Organization Of The Study

This complete study is presented in seven volumes. They are organized as follows* :

- Volume 1 Summary Report, which is contained in the following 42 pages.
- Volume 2: The main Technical Report, which describes the study's analytical approach and presents its consolidated results.
- 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.
- Volume 5-6: Technical Appendices accompanying the efficiency and renewable energy reports. These appendices contain detailed information on the costs and performance 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 greenhouse gas (GHG) emission targets using efficiency and renewable energy resources.

*These volumes are available from NYSERDA by contacting:

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

Final Report

VOLUME ONE:
SUMMARY REPORT

Prepared for

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AUGUST 2003

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Section 1:
OVERVIEW

The New York State Energy Research and Development Authority (NYSERDA) commissioned this study of the long-range potential for energy efficiency and renewable energy technologies to displace fossil-fueled electricity generation in New York. The study examined the potential available from existing and emerging efficiency technologies and practices to lower end-use electricity requirements in residential, commercial, and industrial buildings.[1] The study also estimated renewable electricity generation potential from biomass, fuel cells, hydropower, landfill gas, municipal solid waste, solar, and wind. The study assessed New York's efficiency and renewable potential over three time horizons: five years (through 2007), 10 years (through 2012), and 20 years (through 2022).

The study had four main objectives:

- Estimate the technical potential or theoretical maximum amount of electricity physically able to be displaced by efficiency and renewable energy technologies, both throughout New York and in each of five control area load zones within the State.
- Of this technical potential, determine how much efficiency and renewable energy would be economical compared with conventional generation that would be avoided both statewide and in the five specified zones.
- Working from the theoretical analysis of statewide technical and economic potential, estimate how much electricity New York could realistically expect efficiency and renewable energy resources to displace as part of a least-cost solution to the State's greenhouse-gas reduction targets established for the electricity sector over the next 10 and 20 years.
- Independently assess the impacts throughout New York from currently planned energy policy and program initiatives.

The study found large amounts of technical potential for efficiency and renewable energy. It also found that much of this theoretical potential would be economical compared to conventional electricity generation. These findings vary widely among the individual efficiency and renewable technologies analyzed. The study authors caution how to interpret and use this analysis, noting that it would be a mistake to compare the estimates of technical and economic potential directly with forecasted electricity requirements. This is because these estimates do not account both for the market barriers to efficiency and renewable energy technologies and for the costs of market intervention strategies to overcome these barriers.

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1 Throughout the remainder of this report, the term "efficiency technologies" should be understood to include both energy-efficient equipment and efficient practices (e.g., commissioning high-efficiency equipment in a building to ensure systems perform efficiently). The analysis of efficiency potential did not consider end-use fuel switching from electricity to alternate sources such as gas or oil. It also did not consider load shifting, curtailment, or interruption, or behavioral modifications that might degrade the quality of service at the end use.

Projecting from market intervention strategies that have proved successful in the past, the study concludes that efficiency and renewable energy could be expected to reduce New York's annual electricity generation requirements by more than 19,939 GWh by 2012 and by more than 27,244 GWh by 2022. This energy represents 12.7% and 16.1% of expected statewide requirements for those years. The study finds that these contributions could be achieved at costs below those of the conventional electric generation they would avoid. Therefore, the economically-achievable potential for efficiency and renewable energy in New York is more than sufficient to meet the State's greenhouse-gas emission reduction targets for the electricity sector.

Finally, the study concludes that currently planned initiatives are expected to provide 13,675 GWh and 3,456 summer-peak MW annually by 2022. This represents 7.5% and 9.4% of the expected statewide energy and demand requirements, respectively. These expected outcomes represent significant and cost-effective contributions toward the State's greenhouse-gas targets for the electricity sector, and toward New York's electricity requirements over the decades ahead.

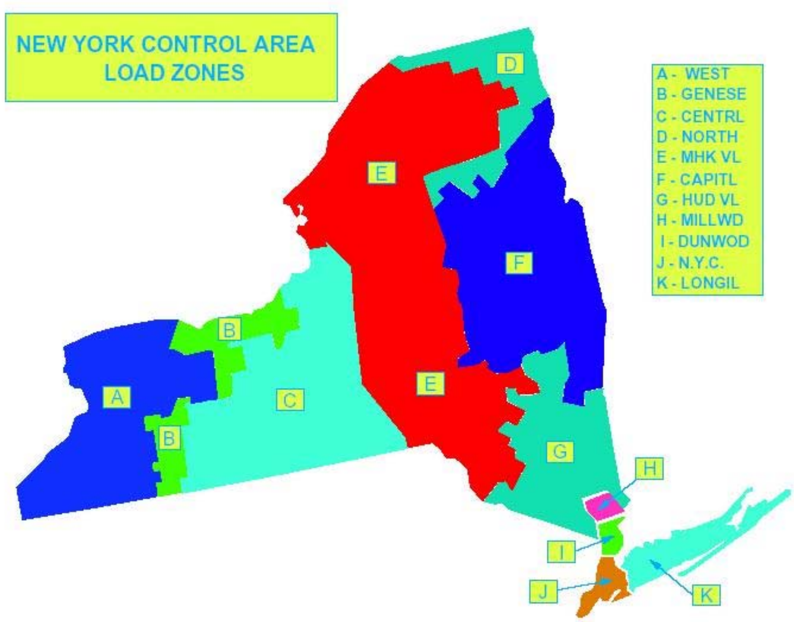
Technical potential estimates for efficiency and renewable energy resources are analogous to estimates of the amount of oil currently known to exist in the Earth. The extent to which these potential oil resources can be realized depends on the effectiveness of the oil drilling technology chosen to recover them. The gap between the known resource and the recoverable oil resource is analogous to the difference between technical and achievable potential for efficiency and renewable energy resources.

The oil analogy also helps illustrate the concept of economic potential. How much of the technically-feasible oil production is worth pursuing depends both on the costs of recovering it and how much it is worth on the oil market. As with oil, the higher the value of electricity from efficiency and renewable energy in the marketplace, the more that available and achievable potential will be found to be economical.

Section 2:
APPROACH

This study estimated the technical and economic potential for energy efficiency and generation of electricity from renewable resources in New York, as well as in five of the State's eleven load zones depicted in Figure 1.1: West (Zone A), Capital (Zone F), Hudson Valley (Zone G), New York City (Zone J), and Long Island (Zone K). The study also analyzed two achievable potential scenarios: first, the achievable contributions by efficiency and renewable technologies toward the State's greenhouse-gas (GHG) reduction targets; and second, independent estimates of the impacts on New York from the State's currently planned policy and program initiatives (CPI) for energy efficiency and renewable energy resources.

Figure 1.1 New York Control Area Load Zones

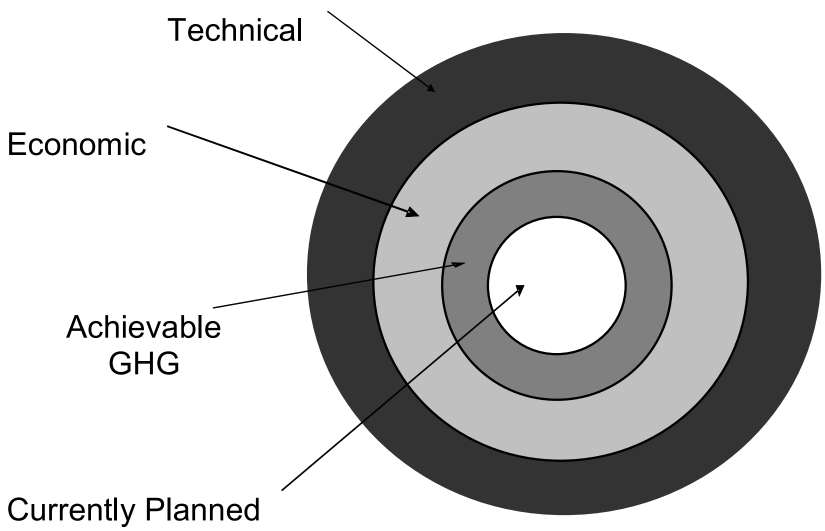


This study presents efficiency and renewable energy potential in terms of electric energy — i.e., gigawatt-hours (GWh) or millions of kilowatt-hours (kWh) — and peak capacity, i.e., megawatts (MW). Figure 1.2 illustrates the relationships among the efficiency and renewable energy potential scenarios analyzed.[2] The

2 Figure 1.2 is presented for illustrative purposes only. It depicts the nature of relationships between the scenarios analyzed, not the relative magnitudes of results found for the scenarios analyzed. For example, it does not accurately portray the fraction of technical potential that the study found to be economic or achievable. Those results are provided later in this report.

outer circle shows how this study proceeded from the theoretical limits of technical potential to assess both economic and achievable potential. The economic and achievable potential estimates are all subsets of, and derived from, the universe of technical potential for electricity savings from efficiency and renewable energy technologies.

Figure 1.2 Electricity Potential Scenarios in the NYSERDA Study



SCOPE OF EFFICIENCY AND RENEWABLE ENERGY POTENTIAL ANALYSIS

The study examined literally thousands of efficiency and renewable applications to different buildings, industries, and markets. Table 1.1 indicates the number of efficiency technologies and practices analyzed in each of the residential, commercial, and industrial sectors. This table also shows the different markets in each sector to which these technologies and practices were applied, along with the end uses and market segments covered in the potential analysis. In the commercial sector, for example, Table 1.1 shows that the study examined 87 technologies and practices applicable to nine end-use categories in four markets involving nine building types. Thus, the commercial efficiency potential analysis dealt with 2,163 technology and practice applications.

Table 1.1 Technologies and Practices Examined in the Efficiency Potential Analysis

	SECTOR:		
	RESIDENTIAL	**COMMERCIAL**	**INDUSTRIAL**
Number of Technologies	**50**	**87**	**39**
Markets	New construction	New construction	New construction
	Retail product sales	Renovation	Process overhaul/Replacement
	Retrofit	Remodel/Replacement	Retrofit
		Retrofit	
End Uses	Cooling	Cooling	Motor systems
	Lighting	Exterior lighting	Lighting
	Space heating	Interior lighting	HVAC
	Water heating	Office equipment	Industry-specific processes
		Refrigeration	
		Space heating	
		Water heating	
		Whole building	
		Miscellaneous	
Market segments	**2 building types:**	**9 building types:**	**4 industry sectors:**
	Single family	Education	Manufacturing
	Multifamily	Grocery	Agriculture
		Health	Mining
		Lodging	Construction
		Office	
		Restaurant	22 specific industries
		Retail	
		Warehouse	
		Other	

Table 1.2 provides the breakdown of technology applications studied in the renewable energy potential analysis. In all, the analysis examined 32 configurations of the eight renewable energy technologies studied.

Table 1.2 Technologies Examined in the Renewable Potential Analysis

Biopower	**Municipal Solid Waste**
Biomass Cofiring with Coal	Waste-to-Energy Large
Biomass Gasification	Waste-to-Energy Small
Biomass Combined Heat and Power	Solid Waste Digestion
Fuel Cells	**Photovoltaics**
Fuel Cell Polymer Electrolyte Membrane	Photovoltaic Residential
Fuel Cell Phosphoric Acid	Photovoltaic Commerical/Industrial
Fuel Cell Solid Oxide	Photovoltaic Building Integrated
Fuel Cell Molten Carbonate	
	Solar Thermal
Hydro Power	Residential Domestic Hot Water
Hydro Relicense	Commerical Domestic Hot Water
Hydro Repower	Commerical/Industrial Ventilation Pre-
Hydro Expanded Capacity Existing Dam	Solar Absorption Cooling
Hydro New Dam sites	
	Wind
Landfill Gas	Wind Farm Installations
Landfill Gas Large Systems	Cluster Installations
Landfill Gas Engines	Small Wind Installations
Landfill Gas Microturbines	Offshore Wind Installations

Readers should bear in mind what the study did *not* cover. It is not an analysis of potential programs. Such an analysis would project the impacts from a particular set of program strategies directed at specific target markets to promote certain technologies. Nor does the study qualify as a plan for acquiring energy efficiency or developing renewable energy resources to meet specific electricity resource requirements. While this study is intended to contribute to such analyses in the future, it is not a substitute for them. In addition, this study considers only technologies and practices that currently exist or are anticipated today to be available by 2022. Innovative technologies and practices continually emerge, and such new technologies and practices not considered by this study will create additional savings opportunities in the future.

TECHNICAL AND ECONOMIC POTENTIAL ANALYSIS

The ***technical potential*** for efficiency and renewable energy represents the theoretical outer bounds of the electricity resources physically available for exploitation, without any regard for cost or market acceptability. By itself, technical potential has no direct applicability to policy or resource planning, which requires information about these characteristics of efficiency and renewable resources. Consequently, the technical potential estimates in this study should be used only as the foundation for further analysis.

This study defines the ***economic potential*** for efficiency and renewable energy as that amount of technical potential available at technology costs below the current projected costs of conventional electric generation that these resources would avoid. The study analyzed economic potential by valuing these potential electricity resources at these avoided electricity generation costs. As discussed further below, NYSERDA was the source for values of avoided electricity generation and fossil fuel costs through 2022 for each of the five load zones analyzed. The study assessed statewide economic potential twice, using the lowest and highest zonal avoided costs.

Included in the study's estimates of efficiency and renewable energy costs for the economic potential analyses were capital, fuel, operation, and maintenance costs. Where appropriate, the study also accounted for benefits of the technologies and practices other than avoided electricity costs. These other resource benefits included direct cost savings from reductions in consumption of water and fossil fuels (e.g., natural gas and oil). For example, the net cost of electricity savings from high-efficiency clothes washers reflects credit both for the value of water saved and for the value of natural gas savings in homes with gas-fired water heaters.[3] In addition, the application of some technologies or practices, particularly in the industrial sector, often produces other non-energy benefits, such as productivity or product quality improvements. Such benefits were included in the economic potential assessment. The economic potential analysis also accounted for estimated future changes in technology costs throughout the 20 year analysis horizon. For example, the costs of photovoltaic technology are expected to continue declining over the next 20 years.

To estimate economic potential, the study first compared the efficiency and renewable energy technology costs and benefits to a current, reference technology over the expected lifespan of each resource. The economic potential consists of the technical potential for electricity from efficiency and renewables remaining after removing those resources with technology costs in excess of avoided electricity generation costs. As with technical potential, results are presented in terms of electric energy (GWh) and peak capacity (MW). Also, as with technical potential, the economic potential analysis ignores the potential market acceptability of efficiency and renewable energy technologies, as well as the costs of programs or policies to increase market acceptance.

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[3] Much of the energy savings potential from efficient clothes washers is associated with reduced use of hot water.

The same caveats on the use of technical potential results apply to economic potential. Since it is derived directly from technical potential, economic potential likewise does not represent achievable potential and therefore cannot be directly applied in policy making or resource planning. As is the case with technical potential, economic potential estimates only have meaning as inputs to further analysis, such as in planning for programs targeted toward specific amounts of electricity savings from efficiency or renewable energy technologies in particular markets.

ACHIEVABLE POTENTIAL SCENARIO ANALYSES

The study's analysis of ***achievable potential*** from efficiency and renewable energy adds two key ingredients missing from the technical and economic potential analysis:

- Market barriers to acceptance of efficiency and renewable energy technologies and practices that could potentially be overcome through targeted policies and market intervention strategies; and,
- Additional administrative costs of such programs and policies to promote higher market acceptance of efficiency and renewable energy technologies.

This study analyzed two distinct achievable potential scenarios:

- Potential contributions toward meeting the State's GHG targets; and,
- Expected achievements under currently planned initiatives.

For each of these two achievable potential scenarios, the study estimates electric energy and peak capacity impacts. It also projects and compares efficiency and renewable energy resource benefits and costs to New York's economy.

Achievable Contributions Toward New York's GHG Targets

For the GHG potential scenario, this study assessed the achievable contributions that efficiency and renewable energy resources could make toward reducing the electricity industry's contribution to New York's greenhouse-gas emissions in 2010 and in 2020, as recommended in the 2002 State Energy Plan.[4] For each efficiency and renewable energy technology, this analysis started with the electricity savings estimated in the technical potential analysis, and the cost and benefit estimates developed for the economic potential analysis.

The analysis used the following steps to develop achievable electricity potential and achievable costs associated with each technology:

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4 New York State Energy Planning Board, June 2002. *The 2002 State Energy Plan and Final Environmental Impact Statement* (Energy Plan). See www.nyserda.org/sep.html.

- As the basis for assessing achievable technology market acceptance over time, the study considered a broad set of market intervention strategies that have proved successful in overcoming market barriers in the past. (These strategies are described in Volume 5.)
- For each technology, the study then projected future market acceptance of efficiency and renewable energy technologies over time if New York pursued the kinds of market intervention policies and programs described in Step 1.
- Next, the study multiplied the estimated market acceptance from Step 2 by its corresponding technical potential estimate, which produced the estimated contribution toward New York's greenhouse-gas targets that each efficiency and renewable energy technology could achieve.
- To develop achievable costs, the study estimated the administrative costs of pursuing aggressive market intervention strategies developed in Step 1.
- Adding the estimated program administration costs from Step 4 to the technology costs developed for the economic potential analysis produced achievable costs for each efficiency and renewable energy technology.
- The study undertook one more preparatory step in the GHG analysis: It estimated the net costs per kWh of achievable electric energy potential. To do this, the study subtracted the value of the peak capacity provided by each efficiency and renewable technology from the Step 5 results above. The greater the peak kW contribution provided by each technology, the greater the offset to the achievable cost of its contribution toward New York's GHG targets. In some cases, the value of peak capacity contributions and/or other non-electricity cost savings associated with a technology or practice exceeded the total achievable cost. In such instances, the net cost of the technology's achievable electric energy contribution was negative (which the study found to be the case for achievable industrial efficiency savings, and for biomass and municipal solid waste technologies).
- At this stage, the study assembled a vast collection of individual points for achievable electric energy contributions toward New York's GHG targets. Each point represents a specific amount of efficiency or renewable energy that can be achieved at a particular cost per kWh. The analysis then "stacked" each technology's potential contribution in increasing order of cost per kWh. The result of this sorting was an achievable cost "curve" for contributions toward New York's GHG savings targets.

NYSERDA provided electric energy offsets for GHG reduction targets for 2010 and 2020, based on the 2002 State Energy Plan for the electricity sector. For the year 2010, the target is a 5% reduction from 1990 levels; for 2020, it is a 10% reduction from 1990 levels. The study interpolated the target values for 2012 and extrapolated the target value for 2022 in order to correspond with the study's analysis horizon, which produced GHG target values of 19,939 GWh and 27,244 GWh for each year, respectively. To meet these electric-energy targets at the lowest possible total cost to New York's economy, the analysis choose the least-costly contributions first, moving progressively up the cost curve until the target is met or achievable resources are exhausted, whichever comes first.

This achievable cost curve for efficiency and renewable energy resources is directly analogous to the order that generators are selected to meet electric-energy requirements. The curve shows which efficiency and renewable energy technologies would be chosen as part of a least-cost resource portfolio for meeting the GHG targets in 2010 and 2020. The analysis also estimates and compares the total resource benefits and costs from pursuing the least-cost combination of efficiency and renewable energy technologies to meet the statewide targets.

Expected Achievements From Currently Planned Initiatives

The study estimated the future electric energy and peak capacity contributions from efficiency and renewable energy resources resulting from initiatives included in the 2002 State Energy Plan, and expected changes to future codes and standards. This analysis included expected market activity due to NYSERDA's energy-efficiency and renewable programs; programs administered by the New York Power Authority (NYPA) and the Long Island Power Authority (LIPA); Executive Order 111; New York's Draft State Purchasing Standards; and anticipated changes to future New York and Federal codes and standards. This statewide analysis assesses the combined effects of these policies and strategies on expected electricity achievements over five, 10, and 20 years. The study assumes these policies and programs do not continue beyond their current authorizations, which vary by initiative, with the exception of changes to codes and standards. The analysis explicitly captures any post-program effects reasonably expected to materialize beyond the authorized period for the initiatives.

The study estimates electric energy and peak capacity achievements, as well as costs and benefits expected from currently planned initiatives through 2007, 2012, and 2022. To develop these estimates of achievable electric potential and costs, the study used information on program expenditures and performance provided by NYSERDA and other State entities to supplement technology costs and performance developed for the technical and economic potential analysis.

ECONOMIC PERSPECTIVE USED IN THIS STUDY

This study assessed the economics of efficiency and renewable energy resource development achievements from a total resource perspective, measuring changes in economic efficiency, i.e., improvement in New York's economic welfare. This study estimated the total costs of obtaining efficiency savings and renewable energy supply without considering who pays these costs. The study did not address distributional equity, i.e., how costs and benefits would be shared among or within groups. Accordingly, the study did not employ other benefit-cost perspectives such as the utility test, participant test or non-participant test.[5] From the total-resource perspective, an efficiency or renewable energy technology is economical or cost-effective if

5 The utility test considers only avoided electricity costs as benefits and counts only expenditures supported by ratepayers. The participant test uses retail electric rates to value the benefits of electricity savings and counts only efficiency or renewable energy costs paid directly by participants. The non-participant test uses the same benefits and costs as the utility test, but also counts the lost sales revenue as a cost.

and only if benefits exceed costs; net-benefits or the difference between total resource benefits and costs must be positive, or equivalently, the ratio of benefits to costs must exceed one.

This study values the electricity benefits from efficiency and renewable energy resources in terms of the electricity resource costs they would avoid, not retail rates paid by household and business consumers. The study took this approach because the electricity resource costs avoided by efficiency and renewable energy consist of the wholesale generation costs that otherwise would be incurred to supply New York's electricity needs. Realizing more of New York's efficiency and renewable energy potential would allow New York's independent system operator (ISO) to back down on the most costly generating sources in use to meet electricity demand, depending on when and where the additional resources materialized.

By contrast, retail electricity rates are set to a large extent based on fixed costs incurred in the past and which, by definition, cannot be avoided in the future. In New York, current retail rates are generally significantly higher than avoided wholesale generation costs. Valuing electricity from efficiency and renewable energy resources at retail rates therefore would overstate their true benefits to New York's economy.[6]

Just because technologies or practices are found to be cost-effective to New York' economy as a whole, however, does not mean that individual consumers find them economically attractive. Economic potential remains untapped precisely because numerous market barriers interact to prevent widespread market adoption of efficiency and renewable technologies. Market barriers are especially pervasive for energy-efficiency technologies and practices. Among the market barriers recognized by policymakers in New York and elsewhere are: insufficient information, restricted access to capital, split incentives between decision-makers, and limited market availability of efficiency technologies.

These market barriers typically lead most consumers of all types to pursue only those efficiency opportunities that pay for themselves in two years or less, even those with expected useful lives lasting 10 years or more. Such a stringent investment criterion is equivalent to requiring efficiency investments to provide returns in excess of 60%. Such a high "hurdle rate" for efficiency investments on the part of individual decision-makers is the manifestation of multiple market barriers.

6 For individual end users who adopt efficiency technologies or practices, retail rates do represent the direct benefit to the participant. However, a portion of these benefits — the difference between retail rates and marginal costs — is borne by all end users. These fixed costs eventually are redistributed among all ratepayers over time as part of the rate-making process.

At the same time, New York' energy planners compare resource alternatives by weighting costs and benefits using a far lower cost of capital (4% after inflation in this study). Viewed from the standpoint of the State's economic well-being, efficiency investment opportunities passed over by individual consumers offer potentially economical resources if the State can realize them for less than avoided wholesale supply costs. Bridging this gap between individual consumer and total resource economics is the overriding purpose behind market-intervention strategies to increase market adoption of efficiency and renewable energy technologies.

New York has been among the nation's leaders in its efforts to overcome market barriers to efficiency and renewable energy investments, thereby making them more economically appealing to individual consumers and businesses. The 2002 State Energy Plan contains a variety of policies and strategies that will lead to increased market adoption of efficiency and renewable energy technologies. This study provides an independent assessment of the additional electricity and economic savings likely to result in the future from these currently planned initiatives. It also shows how much more efficiency and renewable energy resources could contribute toward reducing New York's GHG emissions, and the net benefits to the State's economy from doing so.

AVOIDED ELECTRICITY AND OTHER RESOURCE COSTS

The study valued efficiency and electric energy from renewable resources at the wholesale electricity costs they avoid. NYSERDA provided long-range projections of avoided electric energy and peak capacity costs for each of the five load zones under study. The reader is cautioned that the avoided costs, which were derived from electric system modeling completed for the 2002 State Energy Plan, are not the same as "bid" or "market clearing" wholesale electricity prices. Bid and/or market clearing prices are typically higher than the cost-based estimated wholesale costs provided by the model. No statewide energy and capacity market with a single set of market-clearing prices exists in New York. Consequently, the study used both the lowest (Zone A, West) and highest (Zone K, Long Island) zonal avoided costs for assessing the statewide economic and achievable potential scenarios. Table 1.12, included on page 3-20, summarizes the zonal avoided costs used for the study. The study applied each zone's avoided electricity costs to assess how much of its technical potential would be considered economic.

The study used the values for residential, commercial, and industrial fuel oil and natural gas shown in Table 1.13 (page 3-21). The study applied these values both to increased fuel use associated with renewable electricity production (e.g., co-firing coal with biomass) or fuel savings associated with electric-efficiency savings (e.g., gas space heating savings associated with tighter building shells that save electricity for air conditioning). The study valued water savings at 0.4 cents per gallon.

ELECTRICITY SALES FORECAST AND THE BASE CASE

The focus of this study was on how much additional electricity is potentially available and achievable from efficiency and renewable energy resources above and beyond what would materialize absent further market intervention. This "business as usual" is reflected in the study as the base case. For purposes of the study, the base case for efficiency includes the reduced electricity requirements the State can expect in the future from policies, codes, standards, and market-intervention strategies already on the books as of year-end 2002. The base case for renewable energy consists of projects that are on-line, permitted, or well along in planning.

The base case does not reflect the effects from *continuing* market-intervention policies or programs in the future beyond their current expiration dates. Those impacts are captured as expected achievements under currently planned initiatives. Thus, appliance standards already in effect in 2002 are reflected in the base case; future efficiency standards, even those known to take effect in 2005, are not. Likewise for renewable energy: The base case does not include additional projects in the future that come on line due to the continuation of currently planned initiatives. The renewable energy potential analysis developed an explicit base case projecting electricity generation from renewable resources either already on-line or in development.

For the efficiency analysis, the base case is embedded in the statewide electricity sales forecast. The forecast projects how much electricity it will take to light and cool buildings and run industrial processes. The technical potential for efficiency savings originates from opportunities to reduce the electricity intensity of these underlying end uses in the electricity sales forecast. The achievable potential for efficiency savings depends on the success of market-intervention strategies in raising market acceptance of efficiency technologies.

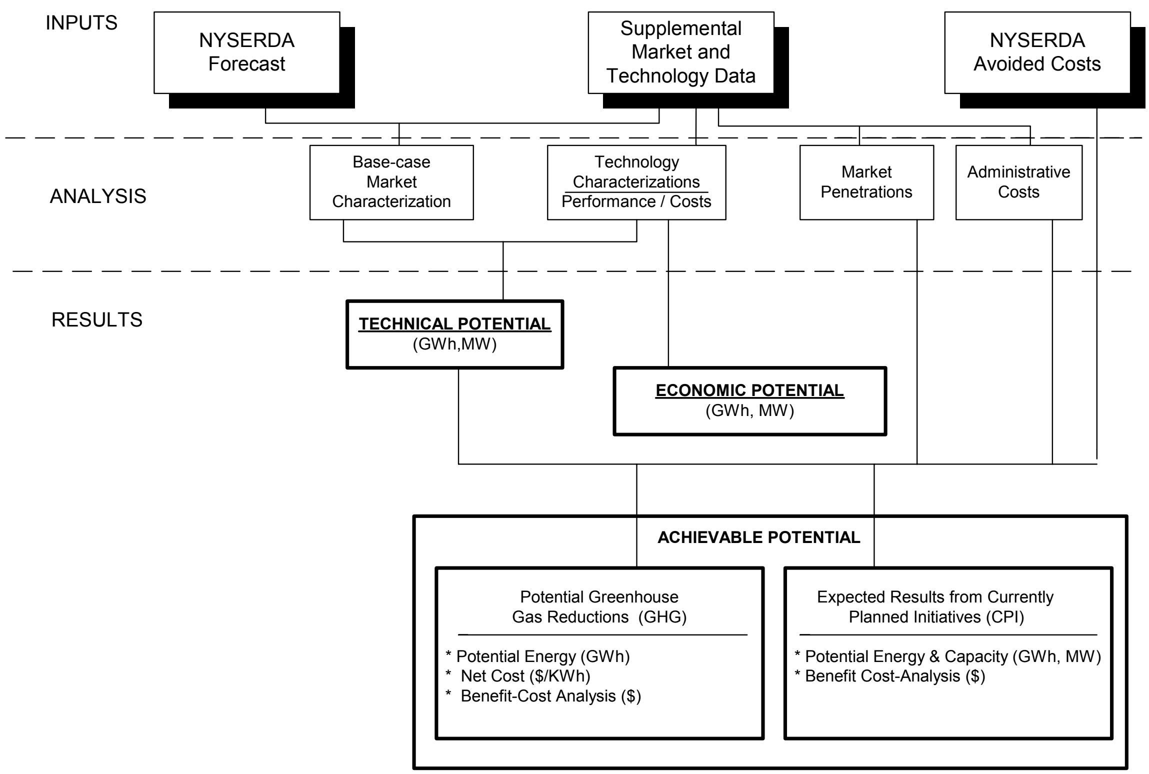
NYSERDA was the source for statewide and zonal electricity forecasts used as the basis for this analysis. Table 1.14 (page 3-22) provides the NYSERDA statewide forecast for residential, commercial, and industrial electric energy requirements through 2022.

The study calibrated the potential analysis to the electricity sales forecast with additional market data available from other public and private sources. By characterizing markets with this additional information, the study was able to examine efficiency and renewable energy potential in much more detail than would have been possible had it relied solely on NYSERDA's electricity sales forecast. For example, the industrial efficiency potential analysis considered 22 separate industries across the State, thanks to additional economic data on New York's industry and industry-specific load profile data. In addition, the study made use of hourly electricity load profiles for residential and commercial end uses in a variety of building types to estimate electricity savings potential. This allowed the study to estimate electricity savings over different periods during the year from many efficiency technologies and practices across numerous building types and industries.

The zonal technical and economic potential analysis is also founded in NYSERDA's electricity sales forecast for each zone. However, compared to the statewide analysis, the level of detail is not nearly as fine for the zonal analysis due to the lack of available market data at the zonal level. For example, little was available on the geographic distribution of the 22 industries analyzed in the statewide industrial efficiency potential analysis.

Figure 1.3 diagrams how the disparate information sources and analytical steps fit together in the study's analysis of technical, economic, and achievable potential.

Figure 1.3 Schematic Diagram of Potential Analysis Approach



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 table below lists the affiliation and responsibility of each of the seven members of the study's integration team.

Table 1.3 NYSERDA Efficiency and Renewable Potential Study Integration Team

Organization	Team Member and Area of Responsibility
Optimal Energy, Inc. (Bristol, VT)	John Plunkett, Project Leader Philip Mosenthal, Commercial Efficiency Leader
American Council for an Energy-Efficient Economy (Washington, DC)	Steve Nadel, Efficiency Leader R. Neal Elliott, Industrial Efficiency Leader
Vermont Energy Investment Corporation (Burlington, VT)	David Hill, Renewable Co-Leader Chris Neme, Residential Efficiency Leader
Christine T. Donovan Associates (Stowe, VT)	Christine Donovan, Renewables Co-Leader

ORGANIZATION OF THE STUDY

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- *Volume 2:* The main Technical Report, which describes the study's analytical approach and presents its consolidated results.
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- *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

This study had four main objectives:

- Determine the technical potential for energy efficiency and renewable energy resource development in New York, statewide and in five load zones.
- Assess how much of this technical potential would be economic compared to conventional electricity generation.
- Project the least cost mix of achievable contributions from efficiency and renewable energy resources toward New York's GHG emission targets
- Independently estimate the likely impacts of currently planned energy policy initiatives.

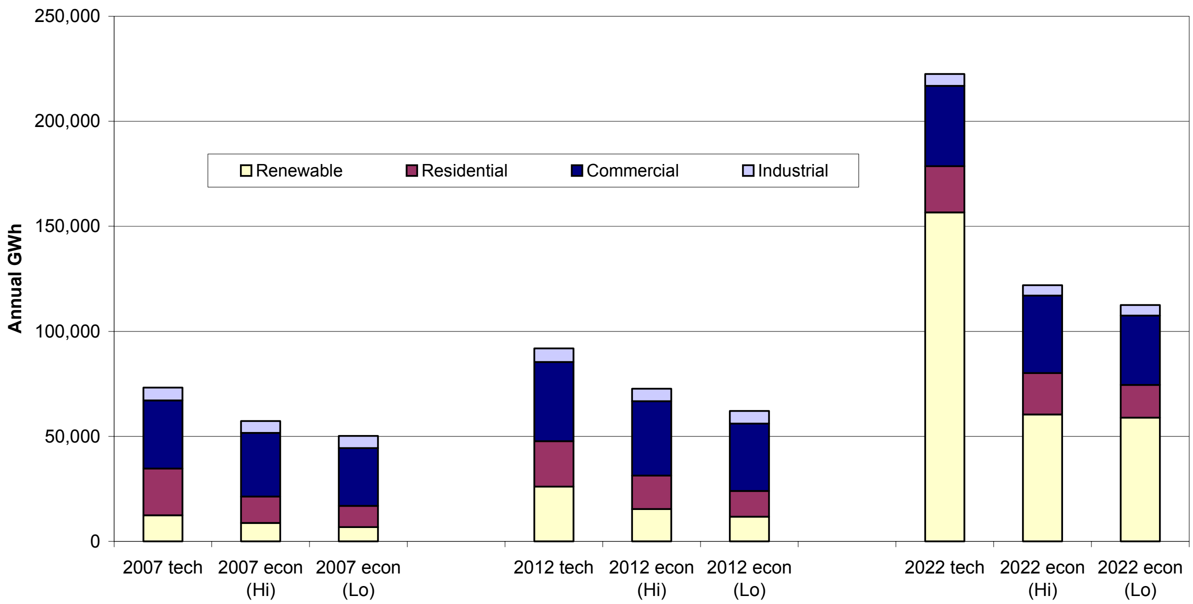
The potential study's results are presented in two sections. Results of the technical and economic potential analysis are presented in Figures 1.4 through 1.10, which summarize the results detailed in Tables 1.5 though 1.8. Results of the two achievable potential scenarios appear in Figures 1.10 through 1.14, which summarize detailed results presented in Tables 1.9 through 1.11. 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 2002 present worth.

TECHNICAL AND ECONOMIC POTENTIAL FOR EFFICIENCY AND ELECTRICITY GENERATED BY RENWABLE SOURCES

Figure 1.4 shows the technical and economic potentials for efficiency and electric energy from renewable energy resources, with efficiency savings broken out among the residential, commercial, and industrial sectors. Figure 1.5 shows the comparable peak-capacity potential. These figures represent the cumulative annual contributions from 2003 up to and including 2007, 2012, and 2022.

The combined technical potential for efficiency and electricity generated by renewable sources in New York is large relative to forecasted electricity requirements (compare Figure 1.4 with Table 1.14). Technical potential from efficiency measures remains flat or grows only slightly over the study's 20-year horizon. This is attributable to two opposing influences. Projected growth in electricity use in new construction, and increasing electricity saturation of some end uses in existing buildings (e.g., residential air conditioning), both increase opportunities for efficiency savings. This is at least somewhat offset by expected improvements in base-case efficiency levels reflected in the underlying forecast of electricity requirements. In contrast, technical potential from renewable energy resources grows substantially over the analysis period. There is a steeper potential trajectory for renewable energy because, unlike efficiency potential, renewable energy supply is largely independent of underlying electricity requirements. Renewable energy technical potential depends much more heavily than efficiency on changes in manufacturing economies over time. For example, the technical potential for photovoltaic electricity depends on substantial growth in the worldwide manufacturing capacity for photovoltaic cells.

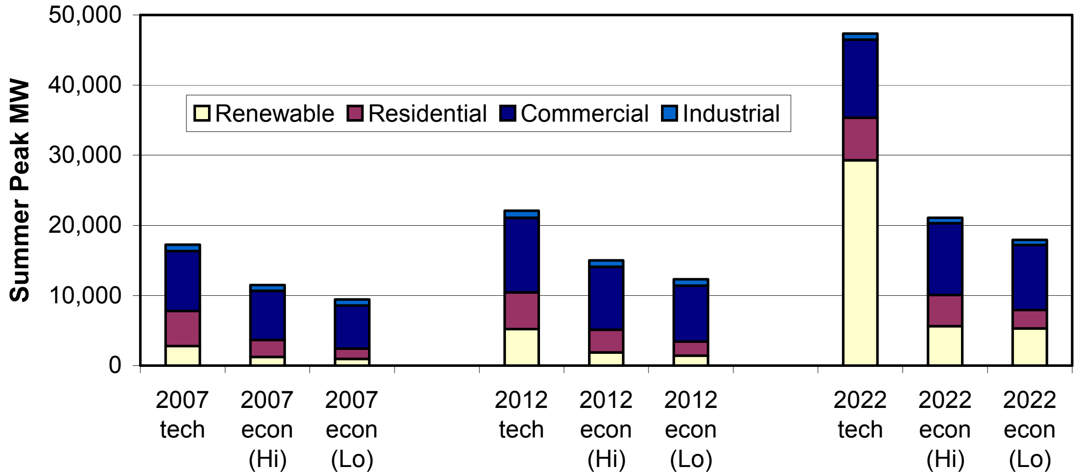
Figure 1.4 Technical and Economic Potential for Electric Energy from Efficiency and Renewables in New York (Annual GWh)



These results indicate that the relative shares of efficiency and renewable energy technical potential change over time. In 2007, efficiency resources comprise most of the technical potential for electric energy, with the greatest potential arising in the commercial sector. By 2022, however, the technical potential for renewable energy supply surpasses the potential for efficiency, as greater efficiency becomes increasingly embedded in the electricity forecast over time.

As indicated in Figure 1.5, the study found that much of New York's efficiency and renewable energy technical potential would be economical at NYSERDA's estimates of avoided electricity costs. (The study used the West and Long Island zonal avoided costs to represent the high and low end of the range for determining the statewide economic potential for efficiency and renewable energy.) On a statewide basis, the study found that 77% of efficiency technical potential in 2012 would be economic at the lowest avoided costs in the State (West Zone); by 2022, the economic potential represents 81% of efficiency technical potential. Valued at the highest avoided costs in the State, 87% of statewide technical potential in 2012 would be economic; 93% would be economic by 2022.

Figure 1.5 Technical and Economic Potential for Electric Capacity from Efficiency and Renewables in New York (Summer Peak MW)



Tables 1.4 through 1.7 present the technical and ecomonic potential results reviewed above in tabular form.

Table 1.4 Technical Electricity Potential from Efficiency and Renewable Resources

	2007		2012		2022	
	Annual GWh	Summer Peak MW	Annual GWh	Summer Peak MW	Annual GWh	Summer Peak MW
Energy Efficiency Savings						
Residential	22,236	5,011	21,642	5,255	21,964	6,067
Commercial	32,402	8,564	37,670	10,655	38,282	11,145
Industrial	6,131	905	6,530	973	5,605	849
Total Efficiency	60,769	14,480	65,842	16,883	65,852	18,061
Renewable Supply						
Biomass	5,141	833	5,325	861	6,344	1,022
Fuel Cells	651	79	5,279	641	37,777	4,596
Hydropower	2,115	257	5,038	555	10,311	1,095
Landfill Gas	460	62	432	58	452	61
Municipal Solid Waste	-	-	682	91	1,421	190
Photovoltaics	155	44	1,244	355	52,556	15,052
Solar Thermal	3,014	1,422	4,173	2,315	6,343	4,041
Windpower	951	75	3,872	304	42,133	3,227
Total Renewable	12,487	2,772	26,045	5,180	157,336	29,283
Total Efficiency Savings & Renewable Supply	73,256	17,252	91,886	22,063	223,187	47,344

Table 1.5 New York Statewide Economic Potential — Low Avoided Costs

	2007		2012		2022	
	Annual GWh	Summer Peak MW	Annual GWh	Summer Peak MW	Annual GWh	Summer Peak MW
Energy Efficiency Savings						
Residential	10,124	1,475	12,205	1,981	15,610	2,646
Commercial	27,490	6,173	32,124	8,009	32,994	9,266
Industrial	5,718	840	6,045	896	4,999	752
Total Efficiency	43,332	8,489	50,374	10,886	53,603	12,664
Renewable Supply						
Biomass	5,141	833	5,325	861	6,344	1,022
Fuel Cells	-	-	-	-	-	-
Hydropower	1,512	109	4,336	375	9,123	816
Landfill Gas	-	-	-	-	-	-
Municipal Solid Waste	-	-	682	91	1,421	190
Photovoltaics	-	-	-	-	-	-
Solar Thermal	175	-	181	-	189	-
Windpower	-	-	1,245	100	41,818	3,255
Total Renewable	6,828	942	11,769	1,427	58,894	5,283
Total Efficiency Savings & Renewable Supply	50,159	9,431	62,143	12,313	112,497	17,947

Table 1.6 New York Statewide Economic Potential — High Avoided Costs

	2007		2012		2022	
	Annual GWh	Summer Peak MW	Annual GWh	Summer Peak MW	Annual GWh	Summer Peak MW
Energy Efficiency Savings						
Residential	12,593	2,433	15,982	3,267	19,660	4,480
Commercial	30,273	7,021	35,340	8,988	36,847	10,225
Industrial	5,718	840	6,045	896	4,999	752
Total Efficiency	48,584	10,294	57,367	13,151	61,506	15,457
Renewable Supply						
Biomass	5,141	833	5,325	861	6,344	1,022
Fuel Cells	-	-	-	-	-	-
Hydropower	2,115	257	5,038	555	10,311	1,095
Landfill Gas	439	59	407	54	419	56
Municipal Solid Waste	-	-	682	91	1,421	190
Photovoltaics	-	-	-	-	-	-
Solar Thermal	175	-	181	-	189	-
Windpower	893	70	3,744	293	41,818	3,255
Total Renewable	8,762	1,219	15,376	1,855	60,501	5,618
Total Efficiency Savings & Renewable Supply	57,347	11,513	72,744	15,006	122,007	21,074

Table 1.7 compares statewide economic potential for efficiency and renewable resources with their respective technical potential.

Table 1.7 Statewide Economic Potential as Share of Technical Potential Under Low and High Avoided Costs

	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	46%	57%	56%	74%	71%	90%
Commercial	85%	93%	85%	94%	86%	96%
Industrial	93%	93%	93%	93%	89%	89%
Total Efficiency	71%	80%	77%	87%	81%	93%
Renewable Supply						
Biomass	100%	100%	100%	100%	100%	100%
Fuel Cells	0%	0%	0%	0%	0%	0%
Hydropower	71%	100%	86%	100%	88%	100%
Landfill Gas	0%	96%	0%	94%	0%	93%
Municipal Solid Waste	N/A	N/A	100%	100%	100%	100%
Photovoltaics	0%	0%	0%	0%	0%	0%
Solar Thermal	6%	6%	4%	4%	3%	3%
Windpower	0%	94%	32%	97%	99%	99%
Total Renewable	55%	70%	45%	59%	37%	38%
Total Efficiency Savings & Renewable Supply	68%	78%	68%	79%	50%	55%

Table 1.7 shows that the economic share of technical potential was lowest in the residential sector, varying between 56% in 2012 under low avoided costs and 93% in 2022 under high avoided costs. The economic potential for commercial efficiency savings was the highest share of technical potential among all three sectors. At low avoided costs in 2012, about 85% of commercial technical potential was found to be economic; virtually all (96%) of commercial efficiency technical potential was found to be economic at high avoided costs in 2022. In the industrial sector, between 89% and 93% of technical potential was found to be economic.

The study found that 45% of renewable energy technical potential would be considered competitive with conventional electric generation by 2012 if valued at the low avoided costs; the comparable share by 2022 would be 38% (of a much higher total technical potential at that point). Avoided costs at the high end of the range for the State increase the fraction of renewable energy technical potential that would be economic to 59% by 2012 and to 39% by 2022. The share of technical potential found to be economic varies widely between efficiency and renewable energy because the technical potential for some renewable energy technologies grows significantly over time, while their costs remain relatively high compared to conventional generation. Photovoltaic electricity provides a case in point. Conversely, biomass, hydropower, and solar thermal energy resources were found to be economic under low zonal avoided costs. At high zonal avoided costs, electric energy from landfill gas and windpower also would become cost-competitive with conventional generation.

Figure 1.6 shows the breakdown of economic potential for renewable energy and efficiency in the residential, commercial, and industrial sectors in 2012, the mid-point of the study horizon. (Volume 2 provides results for 2007, 2012, and 2022.)

Figure 1.6 Statewide Economic Electric Energy Potential in 2012 (% total by Sector)

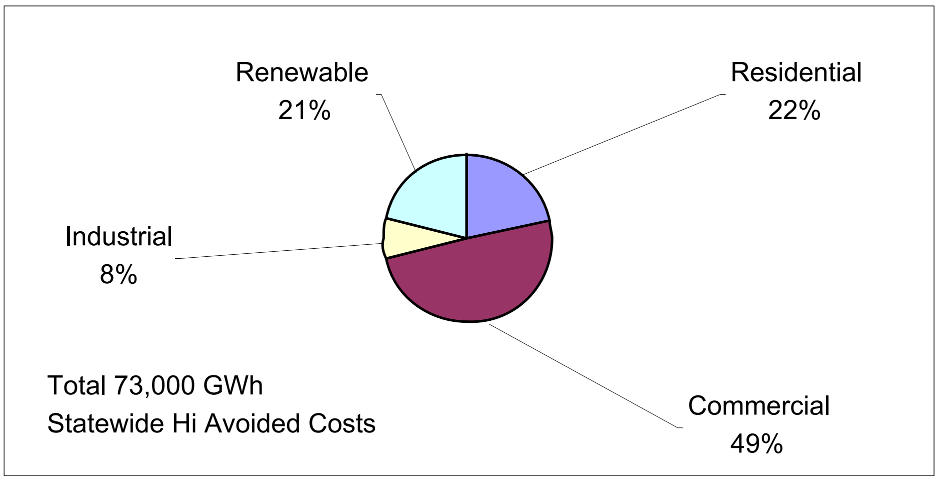


Figure 1.7 gives a comparable breakdown of economic potential for electric summer capacity in that year. Once again, commercial efficiency is the largest single source of potential energy savings, representing 49% of the electric energy potential in Figure 1.6. This sector's economic potential represents an even larger share (60%) of the total economic potential for summer capacity because commercial efficiency can offset relatively more peak capacity requirements than other efficiency sectors or renewable energy generation.

Figure 1.7 2012 Statewide Economic Electric Capacity Potential (% of Total by Sector)

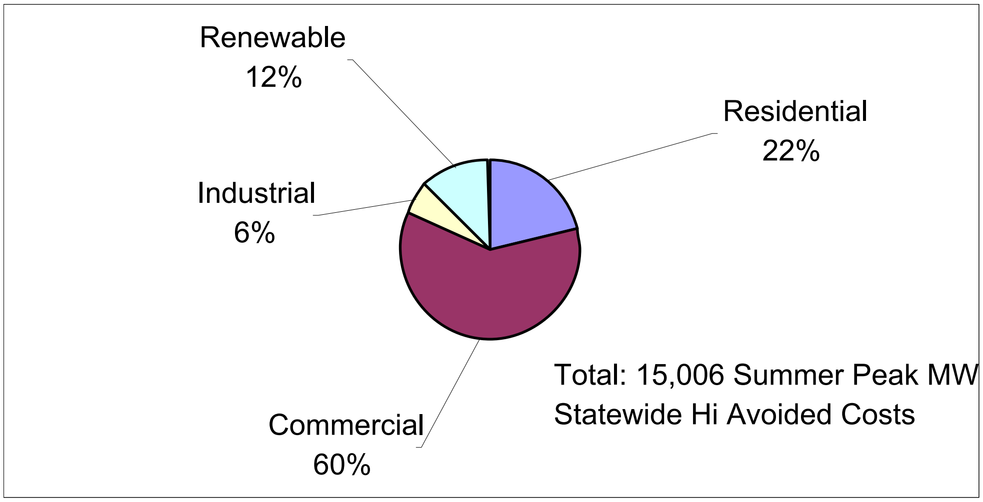
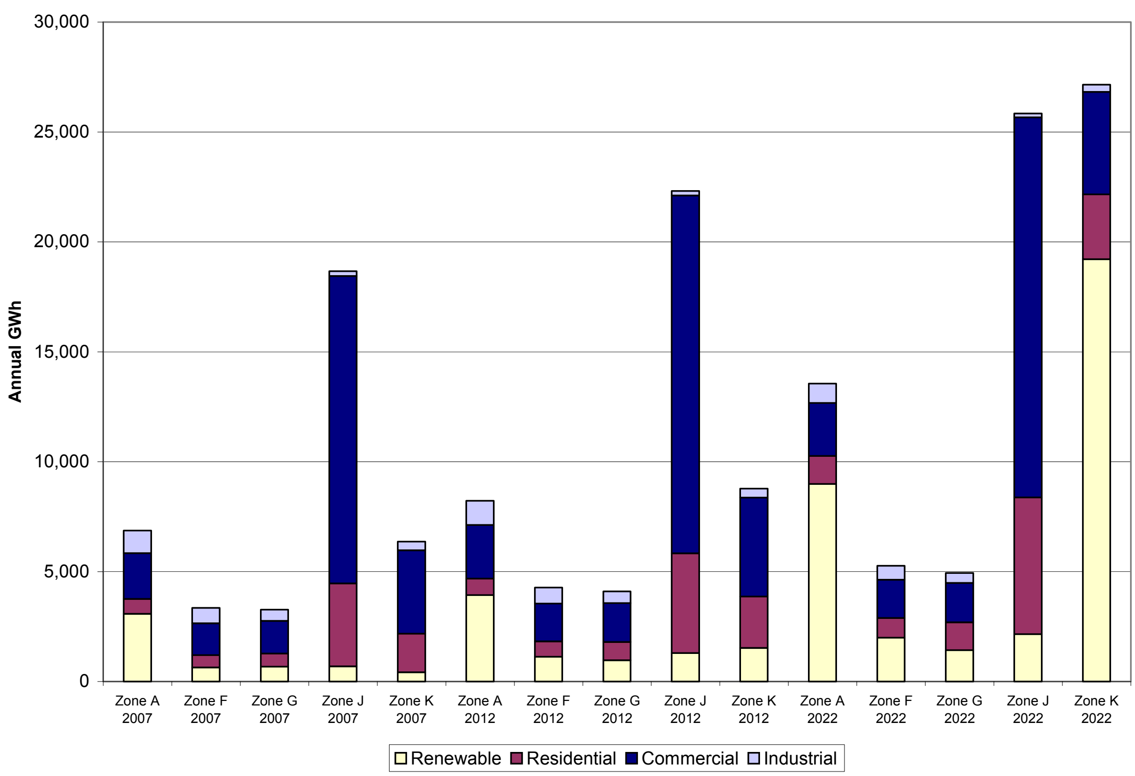


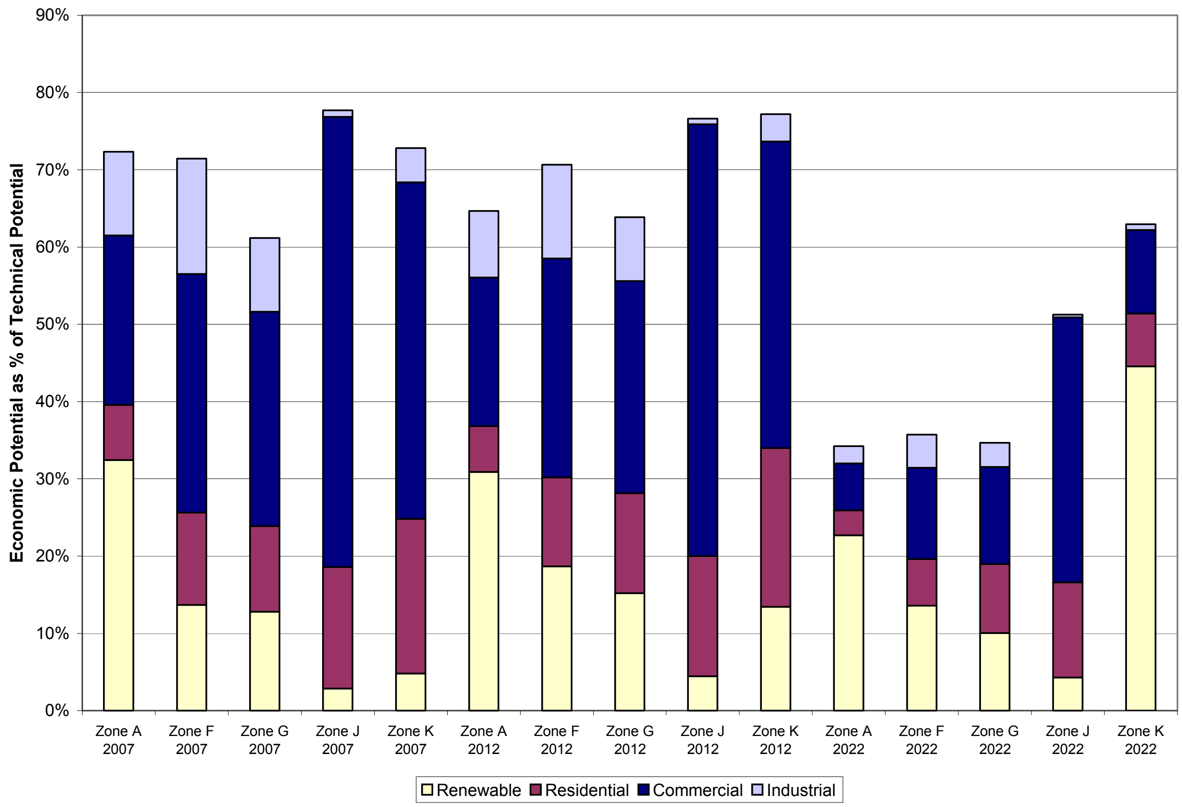
Figure 1.8 portrays the economic potential for efficiency and renewable energy within each zone analyzed.

Figure 1.8 Economic Potential by Zone (Annual GWh)



The study found that the share of technical potential that would be economic varies by load zone. This variation, illustrated in Figure 1.9, is due primarily to the effect of avoided costs, since the technology costs did not vary significantly between zones in the analysis. Volume 2 contains detailed results of the zonal technical and economic potential analysis.

Figure 1.9 Economic Potential as % of Technical Potential by Zone



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

The study produced two kinds of results from the analysis of achievable contributions toward GHG reductions:

- a set of cost "curves" for achieving reductions in fossil-fueled electric energy generation requirements, and thus contributing toward the statewide GHG goals; and
- a set of results indicating the mix of efficiency and renewable energy resources that would be part of a least-cost portfolio to achieve the GHG reductions, and the associated benefits and costs.

Cost Curves for Reducing the Requirements for Fossil-Fueled Electric Energy Generation. The study produced one curve for achieving a reduction of 19,939 GWh in 2012, and another for a reduction in 2022 of 27,244 GWh. These reductions would contribute toward statewide GHG goals by lowering electricity use by 11.0% in 2012 and 14.1% in 2022 from the base-case forecast of electricity requirements.

Figure 1.10 and Figure 1.11 show the cost curves for efficiency and renewable energy for 2012 and 2022, respectively. Each point on the curve represents a particular amount of efficiency or electric energy supply (in GWh) at a specific levelized cost per kWh (over the life span of the resource, using a real discount rate of 4 percent). The points are sorted and presented in order of increasing cost per kWh.

To obtain more achievable electric energy from efficiency and renewable resources, it is necessary to move to the right on the curve and choose progressively more costly sources. The area under the curve represents the total costs of obtaining any given amount of electric energy supply. The vertical line represents the GHG reduction goal for each year. Thus, the area under the cost curve up to the vertical line of the GHG reduction goal indicates the total cost of meeting it. The dark horizontal line represents the average energy avoided cost per kWh. The total area under the horizontal line represents the total benefits to New York from achieving the GHG reductions. Consequently, the area below the horizontal line and above the cost curve represents the net economic benefits to New York from pursuing the least-cost strategy.

Figures 1.10 and 1.11 demonstrate the study's finding that achievable efficiency and renewable energy resources would be more than enough to meet New York's long-range GHG reduction goals for the electricity sector. These figures also demonstrate the study's finding that New York could do so economically; that is, at costs below the avoided conventional electric generation displaced by efficiency and renewable energy. These achievable contributions could be realized at net costs below three cents/kWh.

The study found that achievable costs of these contributions start at a *negative* $1.24/kWh of savings from industrial efficiency improvements. The most expensive analyzed achievable measure costs $6.87/kWh for a pump upgrade for residential well water.[7] The study obtained negative values for some efficiency and renewable energy resource costs because it subtracted the value of non-electric resource savings (such as fossil fuel) as well as avoided generating capacity costs from the achievable costs of the technologies. Volume 7 provides tabular results indicating achievable costs and contributions from each efficiency and renewable technology depicted in Figures 1.10 and 1.11 (including those technologies not shown in these figures).

[7] GHG supply curves are truncated at $0.40/kWh because at higher costs there is very little addition to the GWh savings.

Figure 1.10 Greenhouse Gas Target Supply Curve (2012, Low Avoided Costs)

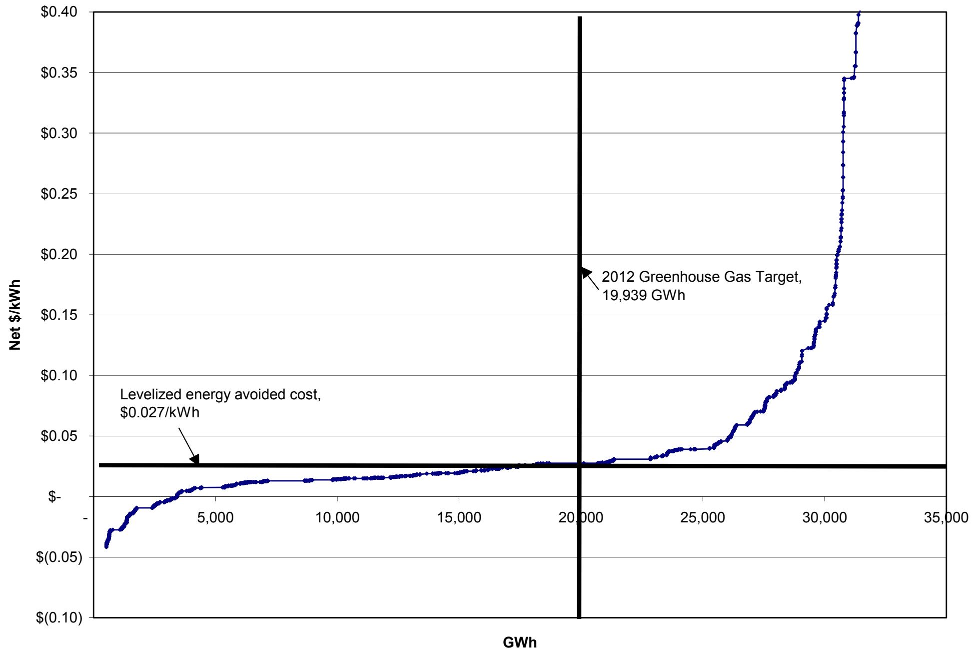


Figure 1.11 Greenhouse Gas Target Supply Curve (2022 Low Avoided Costs)

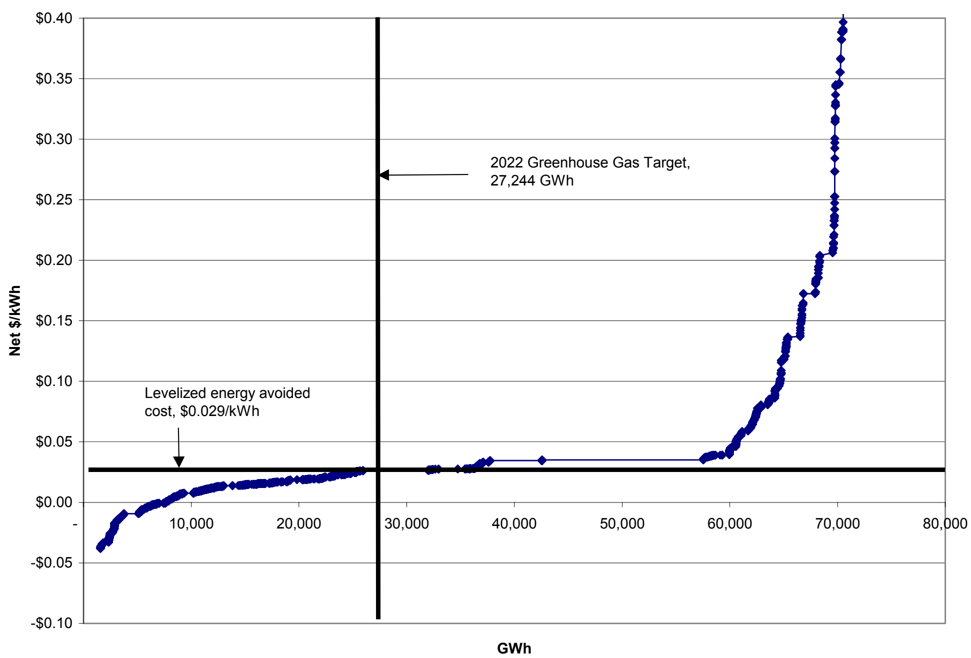


Figure 1.10 indicates that the most expensive resource selected to meet the GHG reductions would cost $0.026/kWh for 2012, which is the achievable cost for retrofitting office lighting with high-efficiency fixtures along with better layout design. In Figure 1.11, the most expensive resource deployed to meet the target in 2022 would be wind-farm installations, also costing $0.026/kWh. Volume 7 of the report provides the values corresponding to each point on the achievable cost curves for efficiency and renewable electric energy.

Significantly, the study found that even the most expensive resources chosen to meet the targets could be achieved for less than the average avoided cost of electric energy. This indicates that the least-cost greenhouse gas solution would be highly cost-effective for New York. Figures 1.10 and 1.11 further demonstrate that additional efficiency and renewable energy contributions could be achieved beyond the GHG reduction goals at costs that would still be economic compared with the conventional electricity supply they would avoid. Observe that the cost curve extends beyond the vertical line while remaining below the horizontal line, representing the average annual avoided cost over the period in question (2012 or 2022).

The Least-Cost Mix of Efficiency and Renewable Energy Resources Needed to Achieve the GHG Reductions. This second set of results also projects and compares the benefits and costs of the least-cost portfolio. Figures 1.12 and 1.13 show the resource composition of the least-cost greenhouse-gas solutions found in the study for meeting the 2012 and 2022 GHG reductions, respectively.

Figure 1.12 Greenhouse Gas Scenario 2012 GWh Savings by Sector

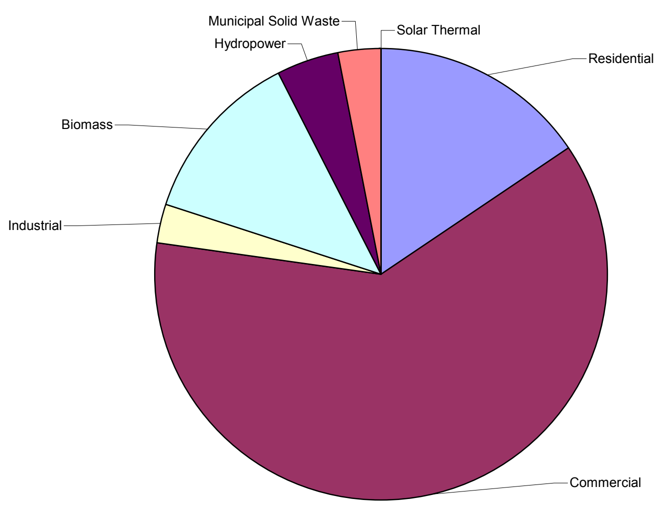


Figure 1.13 Greenhouse Gas Scenario 2022 GWh Savings by Sector

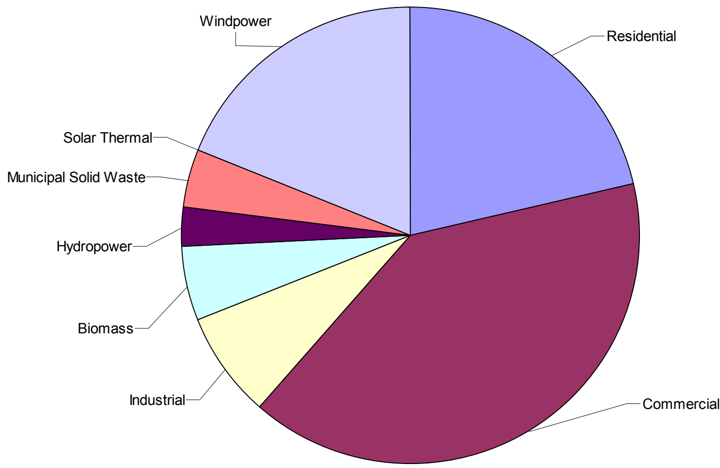


Figure 1.12 shows that the least-cost solution for the 2012 GHG reduction goal would consist primarily of efficiency resources, which are dominated by commercial sector savings. Figure 1.13 provides a comparable breakdown for the 2022 analysis. Biomass, hydropower, MSW, and solar thermal would be the renewable energy resource contributions to the least-cost GHG solution in both 2012 and 2022, with a large amount of wind power added to the mix in 2022.

Tables 1.8 and 1.9 report the values underlying Figures 1.12 and 1.13, assuming low avoided costs, for 2012 and 2022 GHG reductions. (Volume 2 reports complete results, including those for high avoided costs.) They also show how economically advantageous the least-cost solutions would be for New York, even if statewide contributions are valued at the lowest zonal avoided costs.

Table 1.8 Benefits and Costs of Least-Cost Efficiency and Renewable Achievements Toward 2012 Greenhouse Gas Target (Statewide Low Avoided Costs)

			Total Resource			
	Annual GWh	Lifetime net cost per kWh saved	Benefits	Costs	Net Benefits	BCR
Energy Efficiency Savings						
Residential	3,105	$ (0.0224)	1,281,359,428	(26,107,167)	1,307,466,595	-49.08
Commercial	12,454	$ 0.0160	4,068,573,146	2,555,343,290	1,513,229,856	1.59
Industrial	538	$ (0.0164)	139,598,928	(3,325,355)	142,924,283	-41.98
Total Efficiency	16,096	$ 0.0084	5,489,531,502	2,525,910,768	2,963,620,734	2.17
Renewable Supply						
Biomass	2,520	$ (0.0122)	728,546,676	(162,757,236)	891,303,911	-4.48
Fuel Cells	-	NA	-	-	-	
Hydropower	859	$ 0.0075	440,421,346	135,787,348	304,633,997	3.24
Landfill Gas	-	NA	-	-	-	
Municipal Solid Waste	633	$ (0.0093)	329,616,958	(46,022,347)	375,639,305	-7.16
Photovoltaics	-	NA	-	-	-	
Solar Thermal	7	$ 0.0039	2,569,889	352,112	2,217,777	7.30
Windpower	-	NA	-	-	-	
Total Renewable	4,019	$ (0.0055)	1,501,154,868	(72,640,123)	1,573,794,990	-20.67
Total Efficiency Savings & Renewable Supply	20,115,208	$ 0.0050	6,990,686,370	2,453,270,646	4,537,415,724	2.85

Note: Benefits are Cumulative Through 2012 and stated in Present Worth 2003 Dollars

The study found that the net economic benefits to New York from pursuing this least-cost approach to meeting GHG reductions for 2012 are estimated at between $4.5 billion and $9.4 billion. This means that New York would be significantly better off economically if it pursued a least-cost portfolio of efficiency and renewable resources to meet its GHG targets, compared to the base case of doing nothing in the future to increase efficiency and renewable development. The net economic benefits of the least-cost GHG solution also significantly exceed those estimated by the study from currently planned initiatives.[8] The lower and upper ends of this range of net benefits from least-cost GHG reductions are the result of valuing efficiency and renewable energy benefits at the lowest and highest zonal avoided supply costs, and subtracting the total resource costs of achieving them. By 2022, net benefits from pursuing economically achievable efficiency and renewable energy contributions toward New York's GHG reductions would range between $9.1billion and $16.6 billion.

8 See Tables 1.8, 1.9, and 1.10.

Table 1.9 Benefits and Costs of Least-Cost Efficiency and Renewable Achievements Toward 2022 Greenhouse Gas Target (Statewide Low Avoided Costs)

			Total Resource			
	Annual MWh	Lifetime net cost per kWh saved	Benefits	Costs	Net Benefits	BCR
Energy Efficiency Savings						
Residential	6,817,904	$ (0.0286)	2,711,421,735	(369,786,348)	3,081,208,084	-7.33
Commercial	12,845,503	$ 0.0121	5,263,693,023	2,751,613,298	2,512,079,725	1.91
Industrial	2,381,309	$ (0.0175)	659,641,264	(42,566,669)	702,207,933	-15.50
Total Efficiency	22,044,716	$ (0.0002)	8,634,756,023	2,339,260,281	6,295,495,742	3.69
Renewable Supply						
Biomass	1,716,998	$ (0.0236)	870,486,934	(483,331,405)	1,353,818,339	-1.80
Fuel Cells	-	NA	-	-	-	
Hydropower	858,900	$ 0.0075	440,421,346	135,787,348	304,633,997	3.24
Landfill Gas	-	NA	-	-	-	
Municipal Solid Waste	1,324,862	$ (0.0093)	627,719,813	(83,651,065)	711,370,879	-7.50
Photovoltaics	-	NA	-	-	-	
Solar Thermal	9,234	$ 0.0029	3,405,550	353,885	3,051,665	9.62
Windpower	6,048,728	$ 0.0264	1,888,941,797	1,456,403,115	432,538,682	1.30
Total Renewable	9,958,722	$ 0.0067	3,830,975,439	1,025,561,878	2,805,413,561	3.74
Total Efficiency Savings & Renewable Supply	32,003,438	$ 0.0022	12,465,731,462	3,364,822,159	9,100,909,303	3.70

Note that Tables 1.8 and 1.9 report negative values for the lifetime net cost per kWh for residential and industrial efficiency and for renewable energy from biomass and municipal solid waste. The tables also show negative total resource costs for biomass and municipal solid waste, and, consequently, negative benefit-cost ratios. In fact, the negative costs associated with biomass and municipal solid waste are so large that they exceed all the other resource costs associated with hydroelectric and solar thermal included in the least-cost mix. These results are consistent with the foregoing explanation that some efficiency and renewable energy resources also avoid substantial non-electric costs. These additional resource cost savings are discussed in the efficiency and renewable Technical Appendices (Volumes 4 and 6) of this report.

Several clarifying observations are in order regarding the results presented in Tables 1.8 and 1.9. The first column indicates the GWh achievements from each resource that are part of the least-cost resource solution to the GHG reduction for each year. These figures do not represent all the achievable potential for each resource, nor do they necessarily represent that total achievable potential that would be economic. Rather, they indicate the contribution from each resource given the costs of achievable potential from other resources. For example, the absence of wind energy in the least-cost solution to the 2012 greenhouse gas target does not mean that wind is not achievable or economic; it merely indicates that other resources can be obtained at lower achievable costs. If a lower-cost resource was for some reason removed from its position in the order of achievable costs, then wind would improve its position (i.e., move to the left on the supply curve).

EXPECTED CONTRIBUTIONS FROM NEW YORK'S CURRENTLY PLANNED INITIATIVES

Finally, shown below are independent estimates of the expected contribution by New York's currently planned efficiency and renewable energy program initiatives toward the 2002 State Energy Plan's GHG reduction recommendations. Figure 1.14 presents the study's estimate of expected impacts by 2007, 2012, and 2022. The pie charts that follow provide individual sector and renewable technology contributions for each of these three years.

Figure 1.14 Currently Planned Initiatives Savings (Annual GWh)

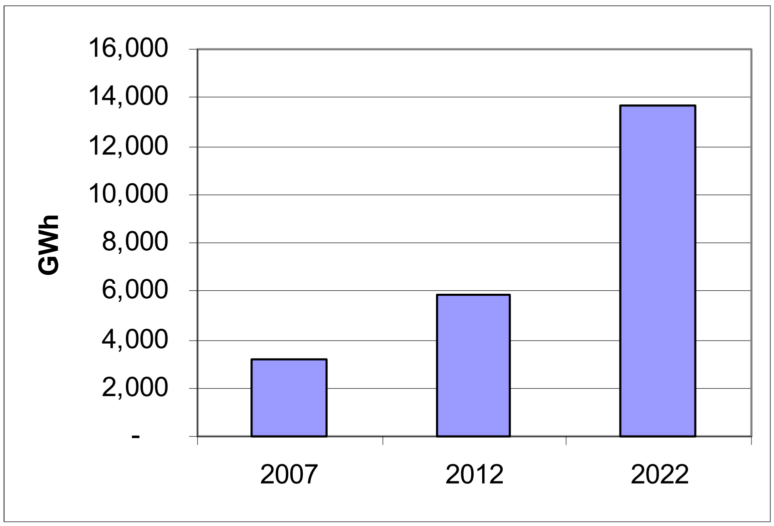


Figure 1.15 Currently Planned Initiatives Savings for 2007 (Annual GWh)

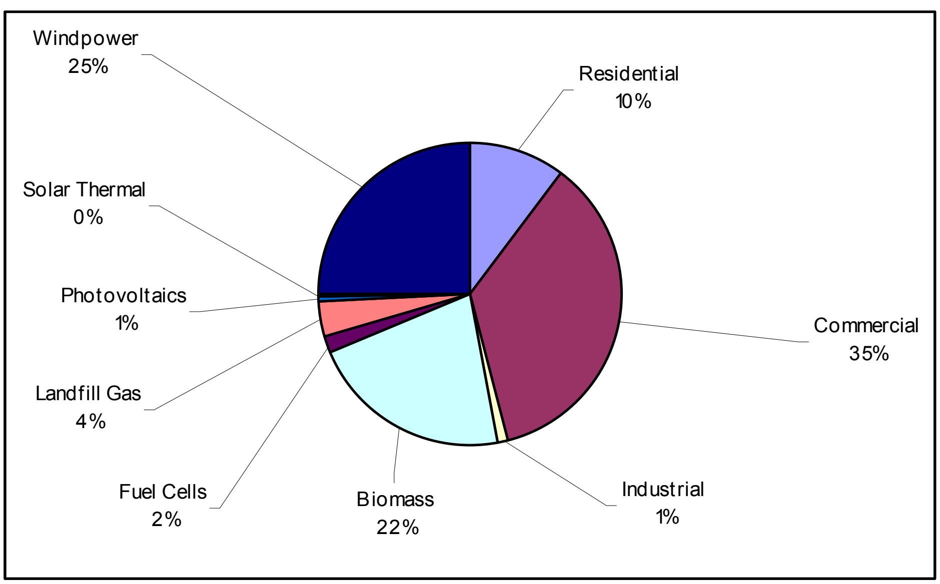


Figure 1.16 Currently Planned Initiatives Savings for 2012 (Annual GWh)

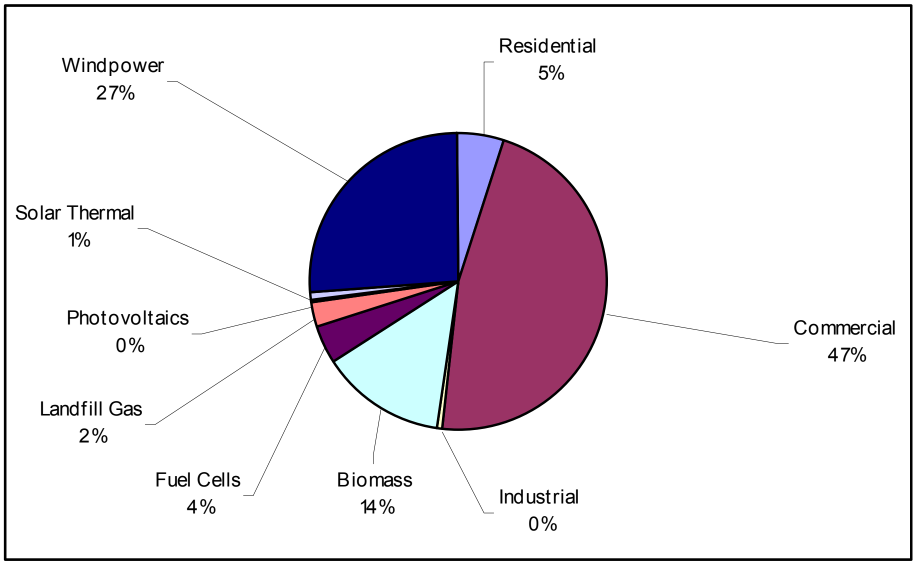
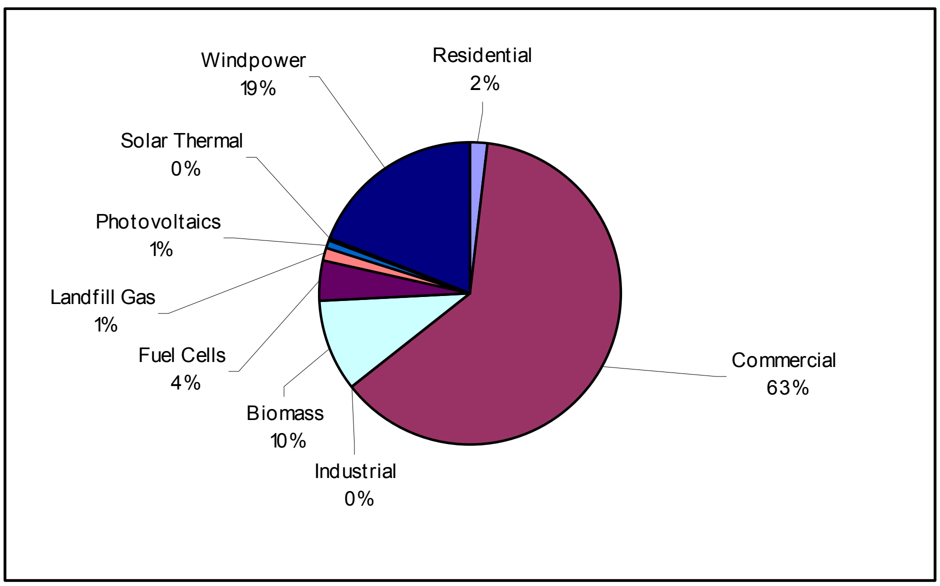


Figure 1.17 Currently Planned Initiatives Savings for 2022 (Annual GWh)



The study estimates that efficiency savings generated by currently planned initiatives will reach 0.9% of the state's electric energy requirements by 2007, 1.7% by 2012, and 4.6% by 2022. Much of the increase in expected contributions from efficiency in the later years is attributable to the growing impacts of efficiency codes and standards over time. The study finds that renewable energy will contribute 1.0% of the State's electricity requirements by 2007, 1.6% by 2012, and 2.5% by 2022. Most of the growth in renewable supply is expected to come from increased biomass and wind development.

Table 1.10 presents numerically the information depicted in Figure 1.14.

Table 1.10 New York Statewide Currently Planned Initiatives Savings

	2007		2012		2022	
	Annual GWh	Summer Peak MW	Annual GWh	Summer Peak MW	Annual GWh	Summer Peak MW
Energy Efficiency Savings						
Residential	328	96	292	84	254	69
Commercial	1,134	335	2,751	798	8,555	2,835
Industrial	29	4	19	3	3	0
Total Efficiency	1,490	435	3,063	886	8,812	2,904
Renewable Supply						
Biomass	684	108	804	124	1,347	204
Fuel Cells	57	7	248	30	575	70
Hydropower	-	-	-	-	-	-
Landfill Gas	118	16	137	18	170	23
Municipal Solid Waste	-	-	-	-	-	-
Photovoltaics	16	5	27	8	108	31
Solar Thermal	7	2	39	10	67	18
Windpower	793	64	1,558	124	2,597	207
Total Renewable	1,676	200	2,812	315	4,863	552
Total Efficiency Savings & Renewable Supply	3,166	636	5,875	1,200	13,675	3,456

Table 1.11 reports the study's estimates of expected benefits and costs applying low zonal avoided costs to statewide achievements from currently planned initiatives. The study finds that currently planned initiatives will achieve cost-effective contributions from both efficiency and renewable energy resources. The economic value to New York from currently planned initiatives is estimated between \$0.5 billion and \$2.0 billion by 2012 and between \$1.7 billion and \$5.4 billion by 2022, depending on whether electricity is valued at the lowest or highest zonal avoided costs in the State. (As explained above and as shown for the GHG analysis, the economic value to New York is the difference between the present worth of total resource benefits from expected efficiency and renewable energy development and the total resource costs of achieving them.)

Table 1.11 Expected Achievements Under Currently Planned Initiatives — Benefit/Cost Analysis Results: Low Avoided Costs (Millons of $ 2003)

Expected Achievements under Currently Planned Initiatives Benefit/Cost Analysis Results: 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

POTENTIAL UNDERSTATEMENT OF ECONOMIC POTENTIAL AND ECONOMIC BENEFITS OF ACHIEVABLE POTENTIAL

Figure 1.5 and Table 1.7 support the study's conclusion that avoided costs have a major influence on how much technical potential is found to be economic. The difference between high and low avoided costs meant a difference of $7.5 billion in net benefits to the State economy from pursuing a least-cost solution to GHG reductions in 2022. These findings are important for New York's electricity resource planning. They indicate that not reflecting the full economic value of efficiency or renewable resources tends to underestimate the true technical and achievable potential that would be economically beneficial for New York.

This study's conclusions on the economic potential for efficiency and especially renewable energy resources are not definitive because of the relatively limited scope of the avoided costs used to value electricity savings. The study concludes that the analysis probably understates the true economic value of electricity potential from efficiency and renewable technologies. This conclusion stems from the omission of several additional beneficial effects from pursuing additional electricity resources from efficiency and renewable energy technologies. In particular, the avoided costs used to value electricity resources in this study *exclude*:

- Avoided transmission and distribution (T&D) capacity costs
- Avoided environmental externalities
- Demand-induced price effects (i.e., lower electricity demand due to efficiency and renewables will tend to lower market-clearing prices)
- Economic development impacts (net benefits from efficiency and renewable energy stimulate economic activity, increasing the New York's gross state product)

Had the study *included* the additional value of these effects, it would have affected results in the following general direction:

- *Economic potential analysis*: A higher fraction of the technical potential for all efficiency and renewable energy resources would have been found to be economic.
- *Achievable contributions toward GHG reductions*: Incorporating the value of avoided T&D costs would lower the net achievable cost of electric energy, since the analysis subtracts the value of capacity from the total achievable cost of electric energy. The estimated benefits to New York's economy from achieving the least-cost solution to New York's GHG reductions would therefore increase.
- *Expected contributions from currently planned initiatives*: The estimated net benefits to New York's economy would increase from policies and strategies contained in the State Energy Plan to promote efficiency and renewable energy resources.

CAVEATS

The Project Team offers several caveats about the use of this study, which are summarized here:

- *It would be a mistake to confuse technical and economic potential with other types of potential analysis.* Technical potential is not achievable potential, and therefore cannot be applied directly to represent the efficiency and renewable resources that New York could actually realize through policy or program initiatives. Doing so would be a misuse of the study's analysis.

  The study's technical and economic potential analysis can and should be used to inform other analysis of policy, program, and resource options. The technology costs and performance characteristics developed from this analysis can be applied in the planning and design of programs, policies, and resource acquisition.

  If using the study's technical and economic potential analysis results in efficiency and renewable energy program or resource planning, then such additional analysis should account for future market acceptance, specific program strategies for realizing market acceptance, and the administrative costs of such programs.
- *Zonal technical and economic potential should be used with caution.* The quality and reliability of supplemental information used to characterize markets within zones is limited, particularly in the industrial sector. The zonal technical and economic potential results are readily applicable in conjunction with more accurate information about zonal market characteristics (e.g., if more information is available regarding the location of specific industries within the State).
- *To avoid understating the economic potential for efficiency and renewable resources and the economic benefits from achieving this potential, future estimates of electricity benefits should account for benefits beyond electric generation.* Such additional potential benefits include avoided transmission and distribution capacity costs, avoided environmental costs not reflected in market prices, (i.e., externalities), the effect of lowering electric demand on wholesale market prices, and the economic stimulus that results from lowering New York's total costs of meeting energy requirements with economic efficiency and renewable resources.

Table 1.12 Summary of New York Zonal Avoided Costs — 2003 $

	A: WEST (Low avoided costs in statewide analysis)		F: CAPITAL		G: HUDSON		J: NEW YORK CITY		K: LONG ISLAND (High avoided costs in statewide analysis)	
	Annual Energy	**Summer Capacity**	**Annual Energy**	**Summer Capacity**	**Annual Energy**	**Summer Capacity**	**Annual Energy**	**Summer Capacity**	**Annual Energy**	**Summer Capacity**
	$/kWh	$/kW-Yr	$/kWh	$/kW-Yr	$/kWh	$/kW-Yr	$/kWh	$/kW-Yr	$/kWh	$/kW-Yr
2003	0.0286	37.42	0.0328	37.42	0.0348	37.42	0.0372	92.17	0.0406	92.17
2004	0.0266	37.60	0.0294	37.60	0.0344	37.60	0.0361	92.62	0.0420	92.62
2005	0.0269	28.20	0.0278	28.20	0.0292	28.20	0.0313	69.46	0.0348	69.46
2006	0.0269	28.31	0.0278	28.31	0.0291	28.31	0.0316	69.74	0.0351	69.74
2007	0.0269	28.42	0.0277	28.42	0.0291	28.42	0.0319	70.01	0.0355	70.01
2008	0.0269	28.53	0.0277	28.53	0.0291	28.53	0.0303	70.28	0.0359	70.28
2009	0.0264	28.64	0.0278	28.64	0.0295	28.64	0.0307	70.55	0.0365	70.55
2010	0.0260	28.76	0.0279	28.76	0.0299	28.76	0.0311	70.83	0.0372	70.83
2011	0.0270	28.87	0.0284	28.87	0.0303	28.87	0.0316	71.11	0.0381	71.11
2012	0.0281	28.98	0.0290	28.98	0.0308	28.98	0.0321	71.39	0.0390	71.39
2013	0.0287	29.10	0.0295	29.10	0.0314	29.10	0.0329	71.67	0.0401	71.67
2014	0.0293	29.21	0.0301	29.21	0.0321	29.21	0.0337	71.95	0.0411	71.95
2015	0.0298	29.32	0.0306	29.32	0.0327	29.32	0.0345	72.23	0.0421	72.23
2016	0.0304	29.44	0.0312	29.44	0.0334	29.44	0.0352	72.51	0.0432	72.51
2017	0.0309	29.55	0.0316	29.55	0.0338	29.55	0.0357	72.79	0.0441	72.79
2018	0.0313	29.67	0.0320	29.67	0.0343	29.67	0.0361	73.08	0.0450	73.08
2019	0.0318	29.78	0.0324	29.78	0.0347	29.78	0.0365	73.37	0.0459	73.37
2020	0.0322	29.90	0.0329	29.90	0.0352	29.90	0.0370	73.66	0.0467	73.66
2021	0.0327	30.02	0.0333	30.02	0.0357	30.02	0.0375	73.94	0.0477	73.94
2022	0.0332	30.14	0.0338	30.14	0.0362	30.14	0.0380	74.23	0.0487	74.23

Notes: Annual energy is simple average of avoided costs in summer, winter, on-peak, and off-peak hours. Potential analysis applied detailed avoided costs to electric energy and capacity in each period.

Table 1.13 NYSERDA Avoided Costs of Fossil Fuels – 2003 $/MMBTU

	Res. Oil	Com. Oil	Ind. Oil	Res. Gas	Com. Gas	Ind. Gas	Coal
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
2021	9.65	7.10	6.71	9.63	5.72	5.64	1.47
2022	9.67	7.12	6.73	9.63	5.72	5.64	1.47

Source: NYSERDA

Table 1.14 Statewide Electricity Requirements, 2003-2022

Year	Residential GWh	Commercial GWh	Industrial GWh	Total GWh
2003	51,738	78,301	25,549	155,588
2004	52,483	79,860	26,091	158,433
2005	53,127	81,480	26,624	161,231
2006	53,643	82,999	26,975	163,617
2007	54,136	84,434	27,405	165,976
2008	54,599	85,780	27,887	168,266
2009	55,004	87,049	28,388	170,441
2010	55,352	88,268	28,990	172,610
2011	55,688	89,414	29,588	174,690
2012	56,091	90,508	29,917	176,516
2013	56,560	91,431	30,312	178,303
2014	57,096	91,905	30,648	179,649
2015	57,640	92,120	31,024	180,785
2016	58,037	92,265	31,383	181,686
2017	58,487	92,357	31,723	182,567
2018	58,964	92,448	32,060	183,471
2019	59,487	92,539	32,378	184,404
2020	60,009	92,630	32,594	185,233
2021	60,531	92,722	32,810	186,063
2022	61,046	93,676	33,123	187,845

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