345	0.0309	0.0341	0.0340	0.0297	0.0336	37.42	4.31
2004	0.0319	0.0277	0.0289	0.0307	0.0271	0.0302	37.60	4.33
2005	0.0302	0.0255	0.0284	0.0292	0.0255	0.0281	28.20	3.25
2006	0.0303	0.0256	0.0282	0.0291	0.0254	0.0280	28.31	3.26
2007	0.0303	0.0257	0.0281	0.0290	0.0253	0.0280	28.42	3.28
2008	0.0304	0.0257	0.0280	0.0289	0.0252	0.0280	28.53	3.29
2009	0.0302	0.0260	0.0282	0.0289	0.0254	0.0279	28.64	3.30
2010	0.0301	0.0263	0.0283	0.0288	0.0257	0.0279	28.76	3.31
2011	0.0309	0.0268	0.0292	0.0293	0.0258	0.0283	28.87	3.33
2012	0.0318	0.0273	0.0301	0.0298	0.0260	0.0288	28.98	3.34
2013	0.0326	0.0277	0.0308	0.0304	0.0263	0.0292	29.10	3.35
2014	0.0335	0.0282	0.0315	0.0309	0.0267	0.0297	29.21	3.37
2015	0.0343	0.0286	0.0322	0.0315	0.0270	0.0301	29.32	3.38
2016	0.0352	0.0291	0.0329	0.0320	0.0274	0.0306	29.44	3.39
2017	0.0356	0.0295	0.0334	0.0323	0.0277	0.0311	29.55	3.41
2018	0.0360	0.0298	0.0339	0.0327	0.0281	0.0315	29.67	3.42
2019	0.0365	0.0302	0.0345	0.0330	0.0285	0.0320	29.78	3.43
2020	0.0369	0.0306	0.0350	0.0333	0.0288	0.0325	29.90	3.45

Notes:

Summer On Peak Energy and Capacity is Jun - August, weekdays noon - 6 pm

Summer Off peak is June - August - midnight to 8am weekdays, all weekend hours June - August, and May, Sept and Oct all hours.

Summer Shoulder is weekdays June - August - 8am to noon and 6pm to midnight.

Winter On-Peak Energy and Capacity is Dec-Feb weekdays noon to 8 pm.

Winter Off peak is Dec-Feb - midnight to 8 am, all weekend hours, and March April, and November all hours.

Winter Shoulder is weekdays Dec- Feb - 8 am - noon and 8pm - midnight.

Table 2.44 NYSERDA Projections of Avoided Electricity Costs through 2020: Zone G (Hudson)

	2003$ without line losses							
	Energy						Capacity With 18% Reserve Margin	
	Summer On-Peak Energy	Summer Off-Peak Energy	Summer Shoulder Energy	Winter On-Peak Energy	Winter Off-Peak Energy	Winter Shoulder Energy	Summer Generation Capacity	Winter Generation Capacity
	$/kWh	$/kWh	$/kWh	$/kWh	$/kWh	$/kWh	$/kW	$/kW
2003	0.0378	0.0321	0.0357	0.0365	0.0310	0.0358	37.42	4.31
2004	0.0391	0.0304	0.0358	0.0367	0.0298	0.0342	37.60	4.33
2005	0.0339	0.0264	0.0304	0.0298	0.0260	0.0286	28.20	3.25
2006	0.0342	0.0264	0.0303	0.0296	0.0258	0.0285	28.31	3.26
2007	0.0345	0.0264	0.0301	0.0294	0.0257	0.0284	28.42	3.28
2008	0.0349	0.0264	0.0300	0.0292	0.0256	0.0284	28.53	3.29
2009	0.0358	0.0267	0.0306	0.0294	0.0258	0.0286	28.64	3.30
2010	0.0367	0.0269	0.0313	0.0296	0.0260	0.0287	28.76	3.31
2011	0.0374	0.0274	0.0320	0.0299	0.0262	0.0289	28.87	3.33
2012	0.0382	0.0279	0.0328	0.0301	0.0264	0.0292	28.98	3.34
2013	0.0393	0.0284	0.0337	0.0307	0.0267	0.0296	29.10	3.35
2014	0.0404	0.0290	0.0347	0.0313	0.0270	0.0301	29.21	3.37
2015	0.0414	0.0295	0.0356	0.0319	0.0274	0.0306	29.32	3.38
2016	0.0425	0.0300	0.0365	0.0324	0.0277	0.0310	29.44	3.39
2017	0.0429	0.0303	0.0371	0.0329	0.0281	0.0315	29.55	3.41
2018	0.0433	0.0307	0.0377	0.0334	0.0285	0.0320	29.67	3.42
2019	0.0438	0.0310	0.0383	0.0338	0.0289	0.0325	29.78	3.43
2020	0.0442	0.0314	0.0388	0.0343	0.0293	0.0330	29.90	3.45

Notes:

Summer On Peak Energy and Capacity is Jun - August, weekdays noon - 6 pm

Summer Off peak is June - August - midnight to 8am weekdays, all weekend hours June - August, and May, Sept and Oct all hours.

Summer Shoulder is weekdays June - August - 8am to noon and 6pm to midnight.

Winter On-Peak Energy and Capacity is Dec-Feb weekdays noon to 8 pm.

Winter Off peak is Dec-Feb - midnight to 8 am, all weekend hours, and March April, and November all hours.

Winter Shoulder is weekdays Dec- Feb - 8 am - noon and 8pm - midnight.

Table 2.45 NYSERDA Projections of Avoided Electricity Costs through 2020: Zone J (New York City)

	2003$ without line losses							
	Energy						Capacity With 18% Reserve Margin	
	Summer On-Peak Energy	Summer Off-Peak Energy	Summer Shoulder Energy	Winter On-Peak Energy	Winter Off-Peak Energy	Winter Shoulder Energy	Summer Generation Capacity	Winter Generation Capacity
	$/kWh	$/kWh	$/kWh	$/kWh	$/kWh	$/kWh	$/kW	$/kW
2003	0.0422	0.0336	0.0392	0.0386	0.0322	0.0373	92.17	52.20
2004	0.0425	0.0317	0.0384	0.0379	0.0308	0.0354	92.62	52.46
2005	0.0377	0.0273	0.0332	0.0322	0.0270	0.0305	69.46	39.34
2006	0.0379	0.0290	0.0348	0.0313	0.0266	0.0299	69.74	39.50
2007	0.0380	0.0307	0.0365	0.0305	0.0263	0.0293	70.01	39.65
2008	0.0381	0.0270	0.0324	0.0296	0.0260	0.0286	70.28	39.81
2009	0.0389	0.0273	0.0331	0.0300	0.0261	0.0289	70.55	39.96
2010	0.0396	0.0276	0.0339	0.0303	0.0263	0.0291	70.83	40.12
2011	0.0405	0.0283	0.0347	0.0305	0.0265	0.0294	71.11	40.28
2012	0.0414	0.0289	0.0355	0.0307	0.0268	0.0296	71.39	40.43
2013	0.0428	0.0294	0.0367	0.0314	0.0271	0.0301	71.67	40.59
2014	0.0442	0.0299	0.0378	0.0320	0.0274	0.0307	71.95	40.75
2015	0.0457	0.0305	0.0390	0.0327	0.0278	0.0312	72.23	40.91
2016	0.0471	0.0310	0.0402	0.0334	0.0281	0.0317	72.51	41.07
2017	0.0476	0.0314	0.0406	0.0338	0.0285	0.0322	72.79	41.23
2018	0.0482	0.0317	0.0411	0.0342	0.0289	0.0326	73.08	41.39
2019	0.0487	0.0320	0.0416	0.0346	0.0293	0.0330	73.37	41.55
2020	0.0493	0.0324	0.0421	0.0350	0.0296	0.0335	73.66	41.72

Notes:

Summer On Peak Energy and Capacity is Jun - August, weekdays noon - 6 pm

Summer Off peak is June - August - midnight to 8am weekdays, all weekend hours June - August, and May, Sept and Oct all hours.

Summer Shoulder is weekdays June - August - 8am to noon and 6pm to midnight.

Winter On-Peak Energy and Capacity is Dec-Feb weekdays noon to 8 pm.

Winter Off peak is Dec-Feb - midnight to 8 am, all weekend hours, and March April, and November all hours.

Winter Shoulder is weekdays Dec- Feb - 8 am - noon and 8pm - midnight.

Table 2.46 NYSERDA Projections of Avoided Electricity Costs through 2020: Zone K (Long Island)*

	2003$ without line losses							
	Energy						Capacity With 18% Reserve Margin	
	Summer On-Peak Energy	Summer Off-Peak Energy	Summer Shoulder Energy	Winter On-Peak Energy	Winter Off-Peak Energy	Winter Shoulder Energy	Summer Generation Capacity	Winter Generation Capacity
	$/kWh	$/kWh	$/kWh	$/kWh	$/kWh	$/kWh	$/kW	$/kW
2003	0.0470	0.0379	0.0434	0.0405	0.0349	0.0396	92.17	52.20
2004	0.0485	0.0390	0.0453	0.0421	0.0359	0.0409	92.62	52.46
2005	0.0420	0.0317	0.0381	0.0357	0.0284	0.0327	69.46	39.34
2006	0.0427	0.0321	0.0387	0.0358	0.0286	0.0328	69.74	39.50
2007	0.0435	0.0326	0.0394	0.0360	0.0288	0.0329	70.01	39.65
2008	0.0442	0.0331	0.0400	0.0361	0.0291	0.0330	70.28	39.81
2009	0.0448	0.0336	0.0407	0.0368	0.0295	0.0338	70.55	39.96
2010	0.0455	0.0341	0.0415	0.0374	0.0299	0.0346	70.83	40.12
2011	0.0467	0.0349	0.0422	0.0384	0.0305	0.0357	71.11	40.28
2012	0.0479	0.0358	0.0430	0.0394	0.0312	0.0369	71.39	40.43
2013	0.0493	0.0365	0.0440	0.0405	0.0321	0.0380	71.67	40.59
2014	0.0507	0.0372	0.0450	0.0416	0.0331	0.0390	71.95	40.75
2015	0.0521	0.0380	0.0459	0.0427	0.0340	0.0401	72.23	40.91
2016	0.0535	0.0387	0.0469	0.0438	0.0350	0.0411	72.51	41.07
2017	0.0544	0.0393	0.0480	0.0448	0.0358	0.0420	72.79	41.23
2018	0.0554	0.0399	0.0491	0.0457	0.0367	0.0429	73.08	41.39
2019	0.0563	0.0405	0.0501	0.0467	0.0376	0.0439	73.37	41.55
2020	0.0573	0.0411	0.0512	0.0477	0.0384	0.0448	73.66	41.72

Notes:

Summer On Peak Energy and Capacity is Jun - August, weekdays noon - 6 pm

Summer Off peak is June - August - midnight to 8am weekdays, all weekend hours June - August, and May, Sept and Oct all hours.

Summer Shoulder is weekdays June - August - 8am to noon and 6pm to midnight.

Winter On-Peak Energy and Capacity is Dec-Feb weekdays noon to 8 pm.

Winter Off peak is Dec-Feb - midnight to 8 am, all weekend hours, and March April, and November all hours.

Winter Shoulder is weekdays Dec- Feb - 8 am - noon and 8pm - midnight.

* Figures in Table 2.46 also are used as statewide high avoided costs.

Table 2.47 NYSERDA Projections of Avoided Fossil Fuel Costs through 2020

	End Use Fuel Costs (2003$)						
	Res. Oil	Com. Oil	Ind. Oil	Res. Gas	Com. Gas	Ind. Gas	Coal
Units:	$/MMBtu	$/MMBtu	$/MMBtu	$/MMBtu	$/MMBtu	$/MMBtu	$/MMBtu
2003	8.71	6.14	5.83	10.55	6.80	5.22	1.59
2004	8.75	6.19	5.87	10.67	6.93	5.20	1.60
2005	8.78	6.21	5.89	10.64	6.91	5.24	1.60
2006	8.77	6.21	5.89	10.50	6.80	5.12	1.60
2007	8.73	6.17	5.85	10.38	6.69	5.13	1.59
2008	8.74	6.18	5.86	10.30	6.61	5.13	1.58
2009	8.92	6.36	6.03	10.18	6.47	5.20	1.57
2010	9.03	6.47	6.13	10.06	6.36	5.26	1.56
2011	9.05	6.48	6.14	10.01	6.31	5.28	1.57
2012	9.08	6.52	6.18	9.95	6.25	5.30	1.56
2013	9.27	6.71	6.35	9.89	6.19	5.35	1.55
2014	9.50	6.95	6.57	9.82	6.12	5.37	1.54
2015	9.53	6.97	6.59	9.77	6.08	5.41	1.53
2016	9.55	6.99	6.61	9.71	6.01	5.44	1.52
2017	9.57	7.01	6.63	9.65	5.94	5.47	1.51
2018	9.59	7.03	6.65	9.64	5.88	5.51	1.50
2019	9.61	7.05	6.67	9.63	5.82	5.55	1.49
2020	9.63	7.08	6.69	9.63	5.76	5.60	1.48