NATURAL GAS ENERGY EFFICIENCY RESOURCE DEVELOPMENT POTENTIAL IN NEW YORK

Final Report

Prepared for

New York Energy Research and Development Authority
Erin P. Hogan, Project Manager

Prepared by

OPTIMAL ENERGY, INC. • BRISTOL, VT
Philip Mosenthal, Project Leader, Commercial Efficiency Leader

AMERICAN COUNCIL FOR AN ENERGY-EFFICIENT ECONOMY • WASHINGTON, D.C.
R. Neal Elliott, Industrial Efficiency Leader
Dan York, Exemplary Programs Leader

VERMONT ENERGY INVESTMENT CORPORATION • BURLINGTON, VT
Chris Neme, Residential Efficiency Leader, Program Design Leader

RESOURCE INSIGHT, INC. • ARLINGTON, MA
Paul Chernick, Avoided Cost Leader

ENERGY AND ENVIRONMENTAL ANALYSIS, INC. • ARLINGTON, VA
Kevin Petak, Forecast and Price Effects Leader

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Errata

for

Natural Gas Energy Efficiency Resource Development Potential in New York

June 7, 2007

These errata correct an addition error in Table 2.21 and the referencing paragraph.

The following paragraph replaces the paragraph on page 2-36.

Table 2.21 shows the estimated total bill reductions by program for the program scenario, based on average 2004 revenue per Dth. This does not reflect any additional consumer savings from price effects. Delivery of the selected portfolio would result in approximately $146 million/yr in bill reductions in 2016, assuming 2004 average rates. Cumulative 10-year customer bill savings by 2016 would be $1.1 billion. No per-customer bill reductions are provided because these reductions would only accrue to the program participants, so averaging reductions across all customers would be misleading. Per-participant bill reductions would depend on the number of customers participating and would likely vary substantially among individual participants and would be highly dependent upon each customer’s unique circumstances and tariff. Because some customers may only implement a single measure, while others might undergo comprehensive efficiency improvements, projecting the actual number of customers participating would be highly speculative. Note these figures do not include gas price effects from efficiency, which could provide potentially larger bill reductions, both to participants and non-participants. For example, cumulative price effect savings through 2016 are estimated at $1.3 billion (including savings to power generation gas consumers).[36] Total cumulative 10-year bill reductions with price effects would be approximately $2.4 billion.

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Table 2.21. Program Scenario Potential, 2007-2016, Bill Reductions, Not Including Price Effects

Program	2004 Average $/Dth	2016 Dekatherm Savings	2016 Annual Bill Reductions	2016 Cumulative 10-Year Bill Reductions
Residential New Construction	$11.69	1,498,270	$17,521,959	$90,345,377
Small Heating and DHW	$10.82	3,269,084	$35,356,251	$202,608,043
Low Income Weatherization	$11.69	760,224	$8,890,666	$71,125,324
C&I New Construction	$9.03	1,008,134	$9,103,219	$46,544,297
C&I Existing Construction	$8.61	7,608,051	$65,484,340	$637,790,167
Food Service and Processing	$9.03	1,060,036	$9,571,889	$50,345,761
Total	**-**	**15,203,799**	**$145,928,324**	**$1,098,758,969**

Notes:

1. Data from NY Public Service Commission, "Average Annual Bill Data, Gas Companies, 2004." More current revenue and customer data was unavailable.
2. Small Heating and DHW (domestic hot water) program includes a combination of residential and commercial customers. C&I Existing Construction includes a combination of commercial and industrial customers.
3. Figures in nominal dollars based on 2004 rates. Not present valued.
4. Actual bill reductions are dependent on actual customer usage patterns and specific tariffs. These reflect approximate savings based on average revenue/Dth by class.
5. Because of recent increases in natural gas costs it is likely that total bill reductions will be larger.
6. Does not include bill savings from commodity price effects. Over the planning horizon, savings from cumulative commodity price effects from the program scenario are an additional $288 million (2005$). Therefore, ultimate total bill savings from both efficiency and price effects might be approximately $0.6 billion (0.3 + 0.3).

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E.1 PURPOSE AND CONTEXT OF STUDY

The New York State Energy Research and Development Authority (NYSERDA) commissioned this study of the potential for energy efficiency to displace natural gas consumption in New York. This study evaluates the potential to reduce gas consumption using existing and emerging efficiency technologies and practices, with the overall goal to lower end-use natural gas requirements in residential, commercial, and industrial facilities. The study assessed New York's gas efficiency potential for the 10-year period between 2007 and 2016.

The study had four main objectives:

- Evaluate the potential cost-effective natural gas efficiency savings (economic potential) in New York over a 10-year horizon (2007-2016)
- Evaluate natural gas efficiency program designs and recommend programs for implementation
- Estimate the potential cost-effective natural gas efficiency savings in New York over a 10-year horizon (2007-2016) from the implementation of a portfolio of recommended efficiency programs given a specified funding level (program scenario); the 10-year horizon includes program delivery for five years with five years of post-program market effects
- Develop a reference case natural gas price forecast and assess the potential impact of efficiency programs on natural gas prices.

The analysis indicates natural gas efficiency comprising approximately 28% of the 2016 forecasted load would be cost effective when compared to forecasted natural gas prices. The authors of the study suggest caution in interpreting and using the analysis. The economic potential estimates do not account for market barriers to adoption of efficiency technologies or the costs of market intervention strategies to overcome these barriers.

The analysis also identifies substantial opportunities for delivery of cost-effective efficiency programs. The authors again recommend caution when interpreting the program scenario results. The study recommends a set of efficiency programs that would optimize efficiency efforts, given specific funding constraints and various policy objectives. However, alternative cost-effective portfolios could be developed at funding levels other than those assumed in the study while satisfying policy constraints such as sector distribution, low income funding, and gas efficiency targets. The authors believe that, if fully understood, the economic potential and program scenario analyses could be useful to support ultimate decisions about future natural gas efficiency programs and spending.

E.2 STUDY SCOPE AND APPROACHES

The project scope called for analyses of “economic” and “program scenario” efficiency potential from natural gas efficiency technologies and practices among residential, commercial, and industrial facilities. These terms are defined below:

- **Economic Potential:** Economic potential refers to the total technical natural gas efficiency potential over the planning period from all measures that are cost effective, as compared with the avoided gas consumption valued at the forecasted natural gas supply costs. Economic potential does not take into account market barriers and costs of market intervention. Potential is defined as the additional savings over and above those expected to occur without gas program intervention.[1]
- **Program Scenario Potential:** Program scenario potential refers to the estimated maximum natural gas efficiency impacts over the planning period, given specific program designs and assumed funding levels. Program scenario potential considers economic and other barriers to efficiency adoption and specific funding and program strategies.

The study scope included all applicable natural gas efficiency technologies, with the exception of fuel switching, electricity generation measures, and combined heat and power technologies. The study analyzed more than 2,000 distinct efficiency measures, consisting of approximately 150 different technologies and practices applied to numerous facility types and markets (*e.g.*, new construction, major renovation, planned equipment replacement and remodeling, and early retirement of operating equipment and systems).

The study addressed efficiency potential from all natural gas end-users in the buildings sector. This includes firm and non-firm full service customers, as well as *transportation* customers that purchase gas supply from third parties but rely on local gas distribution companies (LDCs) for delivery.

E.2.1. Economic Potential Approach

The basic conceptual framework for the economic analysis involved ten steps:

- Developing a comprehensive list of efficiency technologies and practices
- Selecting efficiency technologies and practices for analysis based on an initial qualitative screening
- Characterizing the selected technologies and practices, including defining baseline and efficient levels, costs, savings, load shapes and measure lives
- Characterizing the existing and forecasted markets for each technology and practice, including identifying important industrial and commercial sectors, estimating and

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[1] The base case forecast and technology penetrations include effects from autonomous efficiency improvements that would result from natural market shifts, existing and expected codes and standards, and continuation of New York’s current level of investment in electric energy efficiency.

disaggregating sector-level gas sales by facility type and end use, quantifying housing units and equipment saturations, and forecasting new construction activity

- Estimating baseline penetrations among the existing and forecasted markets of standard efficiency technologies and practices, given likely natural efficiency gains, likely codes and standards, and existing New York electric efficiency programs
- Applying per unit efficient technology and practice characterizations and baseline penetration projections to the relevant existing and forecasted markets to arrive at net potential impacts and costs
- Developing avoided costs using a proprietary national gas supply-and-demand model for commodity costs and data for capacity peak storage, transmission, and distribution costs
- Screening efficiency measures for cost-effectiveness based on avoided cost estimates
- Removing all non-cost-effective measures
- Adjusting for mutually exclusive measures and interactions among measures.

The study relied on a variety of data to support the above approach, including: prior potential analyses; published research studies; equipment and market assessments; baseline studies; Consolidated Edison, Long Island Power Authority, Niagara Mohawk, New York Electric and Gas, New York Power Authority, New York Public Service Commission, NYSERDA, and Orange and Rockland data; engineering analyses; building simulation modeling; and personal communications with industry experts.

E.2.2. Economic Potential Results

The study concludes that the economic efficiency potential, if realized, could reduce New York's annual natural gas generation requirements by more than 282,000 thousand dekatherms (MDth) by 2016. This represents 28.3% of New York's forecast 2016 gas requirements to the residential, commercial and industrial sectors. The study also shows peak day economic potential of more than 2069 MDth in 2016. Figure E.1 illustrates how the economic potential could reduce forecasted loads. Theoretically, if all the cost-effective gas efficiency measures (*i.e.*, economic potential) are implemented, there would be no load growth during the planning period. In fact, if all the economic potential could be captured load growth would decline by an average 2.1% annual rate. The initial reduction in 2007 is because the economic potential reflects a snapshot of existing opportunities without regard for the need to ramp up program delivery to capture it. Therefore, the 2007 reduction represents early retirement opportunities that already exist.

Figure E.1. Gas Sales Forecast Minus Sector Energy Savings (Economic Potential)

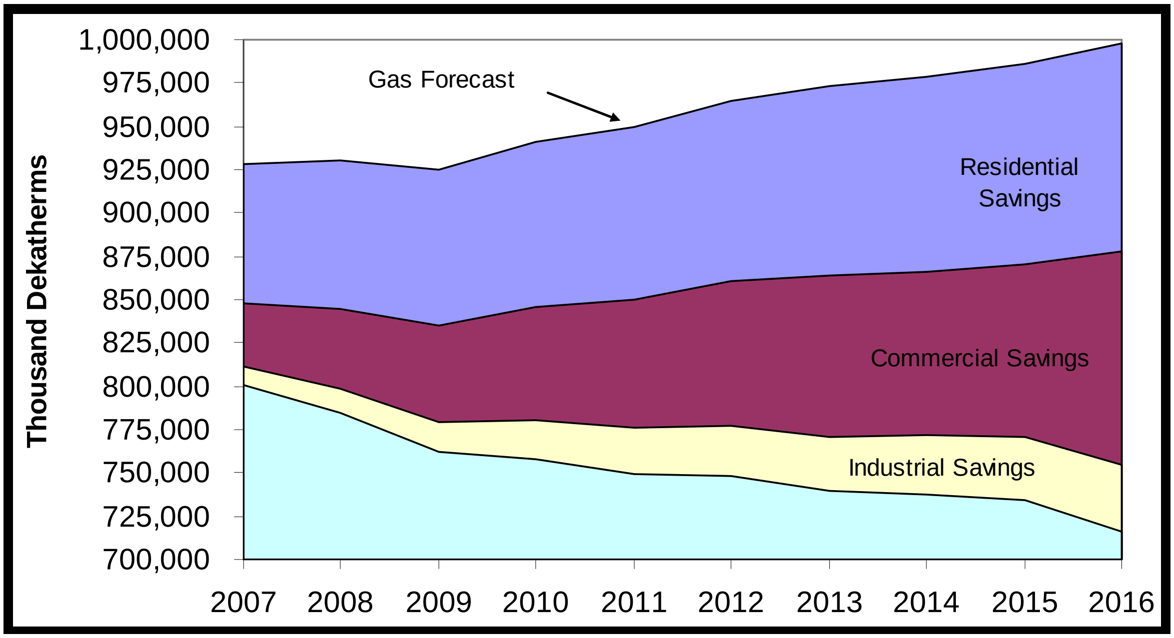
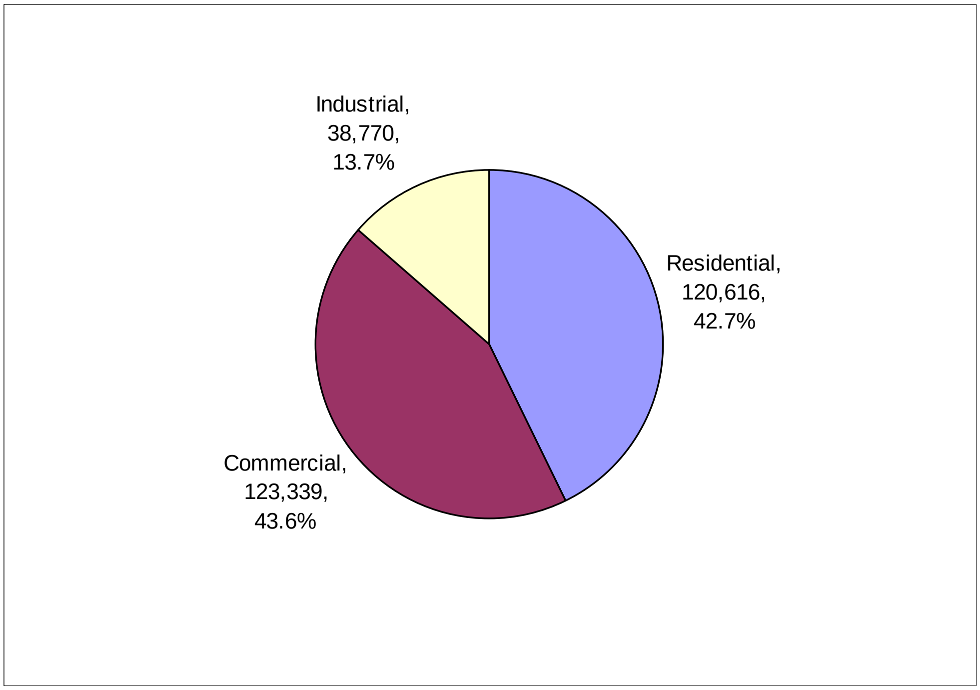


Figure E.2 shows that 2016 energy savings for the commercial sector are slightly more than savings for the residential sector, with 13.7% of savings attributable to the industrial sector. The greatest opportunities for efficiency are in space heating, followed by domestic water heating, service technologies, and food production.

Figure E.2. Economic Potential by 2016 by Sector (MDth and Percent of Total Savings)



The economic potential, if captured, would be extremely cost-effective. Present value net benefits, in 2005 dollars using reference case avoided costs, would be $26.4 billion. In other words, the economic welfare in New York would be improved by this amount if economic potential could be captured with no additional program costs.[2] The overall benefit-cost ratio (BCR) is 2.90. The results are based on a total resource cost (TRC) test that considers all the benefits and costs of efficiency from a societal perspective. The TRC test does not, however, include any monetized values for externalities. Table E.1 shows the TRC economic results.[3] As a sensitivity analysis, the study shows a reference case as well as low and high gas avoided cost scenarios. The low and high scenarios assume gas avoided costs of 25% less than and greater than the reference case avoided cost estimates. Under the reference case, the commercial sector would provide about 55% of the total net benefits and has the highest benefit-cost ratio, at 3.85.

Table E.1. Economic Potential, Total Resource Net Benefits and Benefit-Cost Ratio, by 2016

Avoided Cost Scenario	Sector	Gross Benefits ($Million)	Costs ($Million)	Net Benefits* ($Million)	B/C Ratio**
Reference Case	Residential	$18,212	$7,909	$10,303	2.30
	Commercial	$19,698	$5,112	$14,586	3.85
	Industrial	$2,378	$892	$1,487	2.67
	Total	**$40,289**	**$13,913**	**$26,376**	**2.90**
Low Avoided Costs	Residential	$13,072	$6,228	$6,844	2.10
	Commercial	$15,643	$4,751	$10,892	3.29
	Industrial	$1,784	$892	$892	2.00
	Total	**$30,499**	**$11,871**	**$18,628**	**2.57**
High Avoided Costs	Residential	$22,590	$8,329	$14,261	2.71
	Commercial	$23,929	$5,540	$18,389	4.32
	Industrial	$2,973	$892	$2,081	3.33
	Total	**$49,492**	**$14,762**	**$34,731**	**3.35**

* Net Benefits = Benefits minus costs, present worth 2005$

** B/C Ratio = Gross Benefits/Costs

When considering the overall levelized cost of saved energy, the economic potential costs, excluding program design costs, would be $2.47 per dekatherm downstate, and $3.86 per dekatherm upstate, which are considerably lower than current avoided costs.[4] The economic potential, if captured, would also result in lifetime reductions of 329 million metric tons of CO_2, 90 thousand metric tons of SO_2, and 44 thousand metric tons of NOx. The potential CO_2 reduction

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[2] Note that it would take significant effort and program intervention costs to capture a large portion of the economic potential and, even then, 100% would not be achievable.

[3] The table and figure titles in this report use "2016" to indicate that the table's values are those that would occur in 2016 from all program or potential activity in the 2007-2016 analysis period.

[4] Levelized costs are estimated separately for downstate and upstate because each region was modeled separately.

represents 5.7% of total 2016 forecast New York CO_2 emissions.[5] Finally, capture of economic potential would result in annual customer bill savings in 2016 of approximately $2.8 billion, based on 2004 average gas rates, and not including any price effects from the efficiency potential.

E.2.3. Program Scenario Potential Approach

The program scenario potential considers economic and other barriers to efficiency adoption, relying on past experiences of exemplary gas and electric efficiency programs. The assessment of the program scenario potential assumes five years of program delivery at an average budget of $80 million per year, with five years of post-program market effects. Neither NYSERDA nor the authors intend the selected funding level to represent a recommendation for future gas program funding. Rather, the funding level was established by NYSERDA to inform future discussions about appropriate funding levels and program portfolios.

Development of Program Portfolio

In developing a program portfolio, the study sought to meet certain criteria, including: maintaining equity across sectors by matching sector-level spending to existing sector revenues; providing low-income services, set at 50% of the residential budget; and providing a balance between short-term resource acquisition efforts and long-term market-transformation benefits. In addition, the study sought to provide program services targeting all New York gas customers and to address all important end uses. Finally, the study explicitly designed the recommended programs around broad markets, rather than specific customers and technology types. In other words, the study designed programs that would comprehensively address multiple opportunities and customer types, with strategies and services designed around specific market and supply channels to reflect the way transactions typically occur in the marketplace.

Central to the approach and the focus on comprehensively addressing each market in the context of its unique characteristics, the study indicates the most successful and cost-effective approach to delivering gas programs in New York is to integrate them with electric efficiency services. To that end, an integrated delivery of fuel-neutral, one-stop-shopping programs to combined gas and electric customers was assumed.[6] The budgets and penetration rates presented reflect this assumption. The study did not, however, attempt to redesign, restructure, or analyze the existing electric programs. However, the current broad array of electric programs addresses all the same markets and service categories that are proposed here.

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[5] Center for Clean Air Policy, *Recommendations to Governor Pataki for Reducing New York State Greenhouse Gas Emissions,* April 2003, Interpolation from Table ES-1, p. ES-4.

[6] This approach assumed that electric customers who do not purchase gas would not contribute financially to the gas portion of programs, nor would they benefit from the gas services.

Developing the optimized investment portfolio included:

- Reviewing NYSERDA and other existing electric and gas programs in New York
- Reviewing exemplary gas programs throughout the country
- Identifying the strategies and services that have been central to the success of gas and electric efficiency programs in New York and other jurisdictions
- Assessing the economic potential results and identifying where the most important opportunities exist in terms of end uses, markets, customer types, and technologies
- Selecting a small set of broad-based programs designed to address key markets and take full advantage of the lessons learned from the implementation of exemplary programs reviewed for the study

The selected investment portfolio includes six programs:

Cross-Sector

- Small heating and domestic hot water (DHW) equipment

Residential

- New construction (ENERGY STAR® Homes)
- Low-income weatherization

Commercial / Industrial

- New construction
- Existing construction
- Food service and processing

Program Scenario Potential Savings Analysis

The starting point for analyzing the savings and costs resulting from implementing the program scenario is the economic potential described in the previous section. The following steps were used to estimate the program scenario potential:

- Mapping each measure permutation (combination of technology, market, and facility type) to a program
- Estimating the future market acceptance of each efficiency measure based on anticipated market intervention policies and programs.
- Applying the future measure penetrations to the economic potential analysis results to yield annual measure costs and savings
- Developing non-measure program budgets (costs for all program activities except measure incentives) that reflect the costs of delivering the programs, assuming integration with electric programs
- Developing program incentive costs based on program design features and estimated measure costs
- Analyzing the portfolio of programs to develop estimates of overall costs, benefits, net benefits, and benefit-cost ratios

E.2.4. Program Scenario Results

Based on the funding and policy criteria constraints described above, annual program scenario savings are estimated at 15,204 MDth by 2016, and peak day load reductions are estimated at 100 MDth. These savings represent 1.5% of forecasted 2016 gas requirements. These estimates are based on programs operating for five years. If programs were to continue for a full 10-year period, savings by 2016 would be significantly higher. Figure E.3 shows program scenario potential by program. Neither the authors nor NYSERDA make any representations as to whether this funding level is appropriate. The scenario is presented to inform decision makers about the types of recommended programs and the overall gas efficiency cost-effectiveness at a sample level of spending.

The program scenario is highly cost-effective. Pursuit of the program scenario would result in estimated net benefits to the economy of $1.1 billion, with an overall benefit-cost ratio of 2.48 under the reference case scenario. In other words, for every dollar invested in efficiency $2.48 would be returned to the New York economy. The largest net benefits would come from the C&I Existing Construction and the Small Heating and DHW programs. Substantial net benefits would also come from the C&I New Construction and the Residential New Construction programs. Table E.2 shows economic results by program.

The levelized cost of saved energy (CSE) for the program scenario is $3.42 per dekatherm downstate and $4.47 per dekatherm upstate, which are considerably lower than current avoided costs. The program scenario would also result in lifetime reductions of 16 million metric tons of CO_2, 2,000 metric tons of SO_2, and 1,800 metric tons of NO_x. Finally, customer bill savings thru 2016 would be $293 million, based on 2004 average gas rates, and not including any price effects from implementation of the program scenario.

Figure E.3. Program Scenario Cumulative Gas Savings by Program (MDth and % of Total Savings) by 2016

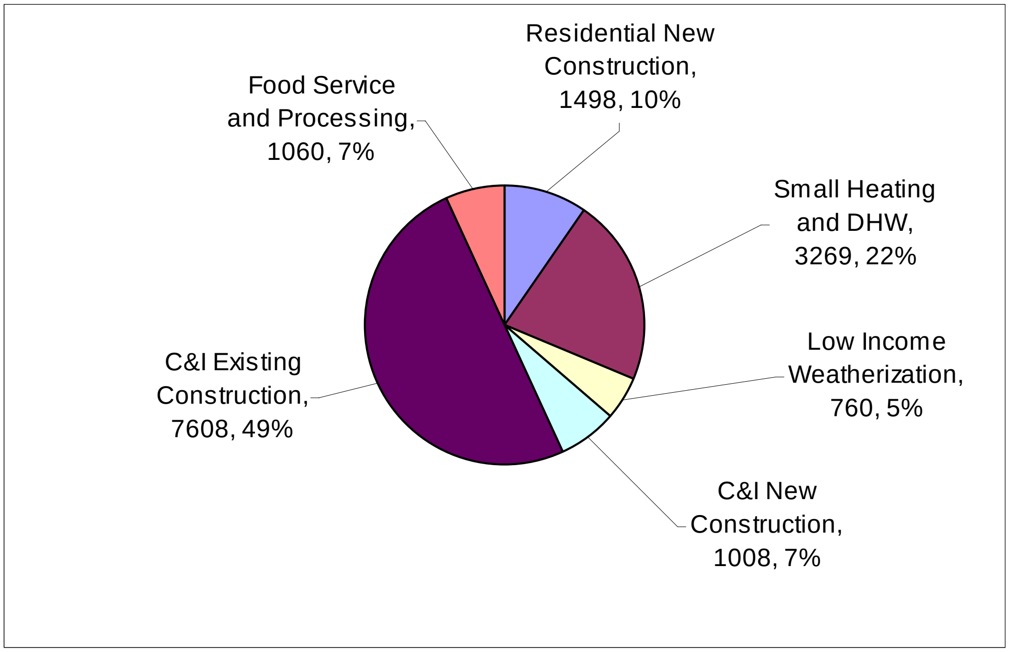

Table E.2. Program Scenario Total Resource Present Value Net Benefits by 2016, Not Including Price Effects

Proposed Program	**Reference Case**			**Low Avoided Costs**			**High Avoided Costs**		
	Net Benefits ($Million)	**% of Total**	**BCR**	**Net Benefits ($Million)**	**% of Total**	**BCR**	**Net Benefits ($Million)**	**% of Total**	**BCR**
Residential New Construction	$141	12.6%	3.06	$93	14.7%	3.20	$170	11.9%	3.68
Small Heating and DHW	$226	20.2%	2.40	$75	11.8%	1.52	$227	15.9%	2.40
Low Income Weatherization	$42	3.8%	1.70	$15	2.4%	1.36	$54	3.8%	1.90
C&I New Construction	$112	10.0%	2.52	$75	11.9%	2.01	$150	10.5%	3.02
C&I Existing Construction	$553	49.4%	2.53	$343	54.4%	1.95	$764	53.6%	3.12
Food Service and Processing	$45	4.0%	2.43	$30	4.7%	1.95	$60	4.2%	2.91
Total Programs	**$1,119**	**100.0%**	**2.48**	**$630**	**100.0%**	**1.91**	**$1,424**	**100.0%**	**2.89**

Note: Net benefits = gross benefits minus costs, present value 2005$. BCR = benefit/cost ratio = gross benefits / costs.

E.3 CONSUMER GAS PRICE EFFECTS OF EFFICIENCY

The analysis included an estimate of the downward pressure on commodity prices from reduced demand by the program scenario savings. Because gas supply is somewhat constrained and expected to remain so, small reductions in demand can result in small reductions in the market clearing commodity price, resulting in significant overall benefits to all gas consumers beyond those captured from program participants directly through reduced energy use. The *total* consumer commodity cost savings from the program scenario have two components: 1) the savings resulting from lower commodity prices (price effect); and 2) result of lower commodity *usage* because of energy savings (energy savings).

The average estimated commodity price decrease from 2007-2016 from the program scenario would be approximately 0.2% of commodity costs. This would result in total present value (2005$) New York gas consumer commodity price savings of $500 million for price effects through 2025.[7] Including these price effects in the economic analysis, shown above in Table E.2, the program scenario TRC benefits would be $2.4 billion, net benefits $1.6 billion, and a benefit-cost ratio (BCR) of 3.14.[8]

Average annual commodity price savings from price effects alone (in 2005$) during the planning horizon (2007-2016) would be $29 million/yr.[9] Total 2016 cumulative consumer commodity price savings from price effects alone (in 2005$) would be approximately $288 million from the program scenario. Table E.3 below shows price effects in 2005 dollars for the planning period.

Table E.3. Annual Price Effects 2007 – 2016, $Million

Sector	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total 2007-2016	Average Annual 2007 -2016	Average Consumer Cost Savings as a Percent of Costs
Residential	2	6	6	6	7	9	8	8	7	10	69	7	0.1%
Commercial	2	6	6	5	8	8	7	8	7	10	66	7	0.2%
Industrial	1	3	3	3	4	5	4	4	4	6	36	4	0.2%
Power Generation	3	7	8	10	16	16	11	14	12	19	116	12	0.3%
Total	**9**	**22**	**22**	**24**	**35**	**38**	**29**	**33**	**30**	**44**	**288**	**29**	**0.2%**

When considering the *total* consumer commodity cost savings resulting from both lower commodity prices and lower total gas consumption, the total savings over the planning horizon

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[7] The $500 million present value consumer savings reflect only the effect of lower prices, and do not include the consumer savings resulting from the fact that gas consumption would also be lower than if the program scenario were not pursued.

[8] Note that the New York Public Service Commission in its March 16, 2006 Order in Case 04-E-0572 has questioned whether price effects should be counted in TRC analyses.

[9] While the program scenario only analyzes impacts through 2016, these savings will continue for the life of the efficiency measures and result in continued price effects beyond 2016.

(2007-2016) would be $1.3 billion (2005$). Note that this is not the same as total bill reductions, which would be based on retail rates that include contributions to transmission and distribution costs as well as commodity costs. Total bill reductions are estimated separately above based on 2004 retail rates.

1. INTRODUCTION

1.1. PURPOSE AND CONTEXT OF STUDY

The New York State Energy Research and Development Authority (NYSERDA) commissioned this study of the potential for energy efficiency to displace natural gas consumption statewide in New York. The study examines the potential of existing and emerging efficiency technologies and practices to lower end-use natural gas requirements in residential, commercial, and industrial facilities. The study assessed gas efficiency potential statewide over ten years from 2007 through 2016.

The study had four main objectives:

- Evaluate the potential cost-effective natural gas efficiency savings (economic potential) in New York over a 10-year horizon (2007-2016);
- Examine natural gas efficiency program designs and suggest programs for implementation;
- Estimate the potential achievable cost-effective natural gas efficiency savings in New York over a 10-year horizon (2007-2016) from delivery of a portfolio of suggested efficiency programs and a target funding level (program scenario), based on program delivery for five years with five years of post-program market effects; and
- Develop a reference case natural gas price forecast and consider the potential impact of efficiency programs on natural gas prices.

The study identified significant efficiency resources that would be economical compared to forecasted gas supply costs. The study authors suggest caution in interpreting and using this analysis. The economic potential estimate *does not* account for the market barriers to adoption of efficiency technologies *nor* the costs of market intervention strategies to overcome these barriers. However, the economic potential does provide an upper bound of available efficiency opportunities that can be targeted. The economic potential analysis also serves as a starting point from which the program scenario assessment was developed.

The study also estimates substantial opportunities for delivery of cost-effective efficiency programs. Again, caution should be used in interpreting the program scenario results. The study identifies a set of efficiency programs that would optimize efficiency efforts given specific funding constraints and various policy objectives. Cost-effective portfolios could be devised with significantly larger or smaller funding levels and optimized to both these different levels and different policy constraints. However, given a full understanding, the economic potential and program scenario analyses are useful to support decisions about future natural gas efficiency programs and spending.

1.2. SUMMARY OF SCOPE AND FINDINGS OF PROJECT

The project scope called for analysis of both "economic" and a "program scenario" efficiency potential from natural gas efficiency technologies and practices among residential, commercial, and industrial facilities. These terms are defined below:

- **Economic Potential:** Economic potential refers to the total natural gas efficiency potential over the planning period from all measures that are cost-effective, as compared to the avoided gas consumption valued at the forecasted natural gas supply costs and other direct benefits (*e.g.*, electricity and water savings). It does not take into account market barriers or the cost of market intervention. Potential is defined as additional savings over and above what is currently expected to occur without a gas program intervention.[10]
- **Program Scenario Potential:** Program Scenario potential refers to the estimated maximum natural gas efficiency impacts over the planning period, given specific program designs and assumed funding levels. The program scenario considers economic and other barriers to efficiency adoption, as well as the specific funding and program strategies.

The analysis includes all New York gas ratepayers, and assumes for the program scenario that all ratepayers would contribute to program funding and be eligible to participate. Full-service customers of the local gas distribution companies and transportation customers purchasing gas from third parties are included.[11] Also included are firm and non-firm customers. The study scope included all applicable natural gas efficiency technologies, with the exception of fuel switching, electricity generation, and combined heat and power technologies.

Figure 1.1 shows the overall flow of the project. The first step was to model the current and forecast natural gas loads and prices. This provided a basis for characterizing the new construction growth and the size of the loads that efficiency could come from. The price forecast was used to feed into the avoided cost analysis and for modeling price effects from the program scenario. Avoided costs were used to value efficiency and determine cost-effectiveness. The economic potential analysis then used these inputs, along with data on the distribution of loads by building type and end use, and on technologies, to develop potential estimates and screen measures for cost-effectiveness. The program scenario involved development of programs after consideration of the economic potential results and review of successful programs in North America. Mapping measures and penetrations to these programs provided results of the program scenario. Finally, price effects were modeled based on the reference case price forecast and results of the program scenario. The project flow diagram is repeated in each section with appropriate shading to show how each sub-task relates to the overall project.

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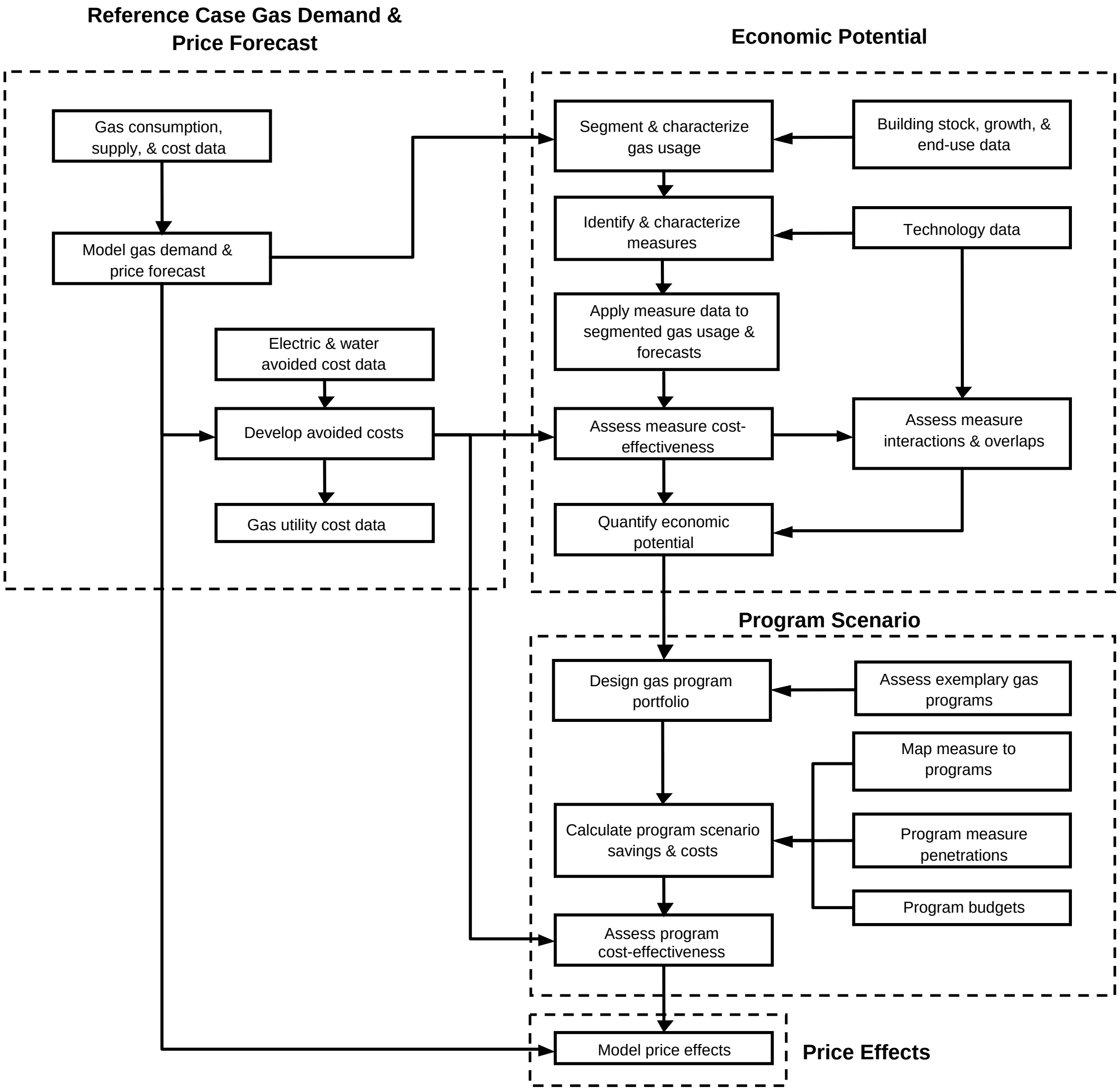
[10] The base-case forecast and technology penetrations include effects from autonomous efficiency improvements that would result from natural market shifts, existing and expected codes and standards, and continuation of New York's current level of investment in electric energy efficiency.

Figure 1.1. Project Flow



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[11] Note that inclusion of transportation customers is different from a similar study recently completed by the authors for Consolidated Edison of New York's service area, which only addressed full service (*i.e.*, not transportation) gas customers.

The analysis shows the economic efficiency potential could reduce statewide annual natural gas requirements by over 282,000 thousand dekatherm (MDth) by 2016. This represents 28.3% of forecast statewide 2016 gas requirements. The study also shows peak day economic potential of more than 2069 MDth in 2016. Figure 1.2 shows energy savings for the commercial sector are slightly more than that of the residential sector, with 13.7% of savings attributable to the industrial sector.[12] Figure 1.3 shows the breakout of the savings as a portion of the 2016 forecast sales.

The program scenario was optimized based on an average program funding level of $80 million per year over five years. The analysis assumes that all gas ratepayers in New York pay into the program funding and are all eligible to participate in programs. Spending was allocated to each sector proportional to the sector level gas consumption statewide. Low-income was allocated 50% of residential funding. Based on these assumptions, estimated program scenario savings by 2016 are 15,204 MDth/yr and peak day load reductions are 100 MDth. Program scenario savings represent 1.5% of 2016 forecast gas requirements. Figure 1.4 shows the program scenario potential by program. Neither the authors nor NYSERDA make any representations as to whether the assumed funding level is an appropriate. Rather, the funding level serves as a sample level of spending to inform decision-makers as to the types of suggested programs and the overall cost-effectiveness given this funding level. Section 2.4.6 discusses options and likely impacts for both ramping up or down funding levels from $80 Million per year.

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[12] The table and figure titles in this report use “2016” or “by 2016” to indicate that the table’s values are those that would occur in 2016 resulting from all program or potential activity in the 2007-2016 analysis period.

Figure 1.2. Economic Potential, by Sector (MDth and % of Total Savings) by 2016

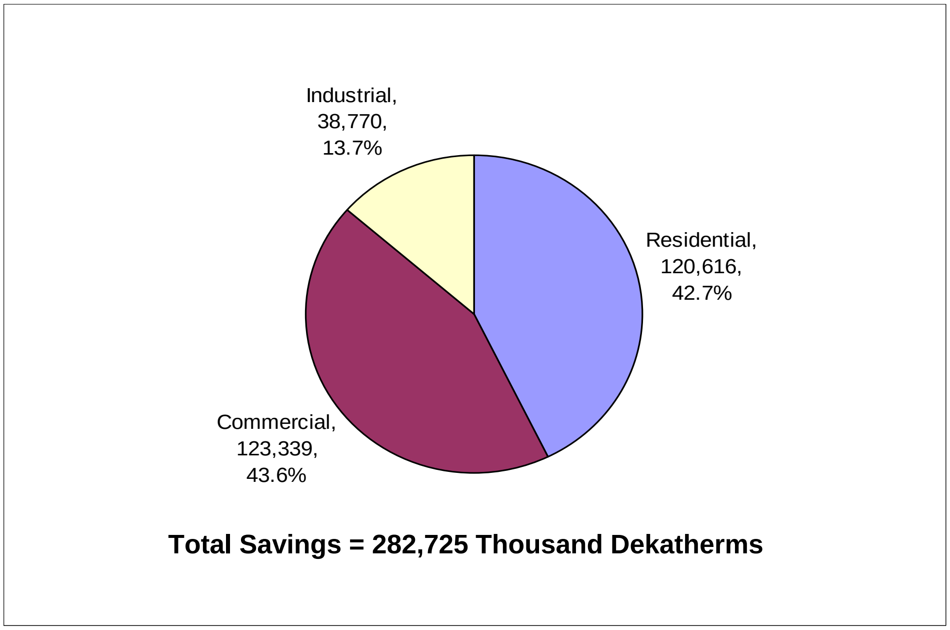


Figure 1.3. Economic Potential, by Sector (% of Total Forecast Gas Usage) by 2016

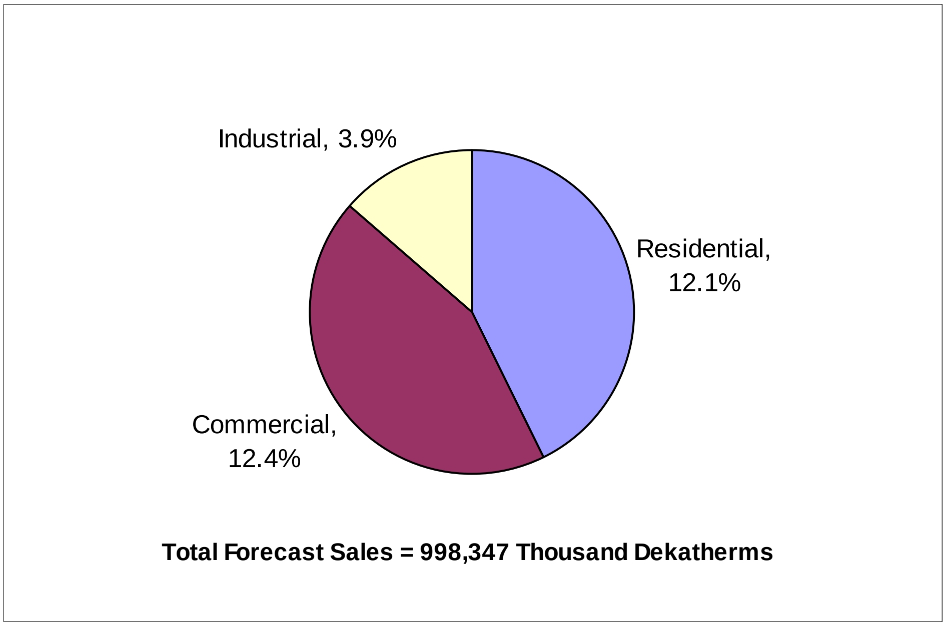
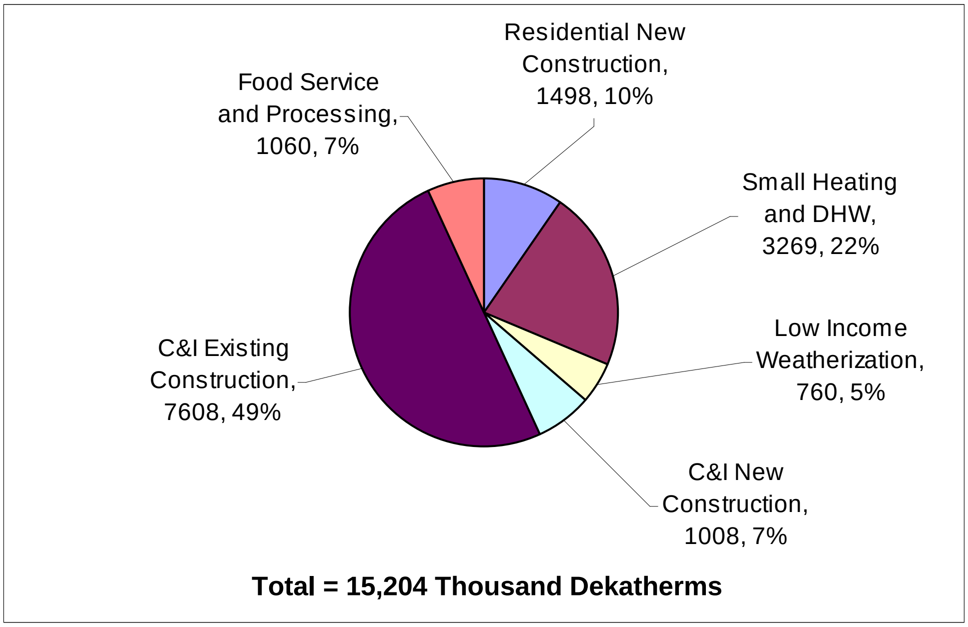


Figure 1.4. Program Scenario Potential, by Program (MDth and % of Total) by 2016



1.3. REPORT ORGANIZATION

The remainder of the report is organized in five sections as follows:

- *Section 2: Summary of Approach and Results* describes the study's analytical approach, major assumptions, and provides an overview of analysis results
- *Section 3: Gas Sales and Price Forecast* details the reference case model and results of forecasted gas sales and prices, as well as describes the methodology and results of the avoided cost analysis
- *Section 4: Economic Potential* describes the analytical approach and major assumptions used for estimating economic potential and provides detailed results
- *Section 5: Program Scenario Potential* provides a discussion of successful gas programs nationally, the methods used for developing the recommended program portfolio, program design summaries, implementation recommendations, and discussion of methods and results for the program scenario potential analysis
- *Section 6: Consumer Price Effects of Energy Efficiency in New York* describes the impact on gas prices of demand reduction resulting from the program scenario

In addition, the following appendices are provided:

A. Residential Analysis Data Inputs and Results

B. Commercial Downstate Analysis Data Inputs and Results

C. Commercial Upstate Analysis Data Inputs and Results

D. List of Industrial Measures

E. References

F. Glossary

2. SUMMARY OF APPROACH AND RESULTS

2.1. SCOPE OF ANALYSIS

As described above, the study analyzed economic potential and a program scenario potential statewide. The analysis covered gas efficiency measures in all sectors, markets, and end uses, with the exception of fuel switching, electricity generation, and combined heat and power technologies. The study considered technologies and practices that are widely available commercially, and emerging technologies expected to become available at cost-effective levels within the next five years. The analysis covers the 10-year period from 2007 to 2016. Economic potential results are presented in annual and peak-day dekatherm (Dth) impacts only for 2016 because the annual pattern of potential is somewhat arbitrary, and dependent on the order different markets are selected. See Section 2.3 below for details. Program scenario potential results are presented for each year of the analysis, assuming five years of program delivery and five years of post-program market effects.

For the residential and commercial sectors, the study analyzed technologies based on different markets. Markets are defined here to refer to events that might precipitate investments in efficiency measures and/or distinct market channels that would dictate different programmatic approaches. The broadest market distinctions are between discretionary decisions to retire functioning equipment early purely for energy efficiency reasons (retrofit) and incremental efficiency improvements in already planned investments (market-driven or lost opportunity). Analyzing efficiency technologies individually for these two categories is essential. Pursuit of retrofit investments requires paying the full cost of new measures, including labor and equipment costs. Retrofit measure initial savings are typically larger than those for market-driven measures because the existing stock of equipment being replaced is generally less efficient than the standard practice baseline equipment that would be purchased today. However, savings drop over time.[13] Conversely, pursuit of market-driven investments requires paying only the additional incremental cost of the efficient equipment compared with purchasing new standard (baseline) efficiency equipment. The incremental cost typically is a small fraction of the total installation cost, and often there is no incremental labor cost. Similarly, market-driven measure savings are based only on the incremental efficiency improvement as compared to what a building owner would have installed in the absence of an efficiency program.[14]

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[13] For retrofit measures, the analysis quantifies both the short-term savings based on improvements over existing equipment efficiencies and long-term savings that result because a building owner would have naturally replaced the old existing equipment at some point during the new efficiency measures lifetime, thereby reducing measure savings. The analysis assumes existing equipment that is retired early is, on average, halfway through its estimated measure life.

[14] A continuum exists from pure discretionary retrofit measures to pure market-driven measures, and classifying opportunities as one or the other when implementing programs is often difficult. However, for analysis purposes, these distinctions are critical and represent average investment decisions.

Market-driven markets are further broken down into new construction, major renovation, planned replacement at time of equipment failure or remodeling, and retail product sales. The first three market categories are treated differently to properly account for the timing and magnitude of efficiency opportunities in each market. The latter category is treated separately primarily because the market channels for retail products, such as residential clothes washers, dryers, and other homeowner installed measures, require different program strategies, including upstream efforts with manufacturers and vendors.

The study examined thousands of efficiency applications for different types of buildings, industries, and markets. Table 2.1 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 2.1 shows that the study examined 40 technologies and practices applicable to six end-use categories in four markets involving ten building types. Overall, the commercial efficiency potential analysis dealt with 980 technology and practice applications.[15]

The multifamily segment was disaggregated into two groups: larger multifamily buildings with central heating and domestic hot water systems (master-metered); and multifamily buildings with decentralized systems and individual tenant meters (individually-metered). The larger multifamily buildings with central systems were characterized using the commercial sector methodology and analysis because the efficiency opportunities most closely resemble those of other commercial opportunities. In addition, the program scenario anticipates treatment of these large, central systems under the commercial and industrial program offerings. For the economic potential results, however, all multifamily is reported within the residential sector.

Several caveats about the use of this study are important, and summarized here:

- It would be a mistake to confuse economic potential with other types of potential analysis. Economic potential is not program or achievable potential, and therefore it should not be assumed that 100% of efficiency resources statewide could be realized through policy or program initiatives. Doing so would be a misuse of this study. Economic potential ignores the many barriers that exist to capturing adoption of efficiency measures and also ignores the programmatic costs necessary to overcome those barriers. It essentially represents an upper bound estimate of the available efficiency opportunities that could be pursued and is the basis from which the program scenario estimates are developed. Economic potential analyses are often used to inform other analyses and decisions of policy, program, and resource options. While not originally part of the scope of this project, an estimate is provided below (Section 2.4.6) of the likely maximum achievable potential which could be captured through aggressive, well designed initiatives.

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[15] Note that not all technologies apply to all building types or markets. For example, retrocommissioning only applies to existing buildings.

Table 2.1. Technologies and Practices Examined in the Efficiency Potential Analysis[16]

	SECTOR:		
	RESIDENTIAL	**COMMERCIAL**	**INDUSTRIAL**
Number of Technologies	**36**	**40**	**16**
Markets	New Construction	New Construction	New Construction
	Retail Product Sales	Renovation	Process Overhaul / Replacement
	Retrofit	Remodel / Replacement	Retrofit
		Retrofit	
End Uses	Envelope	Space Heating	Steam
	Heating, Ventilating & Air Conditioning (HVAC)	Water Heating	Hot Water
	Domestic Hot Water (DHW)	Cooling	Space Heating
	Laundry	Cooking	Direct Process Heating
	Miscellaneous	Whole Building	
		Miscellaneous	
Market Segments	**2 Building Types:**	**10 Building Types:**	**9 Industrial Sub-Sectors:**
	Single Family	Education	Chemicals
	Multifamily	Grocery	Primary Metals
		Health	Food
		Lodging	Paper
		Multifamily (with central systems)	Nonmetallic Minerals
		Office	Fabricated Metals
		Restaurant	Pharmaceuticals
		Retail	Transportation Equipment
		Warehouse	Other
		Other	

- The study is not a detailed program plan for acquiring energy efficiency resources to meet specific gas resource requirements. While this study is intended to contribute to such analyses in the future, it is not a substitute for them. The program scenario develops a portfolio of programs designed to optimize various constraints based on a set funding level averaging $80 million per year over five years. Modifying this funding level, either up or down, would result in a different optimal allocation of spending and different cost-effectiveness, as savings and program spending are not linearly correlated, and all programs are not easily or infinitely scalable. Neither the authors nor NYSERDA make any representation that this funding level is the appropriate level given various issues that policymakers should consider. The funding level analyzed represents approximately

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[16] While the disaggregated energy consumption of the industrial sector in New York was examined for each major sub-sector, the measures were analyzed only on a total end-use basis. The savings potential was not calculated on the industrial sub-sector level.

0.75% of 2004 gas revenues. This funding level serves as a starting point for consideration of ultimate funding levels and programs that might be pursued. Section 2.4.6 provides some guidance on modifications if funding levels significantly higher or lower than $80 million per year were selected.

- The economic potential for efficiency resources are somewhat dependent on the level of avoided costs.[17] The study concludes that the analysis probably understates the true economic value of gas potential from efficiency technologies, because of the omission of several additional beneficial effects of efficiency not included in avoided cost estimates. In particular, the avoided costs used to value gas resources in this study exclude:
    - ♦ *Avoided environmental externalities.* While the report presents estimated physical reductions in CO_2, SO_2 and NOx, the study did not monetize these impacts. In other words, the study did not consider the societal economic value from reductions in environmental emissions.
    - ♦ *Economic development impacts.* The net benefits from efficiency which stimulate economic activity, thus increasing the gross state product, were not included.
    - ♦ *Hard to quantify non-energy benefits.* While the analysis did quantify additional resource impacts (electricity and water), as well as changes in operations and maintenance costs, it did not address other significant benefits that often result from improved efficiency, such as productivity improvements, health and safety, and comfort.

2.2. REFERENCE CASE GAS SALES AND PRICE FORECAST

Energy and Environmental Analysis, Inc. (EEA) developed a reference forecast of the wholesale prices of natural gas for the downstate region including New York City, Long Island, and Orange, Rockland and Westchester Counties, and for the upstate region encompassing the rest of New York, see Figure 2.1. These prices reflect the forecasted North American wholesale price as referenced at the Henry Hub in Louisiana with transportation and congestion charges applied. As Figure 2.1 indicates, prices are projected to continue to remain high over the next few years before peaking in 2008, and then declining somewhat over the next decade, though continuing to remain at a level significantly higher than experienced during the 1990s.

The study also developed a reference projection of natural gas usage by sector for both upstate and downstate. In the reference case, New York annual gas consumption is forecast to grow by over 500 billion cubic feet (Bcf) by 2025 to 1.7 trillion cubic feet (Tcf), see Figure 2.2. The forecast annual average growth rate from 2005 to 2025 is 1.7%. In particular, gas consumption in the power sector will grow substantially, accounting for 80% of the growth in natural gas consumption through 2025, continuing a trend begun in the late 1990s. Power generation 2005 – 2025 average

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[17] The study estimated the sensitivity to avoided costs under both a low and a high avoided cost scenario (25% less than and greater than the reference case avoided costs). The report shows changes in overall potential are not very sensitive to changes in avoided costs through this range of avoided costs.

annual growth is 4.0%. This trend is expected to continue in spite of forecasts of high natural gas prices because of the growing demand for electricity in the State and the pressures of stringent environmental regulations. Nearly 60% of the growth in gas consumption from 2005 to 2025 for New York is concentrated in New York City and Long Island, mainly due to increased consumption in the power generation sector in that area. Most of this growth in power generation gas consumption occurs before 2015.

Figure 2.1. Historical and Reference Forecast Average Annual Wholesale Natural Gas Prices for New York

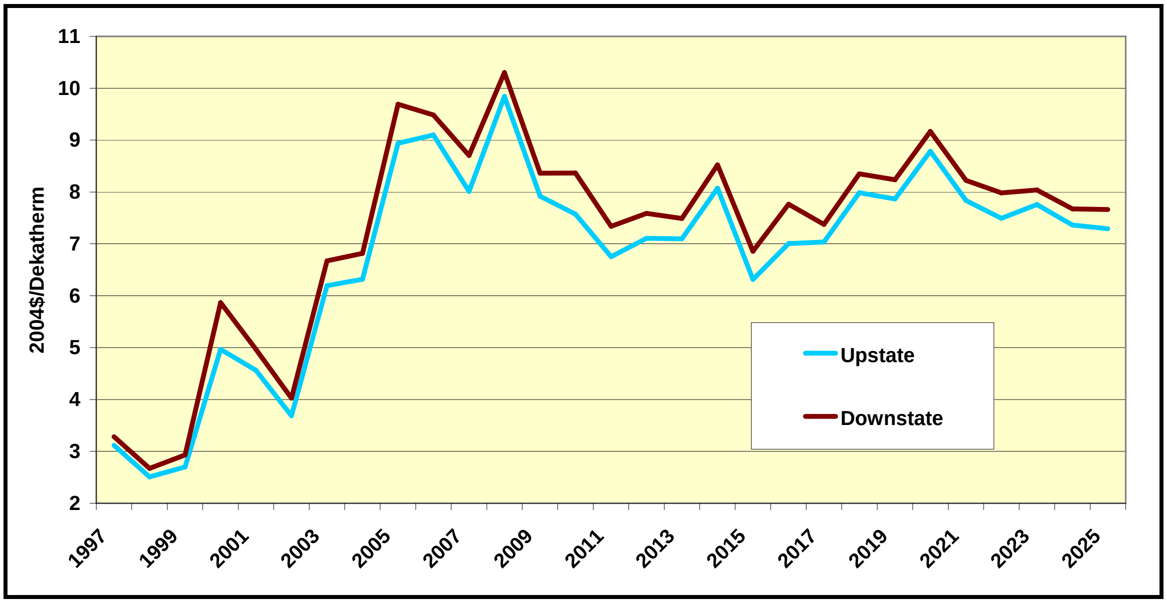
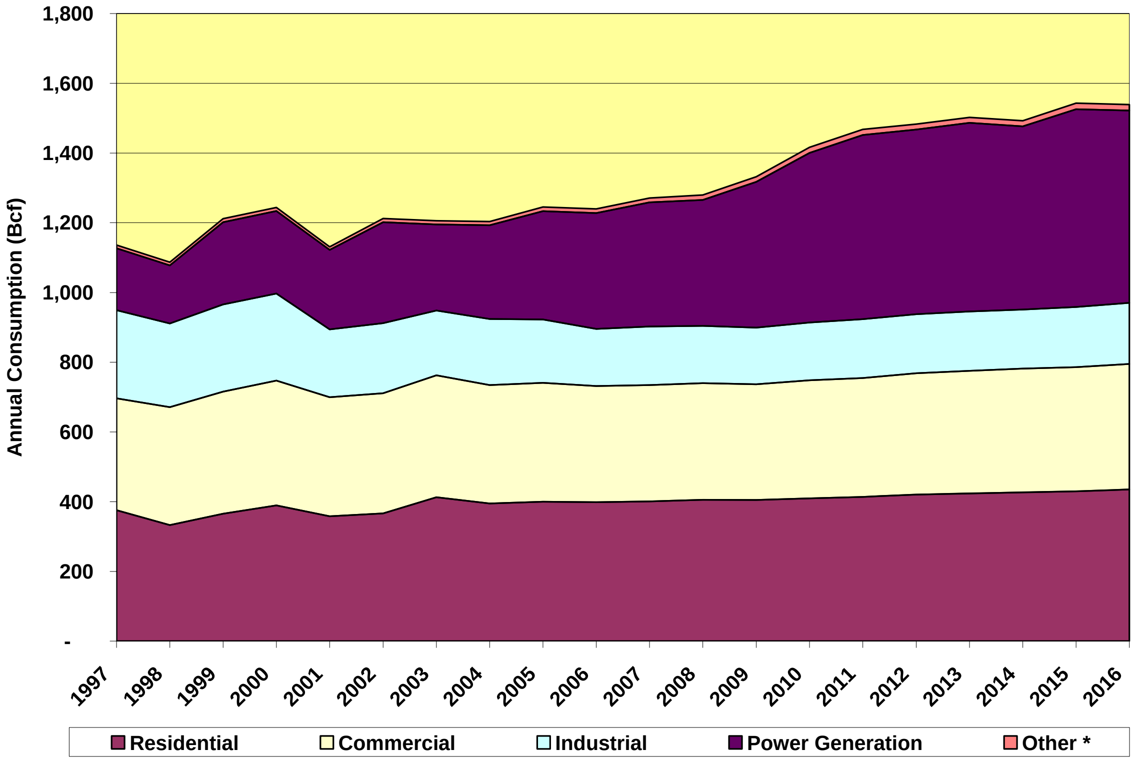


Figure 2.2. Projected Growth in N.Y. State Natural Gas Consumption by Market Segment



[*] Other includes lease and plant fuel (natural gas used in well, field, lease operations and as fuel in natural gas processing plants) and fuel consumed in transmission pipeline pumping.

2.3. ECONOMIC POTENTIAL ANALYSIS

2.3.1. <u>Savings Estimation Approach</u>

This study defines the economic potential for efficiency as the total gas efficiency potential over the planning period from all measures that are cost-effective, based on estimated avoided supply costs; as compared to the reference case forecast assuming no gas programs (but including some gas impacts from existing electric programs). Priority is given to market-driven opportunities. In other words, for measures analyzed from both a retrofit and market-driven perspective, all available market-driven opportunities are assumed to be installed in each year, at the time of planned investment. The remaining opportunities are then captured as retrofit measures in 2016.[18]

The basic conceptual framework for the economic analysis involved 10 steps:

- Developing a comprehensive list of efficiency technologies and practices
- Selecting final efficiency technologies and practices for analysis based on an initial qualitative screening
- Characterizing selected technologies and practices, including defining baseline and efficient levels, costs, savings, and measure life
- Characterizing the existing and forecasted markets for each technology and practice, including identifying important industrial and commercial sectors, estimating and disaggregating sector-level gas sales by facility type and end use, quantifying housing units and equipment saturations, and forecasting new construction activity
- Estimating baseline penetrations among the existing and forecasted markets of standard efficiency technologies and practices, given likely natural efficiency gains, likely codes and standards, and existing New York electric efficiency programs
- Applying the per unit efficient technology and practice characterizations and baseline penetration projections to the relevant existing and forecasted markets to arrive at net potential impacts and costs
- Developing gas, electric and water avoided costs
- Screening efficiency measures for cost-effectiveness based on the avoided cost estimates
- Removing all non-cost-effective measures
- Adjusting for mutually exclusive measures and interactions among measures

The analysis relied on a large variety of data to support the above approach, including: prior potential analyses; published research studies; equipment and market assessments; baseline studies; NYSERDA, LDC and New York Public Service Commission data; engineering analysis; building simulation modeling; and personal communication with industry experts.

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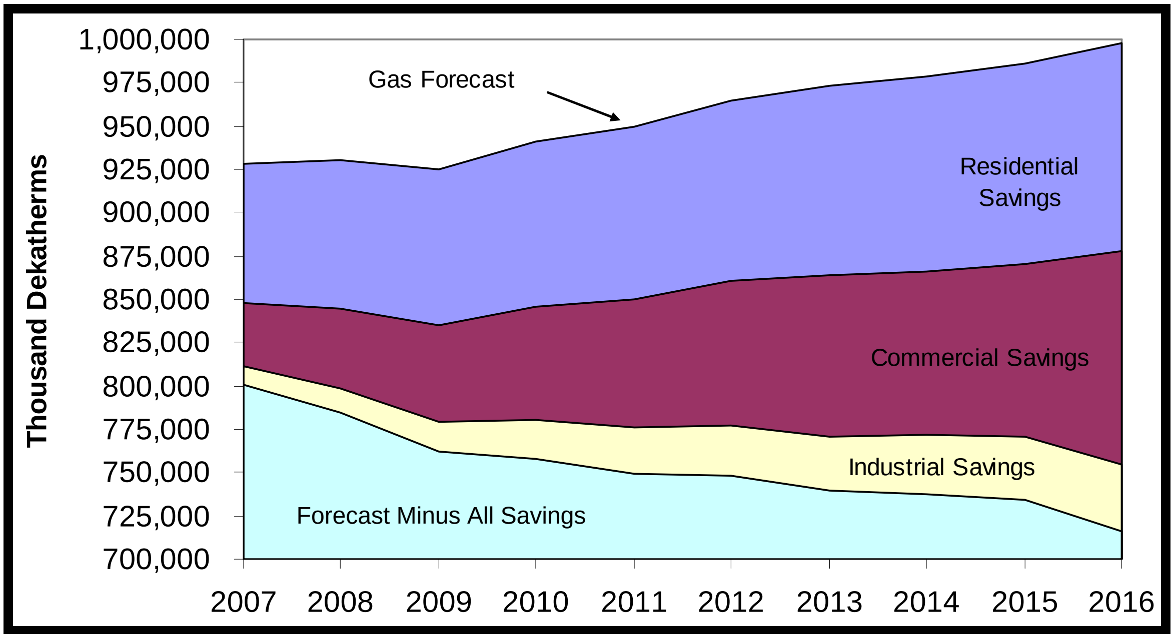
[18] For example, if 1/3 of existing boilers are anticipated to be replaced during the 10-year planning horizon, then the remaining 2/3 would be retrofitted in 2016 (assuming boiler retrofits are a cost-effective measure). To a certain extent whether priority is given to retrofit or market-driven measures is arbitrary. The total savings resulting in 2016 remain the same either way, although the intra-year timing of impacts would shift more toward the first year had priority been given to retrofit measures. As a result, net present value benefits would have been greater. Because gas programs are more likely to focus a greater effort on market-driven opportunities, the analysis uses this method. Had retrofit measures been given priority, many market-driven measures would have no impacts associated with them because 100% of the measures would be assumed to have already been captured in 2007. This approach would provide more limited data to support future program design decisions.

Section 4 provides more detailed discussion of the methods and assumptions used for the economic potential analysis, including the sector-specific detail.

2.3.2. Savings Results

Total estimated economic potential by 2016 is 282,725 MDth, potentially offsetting 28.3% of the forecasted gas load in that year. This potential is roughly equal between the residential and commercial sectors, with 13.7% of the potential coming from industrial facilities. Figure 2.3 shows how the captured economic potential could reduce forecasted loads. Theoretically, if all economic potential were captured, all future load growth during the planning horizon would be eliminated and there would be an average *annual decline* in gas loads of 2.1%. The chart shows significant impacts occurring in 2007. The bulk of these impacts are from retrofit opportunities that are available immediately, and are not competing with market-driven measures. Essentially, economic potential is a snapshot of efficiency opportunities in time unlike the program scenario which explicitly considers the ramp-up required to actually capture savings over time.

Figure 2.3. Gas Sales Forecast Minus Sector Energy Savings (Economic Potential)



Comparison of results with other recent natural gas potential studies shows this study's estimated potential to be lower than those estimated by others. Table 2.2 shows technical potential results for six recent studies. While the study results shown in Table 2.2 are for technical potential, which has a broader definition term than the economic potential in this study, the overall results are similar.

Table 2.2. Comparison of Recent Gas Savings Potential Studies

	California Study	Oregon & Washington (20 year potential)	Utah Study	ACEEE U.S. Median (4 Studies)	PNM Study - All Sectors	PNM Study - Residential and Commercial Sectors Only
Date of Study	**2002**	**2003**	**June 2004**	**2004**	**April 2005**	**April 2005**
Technical Potential	NA	40.0%	38.0%	41.0%	35.5%	39.7%
Residential	43% - 49%	NA	46.2%	48.0%	61.8%	--
Commercial	35.0%	NA	29.2%	20.0%	17.0%	--

Source: Roonery, T., *et. al.*, *Potential for Natural Gas Energy Savings in the Southwest,* Proceedings of American Council for an Energy Efficient Economy Summer Study, 2006.

In addition to the reference case gas avoided cost estimate, the study considered the impact on economic and program scenario potential with low and high avoided cost scenarios of 25% lower and 25% higher than the reference case, respectively. All figures reported in this report are for reference case avoided costs unless explicitly stated as low or high. Figure 2.4 shows economic potential by sector as a portion of the sector forecasted total load, for each case of reference, low and high avoided costs.[19] Table 2.3 shows the total economic potential by sector and the percent of each sector's forecasted sales this represents, also for the reference, low and high avoided costs. Note that total economic potential gas savings are not terribly sensitive to gas avoided costs. This is because: 1) most efficiency technologies examined are highly cost-effective, and therefore pass the cost-effectiveness screening under all three scenarios; and 2) a substantial portion of measure benefits derive from electric impacts, which are not affected under in the low and high avoided cost scenarios.

Figure 2.4. Economic Potential, by Sector (% of Total Forecasted Sales) by 2016

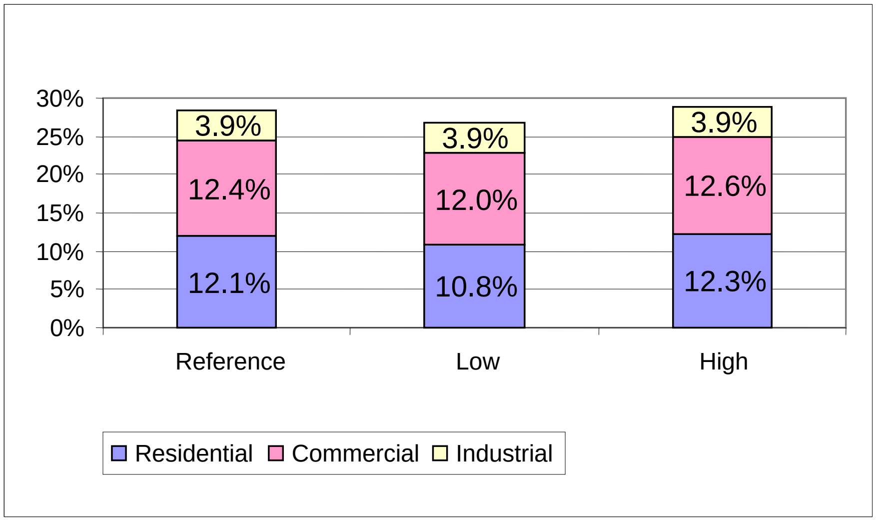


Table 2.3. Economic Potential, by Sector (MDth and % of Forecast Sector Sales) by 2016

Avoided Cost Scenario	Sector	Savings (MDth)	Savings as % of Total Sector Gas Sales	Sector Savings as % of Total Savings
Reference Case	Residential	120,616	26.9%	42.7%
	Commercial	123,339	33.3%	43.6%
	Industrial	38,770	21.5%	13.7%
	Total	**282,725**	**28.3%**	**100.0%**
Low Avoided Costs	Residential	107,806	24.1%	40.4%
	Commercial	120,033	32.4%	45.0%
	Industrial	38,770	21.5%	14.5%
	Total	**266,609**	**26.7%**	**100.0%**
High Avoided Costs	Residential	122,436	27.3%	42.7%
	Commercial	125,772	34.0%	43.8%
	Industrial	38,770	21.5%	13.5%
	Total	**286,978**	**28.7%**	**100.0%**

Figure 2.5 shows how the total potential is distributed by sector. All economic potential results show the total contributions in 2016 that would result from 100% adoption of all applicable efficiency measures from 2007 through 2016. In other words, the amount the 2016 gas sales forecast would be reduced if the total economic potential could be captured.

2.3.2.1. Peak-Day Impacts

Economic potential peak-day impacts are 2,069 MDth in 2016. A greater share of peak-day impacts comes from the commercial sector (1,155 MDth); with a significant contribution from the residential sector (795 MDth). Figure 2.6 shows peak-day economic potential by sector.

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[19] The table and figure titles in this report use "2016" or "by 2016" to indicate that the table's values are those occurring in 2016 resulting from all program or potential activity in the 2007-2016 analysis period.

Figure 2.5. Economic Potential, by Sector (MDth and % of Total Savings) by 2016

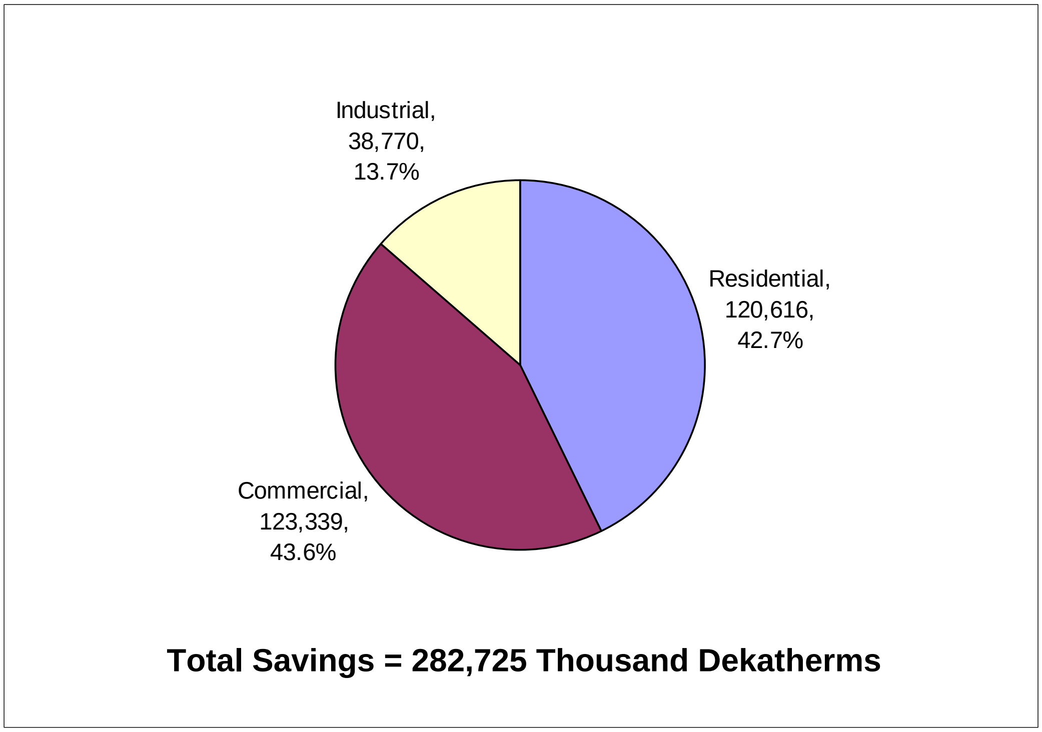
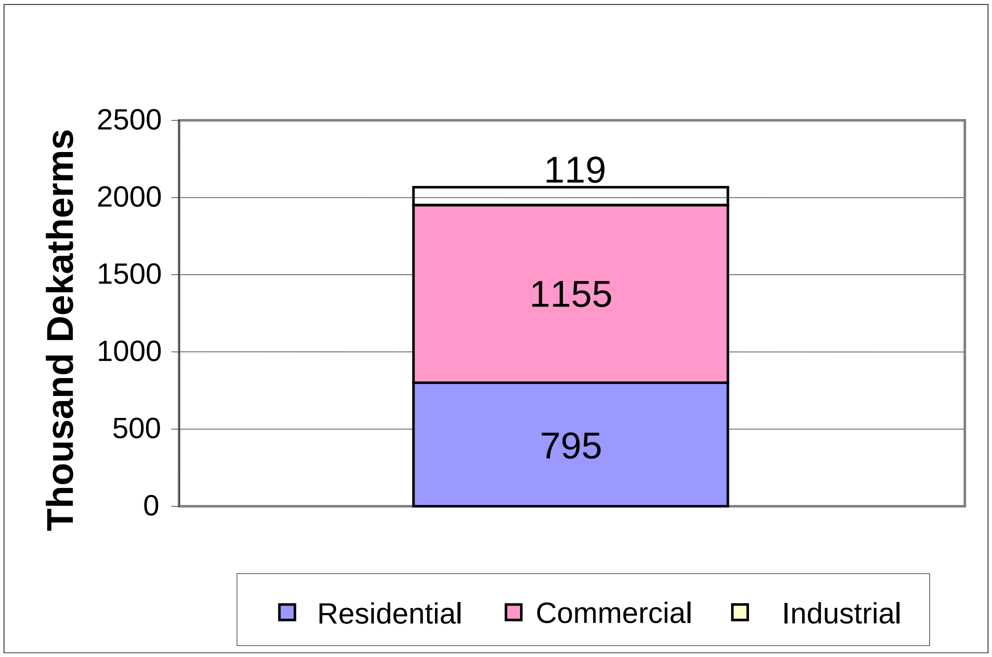


Figure 2.6. Peak Day Economic Potential, by Sector (MDth) by 2016



Note: Peak day savings for low and high avoided costs are virtually the same as the reference case.

2.3.2.2. Emissions Impacts

Capture of the economic potential could result in large emissions reductions over the 10-year planning horizon and into the future for the lives of the measures installed. CO_2, SO_2 and NO_x emission impacts are provided in Table 2.4, which shows both 10-year and lifetime total emission reductions. These emissions reductions result from both gas and electricity impacts. The study does not monetize the value of emissions reductions in any of the economic analyses of costs and benefits.

As a point of reference, total 10-year CO_2 emissions for New York are forecast to be 2.6 billion metric tons.[20] As a result, if the economic potential could be captured total New York CO_2 emissions would be reduced by 5.7%.

Table 2.4. Economic Potential CO_2, SO_2 and NO_x Emission Reductions for Reference Avoided Costs

Emissions Reductions (metric tons)		
Cumulative Annual CO_2	**10-year Total**	**Lifetime**
Residential	66,097,250	149,303,020
Commercial	70,550,852	154,776,995
Industrial	14,037,170	24,651,018
Total	**150,685,273**	**328,731,033**
Cumulative Annual SO_2	**10-year Total**	**Lifetime**
Residential	14,769	32,484
Commercial	36,631	57,227
Industrial	71	124
Total	**51,470**	**89,836**
Cumulative Annual NO_x	**10-year Total**	**Lifetime**
Residential	8,422	18,911
Commercial	11,690	22,653
Industrial	1,392	50
Total	**21,504**	**44,008**

Note: Emissions impacts for low and high avoided costs are virtually the same as for the reference case.

2.3.3. Avoided Cost Estimates

Economic benefits from gas efficiency result from the costs avoided by not supplying the gas that is saved. Therefore, economic analysis of potential relies heavily on avoided gas costs. The estimate of avoided gas costs comprised the following three parts:

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[20] Center for Clean Air Policy, *Recommendations to Governor Pataki for Reducing New York State Greenhouse Gas Emissions,* April 2003, Interpolation from Table ES-1, p. ES-4.

- *Commodity:* The market prices of gas delivered to a gas utility's citygate in a normal year.
- *Peaking capacity:* The costs of local capacity to cover the difference between normal and design-peak conditions.
- *Local transmission and distribution (T&D):* The utility's cost of building, operating, and maintaining the high-pressure transmission and lower-pressure distribution system in its service area.

Based on projections of market citygate commodity prices and the fixed costs of peaking capacity and local transmission and distribution, avoided costs were estimated for five different end-use load shapes: baseload, cooling, water heating, and space heating with two balance points, 65° F for residential space heating and 50° F for commercial space heating. These estimates recognize that the timing of gas usage has a significant impact on gas costs, as costs are driven to a large extent by overall demand on each day of the year. As a result, a given annual gas savings will be worth more when resulting from a space heating measure (when much of the savings occurs during extreme winter weather conditions and high gas demand) than from a cooling measure (when savings occur primarily during the summer when gas demand is lower). Section 3.2 provides more detail on the load shapes and avoided costs and how they are used to value measures.

The analysis computed separate avoided costs for upstate and downstate regions. Downstate avoided costs were computed using EEA's downstate citygate prices and Central Park weather data. Upstate avoided costs used EEA's upstate citygate prices and weather for a composite of Albany and Rochester, weighting Rochester 80% to reflect the fact that gas sales historically are much higher in the western part of upstate than in the eastern part.

Table 2.5 shows the resulting estimates of avoided costs. Section 3.2 provides a detailed discussion of the avoided cost development. While the study only analyzes a 10-year planning horizon, gas impacts continue for the life of the efficiency measures. As a result, avoided costs are applied to savings beyond 2016.

Table 2.5. Total Avoided Gas Costs (2005$/Dth).

	Downstate (NYC)					**Upstate (80% Rochester, 20% Albany)**				
Year	Heating w/ Base			Water Heating		Heating w/ Base			Water Heating	
	65°F	50°F	Baseload		Cooling	65°F	50°F	Baseload		Cooling
2006	$14.31	$19.15	$10.14	$11.18	$9.88	$12.40	$15.27	$9.68	$10.36	$9.61
2007	$12.60	$16.46	$9.36	$10.17	$8.69	$10.19	$11.65	$8.58	$8.99	$8.26
2008	$13.84	$17.22	$11.01	$11.72	$9.55	$12.06	$13.17	$10.48	$10.88	$8.98
2009	$13.27	$17.45	$8.99	$10.06	$6.86	$11.32	$13.47	$8.47	$9.19	$6.46
2010	$12.74	$16.78	$9.01	$9.94	$7.45	$10.06	$11.57	$8.13	$8.61	$6.96
2011	$11.62	$15.76	$7.94	$8.86	$7.33	$9.33	$11.30	$7.27	$7.79	$7.09
2012	$11.26	$14.78	$8.20	$8.97	$7.08	$9.36	$10.73	$7.65	$8.08	$6.72
2013	$11.49	$15.19	$8.09	$8.94	$6.76	$9.78	$11.53	$7.63	$8.17	$6.38
2014	$12.37	$15.97	$9.17	$9.97	$7.92	$10.53	$11.96	$8.65	$9.12	$7.52
2015	$11.79	$16.34	$7.43	$8.52	$6.48	$9.48	$11.97	$6.81	$7.48	$6.31
2016	$11.93	$16.04	$8.38	$9.27	$7.38	$9.21	$10.76	$7.54	$7.95	$7.06
2017	$11.54	$15.12	$7.97	$8.86	$5.92	$9.93	$11.60	$7.56	$8.15	$5.53
2018	$12.05	$15.66	$8.98	$9.75	$7.98	$10.41	$11.98	$8.55	$9.02	$7.61
2019	$12.41	$16.36	$8.86	$9.75	$7.80	$10.66	$12.60	$8.42	$8.98	$7.46
2020	$13.00	$16.75	$9.83	$10.62	$8.74	$11.27	$12.90	$9.38	$9.85	$8.34
2021	$12.60	$16.66	$8.85	$9.79	$7.55	$10.76	$12.76	$8.39	$8.98	$7.24
2022	$12.09	$16.01	$8.61	$9.48	$7.37	$10.03	$11.76	$8.04	$8.54	$7.04
2023	$11.75	$15.28	$8.66	$9.43	$7.50	$10.26	$11.86	$8.31	$8.80	$7.17
2024	$11.63	$15.47	$8.29	$9.12	$7.39	$10.00	$11.88	$7.91	$8.43	$7.13
2025	$11.67	$15.42	$8.27	$9.12	$6.86	$9.91	$11.62	$7.83	$8.35	$6.54
post-2025	$12.07	$15.88	$8.67	$9.52	$7.45	$10.24	$11.97	$8.19	$8.71	$7.11

2.3.4. Economic Test Results

The report presents economic results using a number of different tests and parameters. The primary economic screening criterion for cost-effectiveness is a total resource economic analysis of costs and benefits statewide (TRC test). However, costs and benefits based on natural gas and electric systems tests, as well as the overall levelized cost of saved energy (CSE) are also provided. The total resource cost-effectiveness is generally the overarching consideration because this provides an assessment (from a societal perspective) of the net benefits to the economy, or contribution to the overall economic welfare statewide. However, these other parameters are useful to consider as they provide a sense of how efficiency efforts might more directly affect the gas- and electric-system economics and ratepayers. The cost of saved energy is a useful parameter to consider individual measure economics in comparison to typical gas supply costs. This section presents these perspectives in more detail.

2.3.4.1. Total Resource Cost Test

The primary approach to assessing cost-effectiveness is to measure, from a societal perspective, the economics of efficiency resources, measuring changes in economic efficiency such as improvement in the economic welfare statewide. For this approach the TRC test is used.[21] This approach estimates the total costs of obtaining efficiency savings without considering who pays these costs. It does not address distributional equity, such as how costs and benefits would be shared among or within groups. Accordingly, it differs from other benefit-cost perspectives such as the utility test, participant test or non-participant test.[22] From the total-resource cost perspective, an efficiency measure is economical or cost-effective if 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.

Gas benefits from efficiency resources are valued in terms of the gas resource costs they would avoid, not the retail rates paid by household and business consumers. The study took this approach because the gas resource costs avoided by efficiency consist of the marginal wholesale commodity costs and marginal storage, transmission and distribution costs that otherwise would be incurred to supply New York's gas needs.[23] Realizing more efficiency potential would allow natural gas providers in New York to back down on the most costly supply sources used to meet gas demand, depending on when and where the additional resources materialized.

By contrast, the non-commodity portions of retail gas 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 higher than avoided wholesale commodity costs. Valuing gas from efficiency resources at retail rates, therefore, would overstate their true benefits to the New York economy.[24] The report does, however, show an estimate of overall customer bill savings by sector in Section 2.3.4.4. To accurately calculate the monthly bill savings, one must know both the rate tariff for each customer, as well as their respective monthly usage to determine their monthly

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[21] The TRC test differs from the "Societal Test" in that the latter includes monetized benefits from environmental externalities, which have not been included in the TRC test. However, the TRC test still considers cost-effectiveness from the standpoint of all society, or the total economy, as opposed to from a single segment of society. For example, it does not include lost revenues to the utilities, which are a transfer payment from utilities to ratepayers.

[22] The utility test considers only avoided energy costs as benefits and counts only expenditures supported by ratepayers. Note that this report uses the term "energy system test" here because programs are not necessarily administered by utilities, but may be funded by ratepayers. In addition, this study addresses both the gas energy systems test (similar to a gas utility test) as well as the electric energy systems test (similar to an electric utility test). The participant test uses retail gas rates to value the benefits of gas savings and counts only efficiency 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.

[23] T&D avoided costs are included because they are societal benefits from efficiency investments and because they are generally included in the analysis conducted in other jurisdictions and widely considered standard practice in references such as the California Standard Practice Manual.

[24] 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 ratepayers. These fixed costs eventually are redistributed among all ratepayers over time as part of the rate-making process.

marginal cost of gas. Because data does not support such calculations, the estimate is based on average 2004 revenue per Dth by sector.[25]

The study shows all economic results without consideration for price effects that could result from capture of the economic or program scenario potential. In addition, all measures and programs are screened for cost-effectiveness using a TRC criteria that does not include price effects. However, economics including the benefits of price effects are also shown for the program scenario TRC and gas systems tests. Including price effect benefits dramatically increases the overall net benefits that could accrue to society and the benefit-cost ratios.

The New York Public Service Commission (PSC) has placed primary emphasis on the use of a total resource cost test and has found that price effects should generally not be included in a total resource cost test. This exclusion is because the PSC believes price effects are not resource savings, but transfer payments from consumers to producers.[26] The PSC has, however, found that consideration of price effects can play an important role in energy efficiency decisions but that role must be secondary to the role played by a total resource cost test. The PSC noted,

> “one of our paramount objectives for the present and into the future is to take steps both to reduce market prices and to assist consumers in confronting high utility bills. The service territory-wide and targeted programs provide prime opportunities to achieve both objectives. As discussed above, the demand management programs reduce demand and, therefore, can assist in reducing energy prices.”[27]

The PSC further determined,

> “it is appropriate to broaden the eligibility requirements for the demand management programs … If the program is determined not to be cost-effective under the total resource cost test, NYSERDA and Con Edison may then add consideration of the effect of the program on energy market prices (energy and capacity) to their analyses. If the program will aid in reducing energy market prices and the addition of this benefit to the resource benefits under the total resource cost test makes the program cost-effective, it may then be pursued.”[28]

The authors believe the PSC order considering price effects in a secondary role is appropriate. However, the authors differ in the belief that price effects are transfer payments and do not reflect actual resource savings. In a competitive market, high demand forces prices up because of the need to draw on higher cost supply. Reducing demand results in lower gas costs by backing off on

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[25] Note that gas prices have increased significantly since 2004, and are forecast to remain so in the near future. Therefore, the customer bill reductions are likely to be underestimated.

[26] New York Public Service Commission Order, Case 04-E-0572, March 16, 2006, p.31.

[27] *Id.,* p. 32.

[28] *Id.*, p. 33.

the highest cost supply and relieving transmission congestion. Thus, while higher costs may in fact result in additional profits to some producers, on the margin the market clearing prices of commodity should accurately reflect the societal resource value.

Just because a measure may be societally cost-effective does not necessarily mean that an individual consumer will find it economically attractive. Economic potential remains untapped precisely because numerous market barriers interact to prevent widespread market adoption of efficiency 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 often lead 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 rates of return 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.

At the same time, energy planners in New York compare resource alternatives by weighing costs and benefits using a far lower discount rate (4% after inflation in this study). Viewed from the standpoint of the economic well-being of New York, efficiency investment opportunities passed over by individual consumers offer potentially economical resources if providers of natural gas in New York can realize them for less than avoided 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 technologies.

If the entire economic potential could be captured, the present value net benefits (in 2005$) are estimated at over $26 billion, with an overall benefit-cost ratio (BCR) of 2.90. The commercial sector could provide about 55% of the total net benefits, and have the highest benefit-cost ratio at 3.85. This disproportionate share of economic value is largely a result of high internal heat gains in commercial buildings. As a result, HVAC and building shell measures both save gas at its most expensive (when winter weather is most extreme), and also provide significant electric benefits from space cooling. Table 2.6 and Table 2.7 show the TRC economic results, by sector, for the reference, low and high avoided costs.

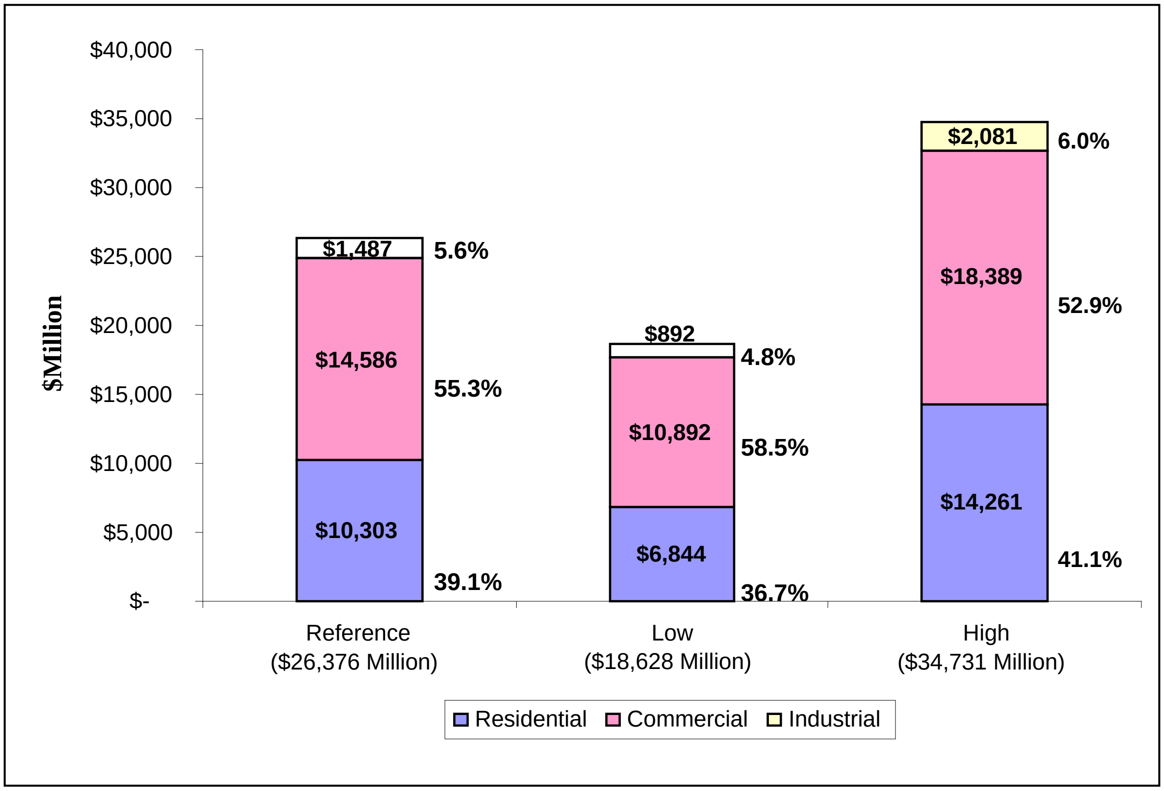
Table 2.6. Economic Potential, Total Resource Economics (Present Value 2005$) by 2016

Avoided Cost Scenario	Sector	Gross Benefits ($Million)	Costs ($Million)	Net Benefits* ($Million)	B/C Ratio**
Reference Case	Residential	$18,212	$7,909	$10,303	2.30
	Commercial	$19,698	$5,112	$14,586	3.85
	Industrial	$2,378	$892	$1,487	2.67
	Total	**$40,289**	**$13,913**	**$26,376**	**2.90**
Low Avoided Costs	Residential	$13,072	$6,228	$6,844	2.10
	Commercial	$15,643	$4,751	$10,892	3.29
	Industrial	$1,784	$892	$892	2.00
	Total	**$30,499**	**$11,871**	**$18,628**	**2.57**
High Avoided Costs	Residential	$22,590	$8,329	$14,261	2.71
	Commercial	$23,929	$5,540	$18,389	4.32
	Industrial	$2,973	$892	$2,081	3.33
	Total	**$49,492**	**$14,762**	**$34,731**	**3.35**

* Net Benefits = Benefits minus costs, present worth 2005$

** B/C Ratio = Gross Benefits/Costs

Figure 2.7. Economic Potential, Total Resource Net Benefits by Sector (Present Value 2005$, % of Total) by 2016



2.3.4.2. Gas and Electric System Tests

In addition to the TRC test, costs and benefits based on a natural gas system test are provided. This test is similar to the "utility test" for gas distribution utilities in that it measures costs and benefits only related to the gas energy system ─ those costs and benefits paid by or accruing directly to gas ratepayers.[29]

The reference case shows total net benefits under the gas system test of $21.2 billion, with a BCR of 2.76. This represents 80% of the TRC net benefits, with the remainder coming from electric, water and non-resource benefits. In this case, the commercial sector BCR of 2.53 is the lowest of all three sectors. This is because of the relatively minimal heating loads in large commercial buildings and the fact that the gas system test does not include electric benefits and other non-resource benefits such as operation and maintenance (O&M), which are most significant in the commercial sector. No BCR is shown for the electric system test because all the costs are allocated to the gas system since the study is of gas efficiency potential. Table 2.7 shows gas system economic impacts for the reference, low and high avoided costs.

Table 2.7. Economic Potential, Gas Energy System Net Benefits and Benefit/Cost Ratio by 2016

Net Benefits (benefits minus costs, present worth 2005$ Million)	Reference Avoided Costs	Low Avoided Costs	High Avoided Costs
Residential	$ 10,594	$ 7,678	$ 14,849
Commercial	$ 9,093	$ 5,419	$ 12,854
Industrial	$ 1,487	$ 892	$ 2,081
Total - Net Economic Potential Savings	**$ 21,173**	**$ 13,989**	**$ 29,784**
Benefit/Cost Ratio			
Residential	3.05	3.55	4.10
Commercial	2.53	1.99	3.00
Industrial	2.67	2.00	3.33
All Sectors	**2.76**	**2.49**	**3.46**

The costs above for the gas system test include all measure costs, similar to the TRC test.[30] Table 2.8 below shows the additional component net benefits (electric and non-energy) that are included in the total TRC net benefits.

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[29] The term gas system and electric system tests are used because not all programs are paid for and delivered by utilities in New York. These tests consider only the program costs (administrative and measure incentive costs) and do not consider additional participant contributions. Benefits are the direct benefits on the energy system (such as avoided gas or electric costs) and do not include other resource or non-resource benefits.

[30] For the program scenario, only ratepayer-funded costs are included (*e.g.*, administration and measure incentives), while direct customer contributions are not included.

Table 2.8. Economic Potential, Electric and Non-Energy Systems Net Benefits by 2016

Net Benefits (benefits minus costs, present worth 2005$ Million)		
Sector	**Electric**	**Non-Energy**
Residential	$ 2,098	$ (2,388)
Commercial	$ 4,025	$ 1,468
Industrial*	$ -	$ -
Total - Net Economic Potential Savings	**$ 6,122**	**$ (920)**

* Electric benefits were not quantified for the industrial sector in this study.

Non-energy net benefits are negative because increases in O&M costs associated with efficiency measures outweigh other positive benefits such as water savings.

2.3.4.3. Levelized Cost of Saved Energy

The levelized CSE is presented in Table 2.9 for the economic potential. CSE is the net cost per Dth saved amortized over the life of the measure. This calculation is useful to get a sense of how efficiency resources compare over their lifetime with supply costs and also provides measure supply curves in Figure 2.8 and Figure 2.9. Measure level CSE's are provided in Appendices A, B, and C. The supply curves can give a sense of the total efficiency potential available for less than a given cost per Dth. CSE shows net costs per Dth of gas potential. To do this, the value of all non-gas benefits are subtracted from costs to arrive at a net measure cost per Dth of gas savings. The report provides all CSE tables and supply curves separately for downstate and upstate. This is because these calculations are dependent on numerous timing effects and avoided cost inputs that are different for the two zones. Because the analysis separately analyzes each zone, combined statewide results for CSE and supply curves are not available.

Overall CSE for the economic potential is $2.47/Dth downstate, and $3.86/Dth upstate. This is significantly lower than expected commodity prices or avoided costs. In other words, efficiency is a much cheaper resource than the alternative of conventional gas supply. Commercial measures tend to have much lower net CSE because of the substantial benefits from non-gas impacts. In fact, many of the commercial measures are cost-effective based solely on electric impacts, thus resulting in negative CSE when considering it from a gas perspective. Basically, this means the measure is cost-effective even if gas supply was free.[31] Upstate CSE costs are generally higher than downstate because electric avoided costs are higher downstate. As a result, the electric benefits accruing from downstate measures offset more of the measure costs than they do upstate.

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[31] Note that even though many measures are cost-effective based solely on electric benefits, this analysis only considers efficiency potential above and beyond what is already projected to be captured with New York's existing and planned electric efficiency programs.

Table 2.9. Economic Potential, Total Resource Levelized Cost Per Saved Dth (2005$) by 2016

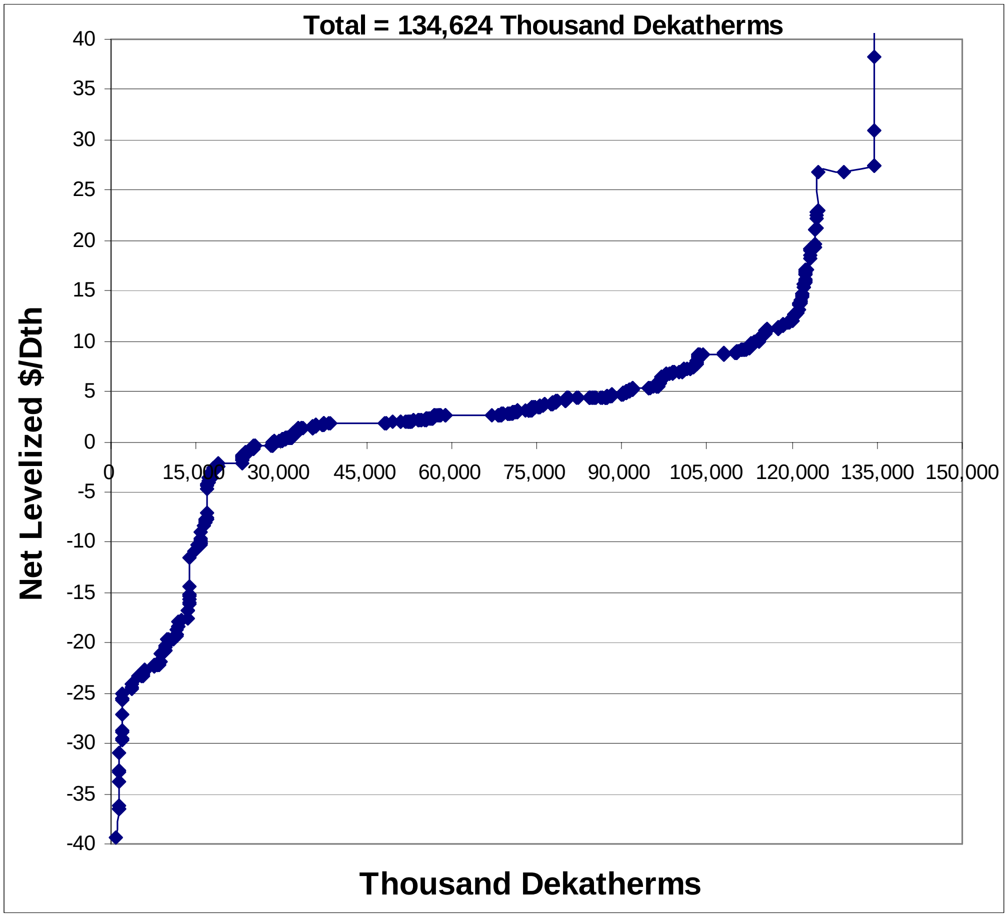
Sector	Downstate ($/Dth)	Upstate ($/Dth)
Residential	$ 4.55	$ 5.08
Commercial	$ 0.09	$ 2.58
Industrial	$ 3.30	$ 3.07
All Sectors	**$ 2.47**	**$ 3.86**

Note: Combined statewide figures are not available because each zone must be analyzed with a separate cost-effectiveness screening tool.

Figure 2.8 and Figure 2.9 show supply curves for the economic potential efficiency resource. Each point on the curve represents a particular measure. The points are sorted and presented in order of increasing cost per Dth. For a given point on the curve, the X-axis shows the amount of efficiency available at a specific cost per Dth, levelized over the life span of the resource at a real discount rate of 4%. To obtain increased economic gas energy from efficiency resources, it is necessary to move to the right on the curve and choose progressively more costly resources. The area under the curve represents the total costs of any given amount of gas efficiency.

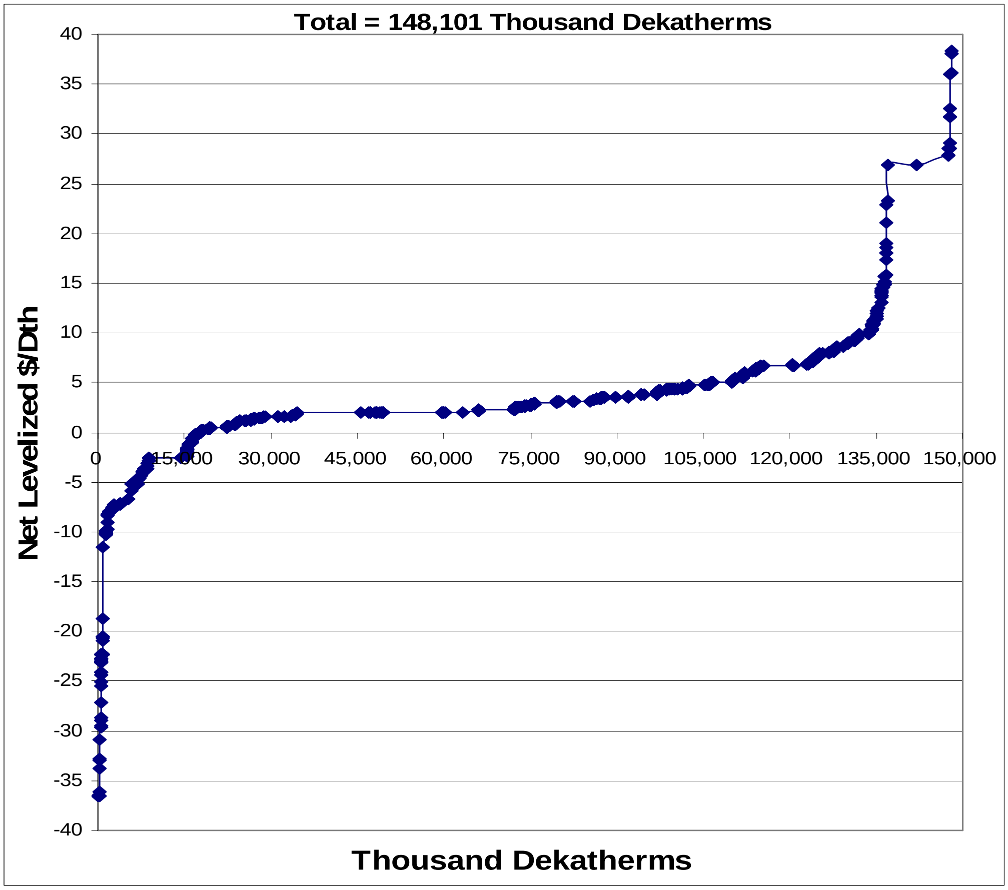
The study found that the economic potential costs of these contributions start at a net negative $39/Dth of savings from demand-controlled ventilation retrofits in retail buildings. The most expensive analyzed economic measure costs $49/Dth for high efficiency heating systems in education buildings. Appendices A, B and C provide tabular measure economics and savings, for residential, commercial downstate and commercial upstate, respectively.

Figure 2.8. All Sectors Economic Potential Supply Curve, by 2016, Downstate



Note: Combined statewide figures are not available because each zone must be analyzed with a separate cost-effectiveness screening tool.

Figure 2.9. All Sectors Economic Potential Supply Curve, by 2016, Upstate



Note: Combined statewide figures are not available because each zone must be analyzed with a separate cost-effectiveness screening tool.

2.3.4.4. Bill Reductions

Bill reductions depend on each customer's individual tariff, and further on each customer's monthly usage, which determines the marginal costs the customer's efficiency would be offsetting. This calculation is further complicated because many customers, particularly large commercial and industrial customers, are on interruptible rates and have dual-fuel capabilities. Thus, an accurate projection would require determining the hours when these customers would be interrupted, and also the choices customers would make in each hour about fuel use given prevailing economic costs for natural gas and oil. In addition, the specific end uses customers use can influence marginal retail costs (*e.g.*, gas cooling customers may receive certain summer blocks of usage at lower rates). The data to support such calculations is not available. As a result, the study estimated bill reductions by sector based on 2004 average revenue per Dth sold for each sector. This approach might tend to overstate actual bill reductions because overall revenue includes fixed customer service charges. However, because current natural gas prices are significantly higher than they were in 2004 (and projected to remain so for quite a while — see Figure 2.1 for the commodity price forecast) it is probable that the estimate significantly understates ultimate bill reductions. In addition, these figures do not include consumer bill reductions from price effects (see Section 6 for details on projected price effects from efficiency). If 100% of the economic potential could be captured, price effects would likely be much larger than bill reductions from efficiency. Therefore, total consumer bill reductions could be much larger. Table 2.10 shows estimated bill reductions by sector for the economic potential.

Table 2.10 Economic Potential Bill Reductions, 2016, Not Including Price Effects

Sector	2004 Average $/Dth	2004 Number Customers	2016 Dekatherm Savings	2016 Annual Bill Reductions	2016 Average Per Customer Annual Bill Reductions
Residential	$11.69	4,098,901	120,615,811	$1,410,577,203	$344
Commercial	$9.03	322,570	123,339,286	$1,113,725,937	$3,453
Industrial	$7.75	17,346	38,769,741	$300,441,288	$17,320
Total	**-**	**4,438,817**	**282,724,839**	**$2,824,744,427**	**$636**

Notes:

1. Data from NY Public Service Commission, "Average Annual Bill Data, Gas Companies, 2004." More current revenue and customer data was unavailable.
2. Figures in nominal dollars based on 2004 rates. Not present valued.
3. Actual bill reductions are dependent on actual customer usage patterns and specific tariffs. These reflect approximate savings based on average revenue/Dth by class.
4. Because of recent increases in natural gas costs it is likely that total bill reductions will be larger.
5. Does not include bill savings from commodity price effects. Over the planning horizon, savings from commodity price effects from the program scenario alone are an additional $288 million (2005$). However, program scenario savings are only about 5% of the total economic potential. Therefore, ultimate total bill savings from both efficiency and price effects might be significantly larger if a large portion of economic potential were actually pursued.

Section 4 provides more detailed and disaggregated economic potential results by sector.

2.4. PROGRAM SCENARIO POTENTIAL ANALYSIS

The program scenario potential was analyzed for a specific portfolio of programs selected and designed to optimize results given the selected funding level as well as other constraints. The following is an overview of the development of the investment portfolio analyzed and the analysis of the costs and savings with this portfolio. Section 5 provides program descriptions and more detailed program scenario results.

2.4.1. Program Design and Funding Levels

The program scenario potential considers economic and other barriers to efficiency adoption, relying on past experience of successful gas and electric efficiency programs. The assessment of the program scenario potential assumes five years of program delivery at an average budget of $80 million per year, with five years of post-program market effects. As already mentioned, neither the authors nor NYSERDA represent the selected funding level as a recommendation for future gas program funding. Rather, it was chosen to support discussions about appropriate future funding levels and program portfolios.

The program scenario was developed to meet certain criteria. These included: maintaining equity across sectors by matching sector-level spending to existing sector gas consumption; providing low-income services, set at 50% of the residential budget; and providing a balance between short-term resource acquisition efforts and longer-term market-transformation benefits. In addition, program services were developed to target all gas customers in New York and to address all major end uses. Finally, programs were designed around broad markets, rather than specific customer or technology types. In other words, programs would comprehensively address multiple opportunities within each particular facility, and/or customer type or market-event, with strategies and services designed around specific market and supply channels to address the way transactions normally happen in the marketplace.

Central to the markets approach and focus on comprehensiveness and addressing each market given its unique characteristics, the most effective approach to delivering gas programs statewide would be to integrate them with electric efficiency services. To that end, integrated delivery of fuel-neutral, one-stop-shopping programs to combined gas and electric customers is analyzed. Budgets and penetration rates reflect this assumption. The study has not, however, attempted to redesign, restructure, or analyze the existing electric programs. However, the current broad array of electric programs address all the same markets and service categories proposed here.

Developing the optimized investment portfolio included:

- Reviewing NYSERDA, LIPA, NYPA, LDC, and other existing New York electric and gas programs
- Reviewing exemplary gas programs throughout the country
- Considering the strategies and services that have been central to the success of gas and electric efficiency programs in New York and other jurisdictions
- Assessing the economic potential results and identifying where the most important opportunities exist, in terms of end uses, markets, customer types, and technologies
- Selecting a small set of broad-based programs designed to address all markets and to take full advantage of the lessons learned from delivering past programs.

The selected investment portfolio includes six programs for statewide implementation:

Cross Sector

- Space and water heating equipment
- Heating, hot water
- Residential and small commercial and industrial

Residential

- New construction (ENERGY STAR® Homes)
- Low-income weatherization

Commercial / Industrial

- New construction
- Existing construction
- Food service and processing

Section 5 provides more detailed discussion of the methods and results of the program design process.

2.4.2. Program Scenario Savings Analysis

The starting point for analyzing the savings and costs resulting from implementation of the program scenario is the economic potential. The following steps were used to estimate the program scenario potential:

- Mapping each measure (combination of technology, market, and facility type) to a program
- For each measure, projecting the future market acceptance of efficiency technologies over time if the kinds of market intervention policies and programs designed were pursued, as well as the portion of those measures adopted by customers that would participate in the programs[32]
- Applying the future measure penetrations to the economic potential analysis results to yield annual measure costs and savings
- Developing non-measure program budgets (those costs for all programmatic activities except measure incentives) that reflect the costs of delivering the programs statewide, assuming integration with electric programs

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[32] Three separate penetration curves were developed for each measure: (1) baseline penetrations assuming no program intervention; (2) overall market penetrations assuming program intervention; and (3) program participation penetration rates. The last reflects those customers who actually directly participate in the program and obtain incentives. While the difference between 1 and 2 provides the net effect of the program intervention, program budgets are dependent on 3. The differences between 2 and 3 are a result of either spillover or represent those customers who have installed the measure but do not bother to apply for an incentive. For market-transformation based programs, 3 can often be significantly smaller than 1 or 2. Appendices A, B and C provide penetration rates.

- Developing program incentive costs based on program incentive structure and designs and estimated participation rates for each measure
- Analyzing the portfolio to develop estimates of overall costs, benefits, net benefits and benefit-cost ratios

As described above, the program scenario potential analyzed an investment portfolio designed to optimize an overall program investment of $400,000,000 over five years. This portfolio is not designed to maximize net benefits for this spending level. Rather, it attempts to optimize a balance between maximizing net benefits, providing equity across sectors, with a substantial focus on low-income customers, addressing all important markets and end uses for gas, and balancing market-transformation and short-term resource acquisition requirements. A focus purely on least cost efficiency resources would have resulted in much greater efforts targeted at large commercial and industrial customers because these offer the most cost-effective savings. Low-income customers, for example, would be eliminated entirely as efficiency opportunities in this sector tend to be more costly to capture. Section 5 describes the program designs and the rationale for this investment portfolio.

2.4.3. Program Scenario Savings Results

Pursuit of the program scenario would offer total savings in year five (2011) of 14,923 MDth (*i.e.,* the last year of the 5-year programs). Ultimate savings by year ten (2016) would continue to grow (although at a slower rate) due to post-program market effects, and total 15,204 MDth. Peak day impacts in 2011 are 76 MDth, growing to 100 MDth by 2016. The largest single program savings would come from the Commercial and Industrial (C&I) Existing Construction program, accounting for roughly half of the total portfolio savings. The next largest would be the Small Heating and Domestic Hot Water (DHW) Equipment program with about one fifth of the savings, followed by Residential New Construction, Food Service and Processing, C&I New Construction, and Low-income Weatherization programs, respectively. Table 2.11 shows incremental and cumulative annual savings, by program and year, and Table 2.12 shows similar data for peak-day impacts. Figure 2.10 shows how 2016 annual impacts breakout by program. Program scenario impacts do not change between reference, low and high avoided cost scenarios because all programs are cost-effective under all three scenarios.

A word on definitions: “incremental” refers to savings in a given year associated only with new installations happening in that year (*e.g.,* new participants); “cumulative annual” refers to the overall savings occurring in a given year from new participants and savings continuing to result from past participation with measures that are still in place (*e.g.,* reduction in gas requirements in that year based on new installations for that year and any prior installations for measures that would still be producing savings). Cumulative annual does not always equal the sum of prior year incremental values because some measures have short measure lives and therefore their associated savings drop off over time. Cumulative annual estimates are the most useful as they reflect the actual reduction in load that would be achieved in a given year.

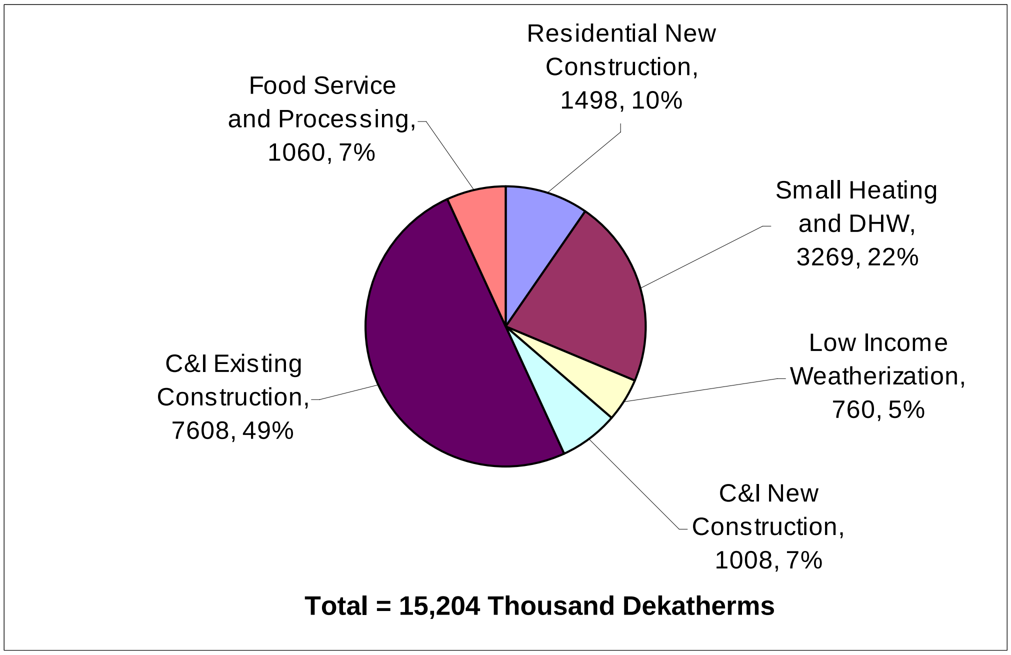
Table 2.11. Program Scenario Incremental Annual and Cumulative Annual Energy Savings (Reference Case)

	Annual Energy Savings (MDth)										Lifetime Savings (MDth)
	Program Years					Post-program Market Effect Years					
Incremental Annual	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
Residential New Construction	80	122	150	178	201	128	141	154	166	178	
Small Heating and DHW	200	333	404	480	557	243	251	259	267	275	
Low Income Weatherization	152	152	152	152	152	-	-	-	-	-	
C&I New Construction	32	65	102	143	185	82	92	102	112	123	
C&I Existing Construction	2,774	2,917	3,077	3,254	3,432	832	877	921	968	1,011	
Food Service and Processing	32	65	104	151	199	102	110	118	127	135	
Total Programs	3,271	3,654	3,989	4,359	4,726	1,387	1,471	1,554	1,641	1,723	
Cumulative Annual	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
Residential New Construction	80	202	352	530	731	859	1,000	1,154	1,320	1,498	32,156
Small Heating and DHW	200	533	937	1,417	1,974	2,217	2,467	2,727	2,994	3,269	66,006
Low Income Weatherization	152	304	456	608	760	760	760	760	760	760	14,543
C&I New Construction	32	97	198	339	521	599	685	783	891	1,008	20,192
C&I Existing Construction	2,774	5,691	7,109	8,675	10,386	9,012	7,641	7,607	7,597	7,608	125,985
Food Service and Processing	32	97	201	353	552	654	764	882	981	1,060	10,298
Total Programs	3,271	6,924	9,253	11,922	14,923	14,100	13,317	13,913	14,543	15,204	269,180

Table 2.12. Program Scenario Incremental Annual and Cumulative Annual Peak Day Savings (Reference Case)

	Peak Day (MDth)									
	Program Years					**Post-program Market Effect Years**				
Incremental Annual	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New Construction	0.5	0.7	0.8	1.0	1.1	0.7	0.8	0.9	0.9	1.0
Small Heating and DHW	1.2	2.0	2.4	2.9	3.3	1.4	1.5	1.5	1.6	1.6
Low Income Weatherization	0.9	0.9	0.9	0.9	0.9	-	-	-	-	-
C&I New Construction	0.4	0.7	1.2	1.6	2.1	0.9	1.1	1.2	1.3	1.4
C&I Existing Construction	9.1	10.7	12.5	14.4	16.4	5.3	5.8	6.2	6.8	7.2
Food Service and Processing	0.1	0.2	0.4	0.5	0.7	0.4	0.4	0.5	0.5	0.5
Total Programs	**12.2**	**15.4**	**18.2**	**21.4**	**24.5**	**8.7**	**9.5**	**10.3**	**11.0**	**11.8**
Cumulative Annual	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New Construction	0.5	1.2	2.0	3.0	4.1	4.8	5.6	6.4	7.3	8.3
Small Heating and DHW	1.2	3.3	5.7	8.6	11.8	13.3	14.8	16.3	17.9	19.5
Low Income Weatherization	0.9	1.9	2.8	3.8	4.7	4.7	4.7	4.7	4.7	4.7
C&I New Construction	0.4	1.1	2.3	3.9	6.0	6.9	7.8	9.0	10.2	11.6
C&I Existing Construction	9.1	19.8	27.4	36.7	47.4	45.3	43.2	45.8	48.7	51.8
Food Service and Processing	0.1	0.4	0.7	1.3	2.0	2.4	2.8	3.3	3.7	4.0
Total Programs	**12.2**	**27.6**	**41.0**	**57.2**	**76.0**	**77.4**	**78.9**	**85.5**	**92.5**	**99.9**

Figure 2.10. Program Scenario 2016 Cumulative Annual Gas Savings by Program (MDth and % of Total Savings)



2.4.3.1. Emissions Impacts

The program scenario would result in lifetime reductions of 16.1 million metric tons of CO_2, 2,005 metric tons of SO_2, and 1,841 metric tons of NO_x. The 10-year total CO_2 reductions are 0.1% of total forecast New York 2007-2016 CO_2 emissions.[33] Table 2.13, below, shows annual and lifetime emission reductions.

2.4.4. Program Scenario Economic Results

The program scenario is highly cost-effective. Pursuit of this scenario would result in estimated present value net benefits to the New York economy of $1.12 billion (2005$), with an overall benefit-cost ratio of 2.48. In other words, for every dollar invested in efficiency, the scenario would return $2.48 to the State economy. The largest portion of net benefits — roughly half — would come from the C&I Existing Construction program. Substantial net benefits would also come from the Small Heating and DHW, Residential New Construction and C&I New Construction programs. Table 2.14, Table 2.15 and Figure 2.11 show economic results by program for reference, low, and high avoided costs.

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[33] Center for Clean Air Policy, *Recommendations to Governor Pataki for Reducing New York State Greenhouse Gas Emissions,* April 2003, New York forecast CO_2 emissions interpolated from Table ES-1, p. ES-4.

Table 2.13. Program Scenario CO_2, SO_2, and NOx Emissions Reductions

Emissions Reductions (metric tons)												
	Program Years					Post-program Market Effect Years					10-year Total	Lifetime Reductions
Cumulative Annual CO_2	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**		
Residential New Construction	2,361	6,562	11,662	17,940	25,068	28,886	33,121	37,771	42,831	48,295	254,496	2,054,461
Small Heating and DHW	4,750	12,567	21,921	32,811	45,239	50,755	56,424	62,246	68,221	74,350	429,284	3,562,860
Low-income Weatherization	4,610	9,220	13,830	18,440	23,050	23,050	23,050	23,050	23,050	23,050	184,402	870,380
C&I New Construction	2,096	6,329	12,876	21,963	33,629	38,431	43,834	49,865	56,411	63,481	328,915	1,561,953
C&I Existing Construction	21,159	51,047	79,568	117,585	164,935	169,215	175,378	191,502	206,748	220,948	1,398,084	7,415,790
Food Service and Processing	1,471	4,437	9,220	16,153	25,270	29,981	35,067	40,531	45,129	48,845	256,104	589,890
Total Programs	**36,447**	**90,162**	**149,077**	**224,892**	**317,191**	**340,318**	**366,874**	**404,965**	**442,390**	**478,969**	**2,851,284**	**16,055,334**
											10-year Total	Lifetime Reductions
Cumulative Annual SO_2	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**		
Residential New Construction	1	3	5	7	9	11	13	15	17	19	100	412
Small Heating and DHW	0	0	0	0	0	0	0	0	0	0	2	18
Low-income Weatherization	1	2	3	4	5	5	5	5	5	5	44	112
C&I New Construction	1	3	5	9	14	16	18	21	23	26	137	603
C&I Existing Construction	4	12	25	42	64	69	76	81	84	84	542	813
Food Service and Processing	0	0	0	1	1	1	1	2	2	2	11	46
Total Programs	**7**	**20**	**39**	**63**	**94**	**103**	**115**	**124**	**132**	**138**	**836**	**2,005**
											10-year Total	Lifetime Reductions
Cumulative Annual NOx	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**		
Residential New Construction	0	1	2	3	4	4	5	6	6	7	38	256
Small Heating and DHW	0	1	2	3	4	5	6	6	7	7	43	353
Low-income Weatherization	1	1	2	2	3	3	3	3	3	3	24	100
C&I New Construction	0	1	2	3	5	6	7	8	9	10	50	232
C&I Existing Construction	3	7	11	17	25	26	27	29	31	33	208	836
Food Service and Processing	0	0	1	2	3	3	4	4	5	5	27	64
Total Programs	**5**	**11**	**20**	**30**	**43**	**47**	**51**	**56**	**61**	**65**	**389**	**1,841**

Table 2.14. Program Scenario Total Resource Net Benefits and Benefit-Cost Ratios, Not Including Price Effects

Resource Avoided Costs	**Total Resource Net Benefits ($Million)**									
	Program Years					**Post-Program Market Effect Years**				
Cumulative Net Benefits (benefits minus costs, present worth 2005$)	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New Construction	9	23	39	56	75	87	99	113	127	141
Small Heating and DHW	16	42	72	106	144	161	177	194	210	226
Low Income Weatherization	9	18	27	35	42	42	42	42	42	42
C&I New Construction	2	9	21	37	56	66	77	88	100	112
C&I Existing Construction	59	128	204	288	382	411	443	478	515	553
Food Service and Processing	0	2	6	11	18	23	28	34	39	45
Total Programs	**96**	**223**	**368**	**533**	**718**	**790**	**867**	**948**	**1,032**	**1,119**
Cumulative Benefit/Cost Ratio (2005$)	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New Construction	3.23	3.19	3.14	3.08	3.03	3.03	3.04	3.05	3.05	3.06
Small Heating and DHW	2.24	2.30	2.33	2.34	2.34	2.36	2.37	2.38	2.39	2.40
Low Income Weatherization	1.73	1.71	1.71	1.70	1.70	1.70	1.70	1.70	1.70	1.70
C&I New Construction	1.50	1.78	2.00	2.13	2.21	2.29	2.36	2.42	2.47	2.52
C&I Existing Construction	2.25	2.31	2.34	2.37	2.39	2.42	2.45	2.48	2.51	2.53
Food Service and Processing	1.12	1.40	1.64	1.79	1.90	2.03	2.15	2.25	2.34	2.43
Total Programs	**2.14**	**2.22**	**2.26**	**2.29**	**2.31**	**2.35**	**2.39**	**2.42**	**2.45**	**2.48**

Low Avoided Costs	**Total Resource Net Benefits ($Million)**									
	Program Years					**Post-Program Market Effect Years**				
Cumulative Net Benefits (benefits minus costs, present worth 2005$)	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New Construction	6	15	26	37	49	57	65	74	83	93
Small Heating and DHW	4	12	22	33	45	51	57	63	69	75
Low Income Weatherization	4	7	10	13	15	15	15	15	15	15
C&I New Construction	1	5	12	23	36	43	50	58	66	75
C&I Existing Construction	33	74	119	170	228	247	269	292	317	343
Food Service and Processing	0	1	3	6	11	14	18	22	26	30
Total Programs	**48**	**114**	**192**	**282**	**384**	**428**	**474**	**524**	**576**	**630**
Cumulative Benefit/Cost Ratio (2005$)	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New Construction	3.32	3.29	3.25	3.20	3.16	3.16	3.17	3.18	3.19	3.20
Small Heating and DHW	1.36	1.41	1.44	1.46	1.47	1.49	1.50	1.51	1.52	1.52
Low Income Weatherization	1.39	1.37	1.38	1.37	1.36	1.36	1.36	1.36	1.36	1.36
C&I New Construction	1.20	1.42	1.59	1.70	1.77	1.83	1.89	1.94	1.98	2.01
C&I Existing Construction	1.70	1.76	1.78	1.81	1.83	1.85	1.88	1.90	1.93	1.95
Food Service and Processing	0.89	1.12	1.32	1.43	1.52	1.63	1.72	1.81	1.88	1.95
Total Programs	**1.61**	**1.67**	**1.71**	**1.74**	**1.76**	**1.79**	**1.83**	**1.86**	**1.88**	**1.91**

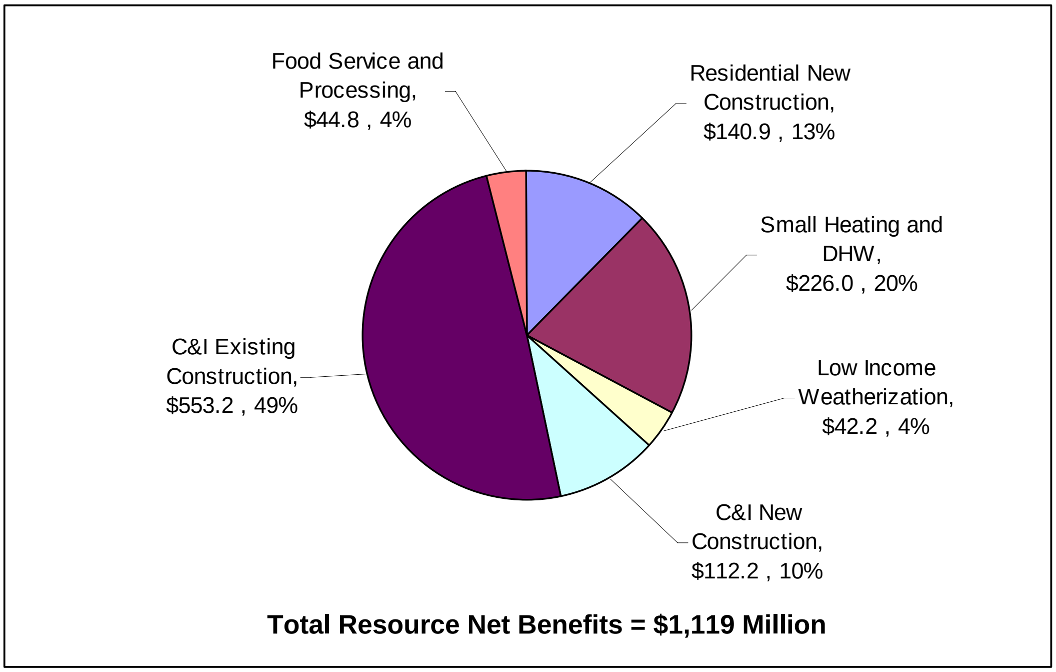
High Avoided Costs	**Total Resource Net Benefits ($Million)**									
	Program Years					**Post-Program Market Effect Years**				
Cumulative Net Benefits (benefits minus costs, present worth 2005$)	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New Construction	11	28	47	68	91	105	120	136	153	170
Small Heating and DHW	15	41	72	106	144	161	177	194	210	227
Low Income Weatherization	12	23	34	44	54	54	54	54	54	54
C&I New Construction	4	13	29	50	77	90	103	118	133	150
C&I Existing Construction	84	182	288	406	536	575	618	664	713	764
Food Service and Processing	1	4	9	16	26	32	39	45	52	60
Total Programs	**128**	**292**	**479**	**691**	**927**	**1016**	**1111**	**1212**	**1,316**	**1,424**
Cumulative Benefit/Cost Ratio (2005$)	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New Construction	3.85	3.84	3.78	3.72	3.66	3.66	3.66	3.66	3.67	3.68
Small Heating and DHW	2.21	2.28	2.32	2.32	2.33	2.35	2.37	2.38	2.39	2.40
Low Income Weatherization	1.93	1.91	1.91	1.90	1.90	1.90	1.90	1.90	1.90	1.90
C&I New Construction	1.80	2.14	2.40	2.56	2.66	2.75	2.84	2.91	2.97	3.02
C&I Existing Construction	2.80	2.87	2.90	2.92	2.94	2.98	3.02	3.05	3.09	3.12
Food Service and Processing	1.34	1.68	1.97	2.14	2.27	2.43	2.57	2.70	2.81	2.91
Total Programs	**2.53**	**2.60**	**2.65**	**2.68**	**2.70**	**2.74**	**2.79**	**2.82**	**2.86**	**2.89**

Table 2.15. Program Scenario, Total Resource Economics, Not Including Price Effects by 2016

Proposed Program	Reference Case Net Benefits ($Million)	Reference Case % of Total	Reference Case BCR	Low Avoided Costs Net Benefits ($Million)	Low Avoided Costs % of Total	Low Avoided Costs BCR	High Avoided Costs Net Benefits ($Million)	High Avoided Costs % of Total	High Avoided Costs BCR
Residential New Construction	$141	12.6%	3.06	$93	14.7%	3.20	$170	11.9%	3.68
Small Heating and DHW	$226	20.2%	2.40	$75	11.8%	1.52	$227	15.9%	2.40
Low Income Weatherization	$42	3.8%	1.70	$15	2.4%	1.36	$54	3.8%	1.90
C&I New Construction	$112	10.0%	2.52	$75	11.9%	2.01	$150	10.5%	3.02
C&I Existing Construction	$553	49.4%	2.53	$343	54.4%	1.95	$764	53.6%	3.12
Food Service and Processing	$45	4.0%	2.43	$30	4.7%	1.95	$60	4.2%	2.91
Total Programs	**$1,119**	**100.0%**	**2.48**	**$630**	**100.0%**	**1.91**	**$1,424**	**100.0%**	**2.89**

Note: Net benefits = gross benefits minus costs, present value 2005$. BCR = benefit/cost ratio = gross benefits / costs.

Figure 2.11. Program Scenario, Total Resource Net Benefits, by 2016 for Reference Avoided Costs, Not Including Price Effects (2005$Million and % of Total)



The study included an analysis of the gas commodity price effects of reduced demand on the gas system from the program scenario. Currently gas supplies are constrained, so as demand increases prices tend to rise. As a result, significant reductions in demand can result in downward pressure on market clearing commodity prices. Section 6 describes the price effects analysis. Table 2.16 provides the total resource economic results with and without price effects. Price effects included are the present value of consumer cost savings from 2007 through 2025.[34] Including price reductions that would be enjoyed by all New York gas consumers, present value net benefits increase to $1.6 billion (2005$), with a benefit-cost ratio of 3.14.

Table 2.16. Program Scenario Total Resource Economics by 2016, Including Price Effects (Present Value 2005$ Million)

Gross Benefits without Price Effects*	Price Effect Benefits	Costs	Net Benefits	B/C Ratio
$1,876.2	$500.7	$757.0	$1,619.9	3.14

*For the Program Scenario, benefits and costs are not available at the sector level. See discussion of the appropriateness of considering price effects in cost-effectiveness analyses and under Section 2.3.4.

Table 2.17 shows the cost-effectiveness results for the gas system test. All programs are cost-effective from a gas system perspective, providing reference case total present value net benefits of approximately $1.4 billion (2005$), and an overall BCR of 5.11. The BCR for the Residential New Construction program is quite high. This is because this program is already being offered in New York funded by electric ratepayers. As a result, provision of gas incentives to an existing program infrastructure provides great value at relatively low cost. In addition, because these additional funds will allow service to more participants, the result is both increased electric and gas benefits. If gas is integrated into this program, consideration should be made for sharing fixed (non-measure related) program costs equitably between electric and gas ratepayers based on the benefits derived to them.[35]

Table 2.18 provides the gas energy system economic results with and without price effects. Including price effects increases present value net benefits to $1.9 billion (2005$), and the benefit-cost ratio to 6.60.

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[34] While the analysis period is only to 2016, efficiency savings from the program scenario continue for the life of the measures installed, sometimes as long as 30 years, or until 2046. As a result, only counting present value price effects through 2025 underestimates the total benefits.

[35] Note, allocating costs to gas and electric ratepayers based on their respective benefits would result in much lower gas BCRs than shown here. However, the electric BCR would be commensurately increased.

Table 2.17. Program Scenario Gas Energy System Net Benefits by 2016 in 2005$, Not Including Price Effects

Cumulative Net Benefits ($Million) and Benefit/Cost Ratio (BCR)*									
	Reference Case			Low Avoided Costs			High Avoided Costs		
Proposed Programs	**Net Benefits**	**As % of Total**	**BCR**	**Net Benefits**	**As % of Total**	**BCR**	**Net Benefits**	**As % of Total**	**BCR**
Residential New Construction	$170.6	12.4%	31.68	$102.2	12.0%	24.93	$195.7	11.7%	36.18
Small Heating and DHW	$326.6	23.7%	6.30	$155.6	18.2%	3.53	$327.4	19.5%	6.32
Low Income Weatherization	$26.9	2.0%	1.40	$7.8	0.9%	1.18	$38.9	2.3%	1.58
C&I New Construction	$113.7	8.3%	4.16	$76.3	8.9%	3.12	$151.1	9.0%	5.20
C&I Existing Construction	$694.6	50.5%	5.72	$484.1	56.7%	4.29	$905.0	54.0%	7.14
Food Service and Processing	$43.2	3.1%	3.53	$28.1	3.3%	2.65	$58.2	3.5%	4.42
All Programs	**$1,375.5**	**100.0%**	**5.11**	**$854.1**	**100.0%**	**3.77**	**$1,676.3**	**100.0%**	**6.01**

* Cumulative Net Benefits = Benefits minus costs, present worth 2005$. B/C Ratio = gross benefits / costs.

Table 2.18. Program Scenario Gas Energy System Economics by 2016, Including Price Effects (Present Value 2005$Million)

Gross Benefits without Price Effects*	Price Effect Benefits	Costs	Net Benefits	B/C Ratio
$1,710.5	$500.7	$335.0	$1,876.2	6.60

*For the Program Scenario, benefits and costs are not available at the sector level. See discussion of the appropriateness of considering price effects in cost-effectiveness analyses in Section 2.3.4.

Figure 2.12 shows the distribution of net benefits by program from the gas system perspective for the reference avoided costs.

Figure 2.12. Program Scenario Gas Energy System Net Benefits by 2016, Not Including Price Effects (2005$ Million and % of Total)

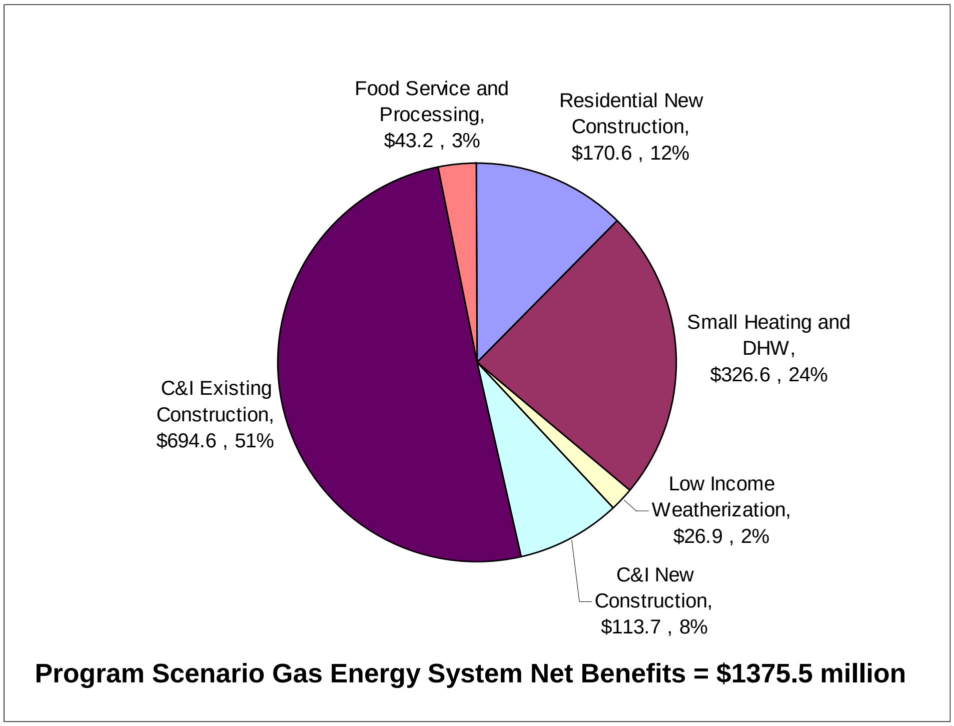

Table 2.19. Program Scenario Total Resource Levelized Cost Per Saved Dth, Not Including Price Effects - Downstate

	Total Resource Levelized Cost Per Saved Dekatherm ($/Dth)									
	Program Years					**Market Effect Years**				
Cumulative	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New Construction	2.73	2.75	2.83	2.92	3.00	3.02	3.03	3.03	3.03	3.02
Small Heating and DHW	5.22	5.02	4.88	4.81	4.74	4.69	4.66	4.62	4.60	4.58
Low Income Weatherization	7.55	7.64	7.60	7.62	7.61	7.61	7.61	7.61	7.61	7.61
C&I New Construction	5.50	4.39	3.67	3.35	3.16	3.00	2.86	2.74	2.64	2.56
C&I Existing Construction	4.17	3.57	3.15	2.90	2.73	2.68	2.62	2.55	2.47	2.40
Food Service and Processing	10.13	7.97	6.65	6.04	5.64	5.26	4.96	4.73	4.53	4.37
Total Programs	**5.27**	**4.73**	**4.33**	**4.10**	**3.92**	**3.81**	**3.70**	**3.61**	**3.51**	**3.42**

Note: Combined statewide figures are not available because each zone must be analyzed with a separate cost-effectiveness screening tool.

Table 2.20. Program Scenario Total Resource Levelized Cost Per Saved Dth, Not Including Price Effects - Upstate

	Total Resource Levelized Cost Per Saved Dekatherm ($/Dth)									
	Program Years					**Market Effect Years**				
Cumulative	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New Construction	2.07	2.15	2.23	2.33	2.42	2.39	2.36	2.33	2.31	2.29
Small Heating and DHW	4.97	4.91	4.90	4.95	5.01	4.98	4.97	4.96	4.96	4.96
Low Income Weatherization	6.22	6.29	6.26	6.28	6.27	6.27	6.27	6.27	6.27	6.27
C&I New Construction	22.82	17.51	14.63	12.85	11.85	11.07	10.45	9.97	9.58	9.26
C&I Existing Construction	4.07	4.10	4.14	4.18	4.23	4.25	4.28	4.30	4.33	4.35
Food Service and Processing	10.87	8.28	6.74	6.02	5.56	5.12	4.78	4.51	4.30	4.11
Total Programs	**4.35**	**4.38**	**4.40**	**4.45**	**4.50**	**4.49**	**4.48**	**4.48**	**4.47**	**4.47**

Note: Combined statewide figures are not available because each zone must be analyzed with a separate cost-effectiveness screening tool.

Table 2.21 shows the estimated total bill reductions by program for the program scenario, based on average 2004 revenue per Dth. This does not reflect any additional consumer savings from price effects. Delivery of the selected portfolio would result in approximately $53 million/yr in bill reductions in 2016, assuming 2004 average rates. Cumulative 10-year customer bill savings by 2016 would be $293 million. No per-customer bill reductions are provided because these reductions would only accrue to the program participants, so averaging reductions across all customers would be misleading. Per-participant bill reductions would depend on the number of customers participating and would likely vary substantially among individual participants and would be highly dependent upon each customer's unique circumstances and tariff. Because some customers may only implement a single measure, while others might undergo comprehensive efficiency improvements, projecting the actual number of customers participating would be highly speculative. Note these figures do not include gas price effects from efficiency, which could provide potentially much larger bill reductions, both to participants and non-participants. For example, cumulative price effect savings through 2016 are estimated at $1.3 billion (including savings to power generation gas consumers).[36] This would more than quadruple the total bill savings to New York gas customers. Total cumulative 10-year bill reductions with price effects would be approximately $1.6 billion.

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[36] While efficiency from power generators was not part of the scope of this study, price effects from gas efficiency in buildings will benefit consumers of gas for power generation as well as those using gas for building systems and equipment.

Table 2.21. Program Scenario Potential, 2007-2016, Bill Reductions, Not Including Price Effects

Program	2004 Average $/Dth	2016 Dekatherm Savings	2016 Annual Bill Reductions	2016 Cumulative 10-Year Bill Reductions
Residential New Construction	$11.69	1,498,270	$17,521,959	$90,345,377
Small Heating and DHW	$10.82	3,269,084	$35,356,251	$202,608,043
Low Income Weatherization	$11.69	760,224	$8,890,666	$71,125,324
C&I New Construction	$9.03	1,008,134	$9,103,219	$46,544,297
C&I Existing Construction	$8.61	7,608,051	$65,484,340	$637,790,167
Food Service and Processing	$9.03	1,060,036	$9,571,889	$50,345,761
Total	**-**	**15,203,799**	**$52,878,210**	**$292,953,420**

Notes:

1. Data from NY Public Service Commission, "Average Annual Bill Data, Gas Companies, 2004." More current revenue and customer data was unavailable.
2. Small Heating and DHW (domestic hot water) program includes a combination of residential and commercial customers. C&I Existing Construction includes a combination of commercial and industrial customers.
3. Figures in nominal dollars based on 2004 rates. Not present valued.
4. Actual bill reductions are dependent on actual customer usage patterns and specific tariffs. These reflect approximate savings based on average revenue/Dth by class.
5. Because of recent increases in natural gas costs it is likely that total bill reductions will be larger.
6. Does not include bill savings from commodity price effects. Over the planning horizon, savings from cumulative commodity price effects from the program scenario are an additional $288 million (2005$). Therefore, ultimate total bill savings from both efficiency and price effects might be approximately $0.6 billion (0.3 + 0.3).

2.4.5. Price effects

As mentioned above, the analysis included an estimate of the downward pressure on commodity prices from reduced demand by the program scenario savings. Because gas supply is somewhat constrained and expected to remain so, small reductions in demand can have a small impact on the market clearing commodity price, resulting in additional benefits to all gas consumers beyond those captured from program participants directly through reduced energy use. The *total* consumer commodity cost savings from the program scenario have two components: 1) the savings resulting from lower commodity prices (price effect); and 2) the result of lower commodity *usage* because of energy savings (energy savings).

The average estimated commodity price decrease from 2007-2016 from the program scenario would be approximately 0.2% of commodity costs. This would result in total present value (2005$) New York gas consumer commodity price savings of $500 million for price effects through 2025.[37] Including these price effects in the economic analysis, shown above in Table 2.22, the program scenario TRC benefits would be $2.4 billion, net benefits $1.6 billion, and a benefit-cost ratio (BCR) of 3.14.[38]

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[37] The $500 million present value consumer savings reflect only the effect of lower prices, and do not include the consumer savings resulting from the fact that gas consumption would also be lower than if the program scenario were not pursued.

[38] Note that the New York Public Service Commission in its March 16, 2006 Order in Case 04-E-0572 has questioned whether price effects should be counted in TRC analyses.

Average annual commodity price savings from price effects alone (in 2005$) during the planning horizon (2007-2016) would be $29 million/yr.[39] Total 2016 cumulative consumer commodity price savings from price effects alone (in 2005$) would be approximately $288 million from the program scenario. Table 2.22 below shows price effects in 2005 dollars for the planning period.

Table 2.22. Annual Price Effects 2007 – 2016, Million 2005$

Sector	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total 2007-2016	Average Annual 2007-2016	Average Consumer Cost Savings as a Percent of Costs
Residential	2	6	6	6	7	9	8	8	7	10	69	7	0.1%
Commercial	2	6	6	5	8	8	7	8	7	10	66	7	0.2%
Industrial	1	3	3	3	4	5	4	4	4	6	36	4	0.2%
Power Generation	3	7	8	10	16	16	11	14	12	19	116	12	0.3%
Total	**9**	**22**	**22**	**24**	**35**	**38**	**29**	**33**	**30**	**44**	**288**	**29**	**0.2%**

When considering the *total* consumer commodity cost savings resulting from both lower commodity prices and lower total gas consumption, the total savings over the planning horizon (2007-2016) would be $1.3 billion (2005$). Note that this is not the same as total bill reductions, which would be based on retail rates that include contributions to transmission and distribution costs as well as commodity costs. Total bill reductions are estimated separately above based on 2004 retail rates.

2.4.6. Alternative Funding Scenarios

As noted above, the program portfolio analysis was performed with a single funding scenario, rather than various levels, due to limited budget and time. However, the report provides some preliminary estimates of achievable program potential at different levels of funding. Readers are cautioned that these estimates are not the result of in-depth analyses conducted in this study, but rather estimated based on the authors' prior experience with numerous other programs and potential studies in New York and other jurisdictions. These alternate scenarios also should not be viewed as recommendations but as an attempt to give readers a sense of likely impacts and provide guidance on how to extrapolate results from the more detailed analysis.

Three alternate scenarios are provided for consideration:

- **Maximum achievable potential** — a preliminary estimate of the portion of total maximum amount of economic potential that could be achieved. As a maximum, this

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[39] While the program scenario only analyzes impacts through 2016, these savings will continue for the life of the efficiency measures and result in continued price effects beyond 2016.

implies delivery of well designed, aggressive, fully funded programs paying 100% of the costs of all economic efficiency measures.[40]

- **Spending 150% of the program scenario funding level** — a preliminary estimate of the likely additional savings that could be captured by increasing the average spending of $80,000,000 per year spending to $120,00,000 per year.
- **Spending 50% of the program scenario funding level** — a preliminary estimate of the likely reduction in savings by decreasing the $80,000,000 per year spending to $40,000,000 per year average spending.

The study estimates maximum achievable potential over the 10-year period would be approximately 65% of the total 2016 economic potential, or 184,000 MDth. This would represent an overall reduction of 18% of 2016 forecasted load, more than offsetting expected load growth over the 10-year planning horizon, and providing a *decline* in average annual growth of approximately 1.1%. Note that this maximum achievable would require program delivery for a full 10-year period, as opposed to the program scenario which only analyzed programs for five years of delivery. This is because the ability to fully ramp up program delivery and build capability to capture maximum achievable potential at this aggressive level would take time and effort, and also because it would require maximum capture of all new construction savings in each year. The estimated overall costs to pursue maximum achievable savings would require average additional spending (in excess of measure costs) of approximately 30% of measure costs to cover program delivery costs including general administration, marketing, tracking, technical assistance, monitoring and evaluation, and other non-incentive costs.

Maximum achievable projections are based on professional judgment. The authors have conducted numerous other potential studies (including an electric and renewable efficiency study in 2003 for NYSERDA) and have reviewed numerous potential studies, program evaluations, and documents researching the penetration rates and costs of the best efficiency programs throughout North America.

For the 50% and 150% funding level scenarios, estimated savings would be approximately 60% and 140%, respectively, of the estimated portfolio savings. In other words, at an average annual funding level of $40 million, total 2016 savings would be roughly 9,120 Mdth. At $120 million/yr, 2016 savings would be roughly 21,280 Mdth. The reason for larger yield in Dth saved per $ spent from the 50% scenario is that moving up the efficiency resource supply curve increases the costs of capturing additional savings. In addition, at the increased funding level incentive levels might also increase. This has a two-pronged effect in that the program would pay increased incentives not only for the new additional savings, but also for all the savings that could have been captured at the lower incentive level.

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[40] In theory a program could pay more than 100% of measure costs and achieve higher levels of potential. However, maximum achievable analyses generally assume incentives capped at 100% of measure costs by convention. Note this report does not propose paying programs be implemented that 100% incentives for all measures.

The estimates at the 50% and 150% spending levels should be treated with a great deal of caution. These are not based on any analysis of exactly what one might do to modify the program portfolio. For example, if one wanted to, certain programs could be eliminated at the lower spending level, and if these were generally lower yield programs, then savings might be higher. Alternatively, if one were to choose to spend the additional funds on low-income programs, yields might be lower than estimated. In general, however, because the levels of spending and savings considered are roughly an order of magnitude lower than those associated with capture of maximum achievable potential, it is likely that this represents a fairly flat part of the efficiency resource supply curve. In other words, moderate increases or decreases in funding should provide roughly proportional increases or decreases in savings, depending of course on policy and other decisions about how to allocate the funds.

2.4.6.1. Guidance on Potential Portfolio Modifications

While this study does not substitute for a more detailed program plan, once funding levels are established, the following suggestions provide some guidance on things to consider given different possible funding scenarios. Individual programs are not necessarily easily scalable up or down. While some are, others require a minimum level of effort and spending, particularly related to upstream markets, to be worthwhile to pursue. Also, modifications to the portfolio can result in a skewed allocation of resources from an equity perspective.

Given that, the following guidance is provided:

- For small funding level adjustments up or down (such as less than 15%), flexibility should exist to maintain a similar portfolio and scale programs roughly equally, preserving the allocation among sectors and for low-income.
- In general, the low-income and C&I existing construction programs are scalable up and down because they include significant components of discretionary retrofit measures, which can be captured at any time. In addition, both the Residential and C&I New Construction programs are fairly scalable (particularly downward) because, although they involve significant upstream efforts and fixed costs, the infrastructure for these programs already exists within New York's electric efficiency portfolio and gas funds can simply enhance service offerings and expand participation. However, substantial increases in funding for these programs are obviously constrained by the overall new construction activity occurring.
- For significant drops in funding, one might want to consider eliminating the Food Service program and/or the Small Heating and DHW programs. These programs are designed to transform these markets through aggressive and sustained upstream efforts directed at manufacturers, distributors, vendors and contractors. With lower funding, it may be more advantageous to shift efforts to the Residential and C&I New and Existing and low income programs. Food service, small heating and domestic hot water technologies can still be promoted under these broader programs, but would likely not have the full market-transformation benefits anticipated from a more focused effort.

- Significant increases in funding would allow for consideration of additional programs as well as scaling up the currently analyzed ones. A residential home performance program designed to capture retrofit opportunities in existing homes is a prime example. This was not included in the portfolio because the funding limitations could not support it.

3. GAS DEMAND AND PRICE FORECASTS

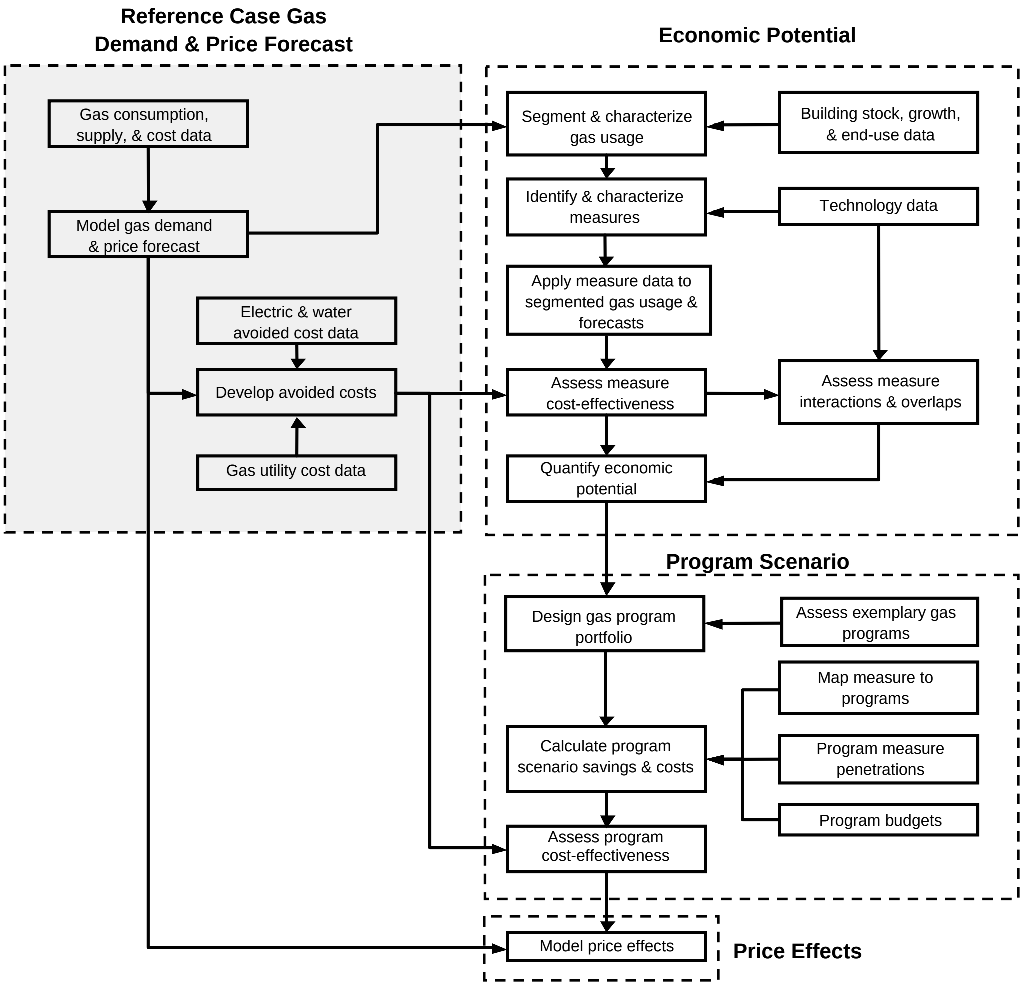
3.1. INTRODUCTION

This section describes the development of the natural gas price and demand forecasts for New York, and the development of gas avoided costs. The results of tasks are used to:

- Establish future gas loads and new construction activity as a starting point in estimating the economic potential
- Establish current and forecast gas avoided costs to use for valuing efficiency savings
- Model future gas commodity prices to analyze the price effects of capturing savings from the program scenario

Figure 3.1 below shows how these tasks relate to the overall project.

Figure 3.1. Project Flow: Reference Case Gas Demand and Price Forecast



3.2. REFERENCE CASE GAS DEMAND AND PRICE FORECAST

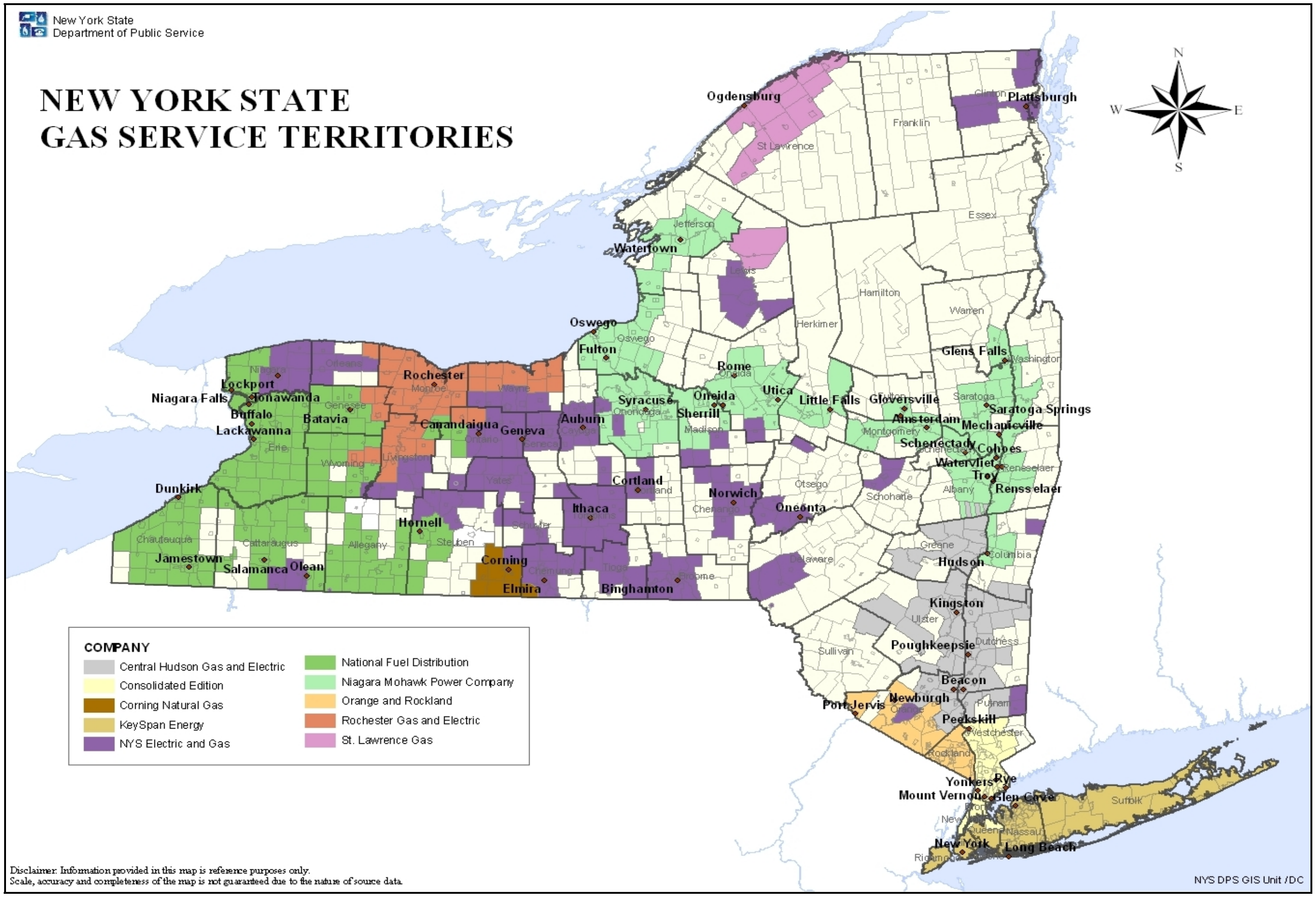
The reference case natural gas sales and price forecasts were developed using Energy and Environmental Analysis, Inc.'s (EEA) *Gas Market Data and Forecasting System.* This system is a full supply/demand equilibrium model of the North American gas market. The model solves for monthly natural gas prices throughout North America, given different supply/demand conditions, the assumptions for which are specified by the user. Overall, the model solves for monthly market clearing prices by considering the interaction between supply and demand curves at each of the model's nodes. On the supply-side of the equation, prices are determined by production and storage price curves that reflect prices as a function of production and storage utilization. Prices are also influenced by "pipeline discount" curves, which reflect the change in the basis or the marginal value of gas transmission as a function of load factor. On the demand-side of the equation, prices are represented by a curve that captures the fuel-switching behavior of end-users at different price levels. The model balances supply and demand at all nodes in the model at the market-clearing prices determined by the shape of the supply curves. Unlike other commercially available models for the gas industry, the model does significant back-casting (calibration) of the curves and relationships on a monthly basis to make sure that the model reliably reflects historical gas market behavior, instilling confidence in the projected results.

3.2.1. Reference Case Assumptions

The analysis developed a reference case forecast specifically for this study of consumption and price based on EEA's July 2005 forecast. This forecast uses default assumptions that imports of liquefied natural gas (LNG) increase during the forecast period, that the Alaska gas pipeline is constructed but does not begin delivering gas until the very end of this study's period (2016), and that additional pipeline and storage capacity is constructed supplying the State – particularly into the supply-constrained downstate region. The primary deviation in the reference case from the default forecast assumptions is an increase in the share of electric power generation in the State that comes from renewable energy sources. This change was made to be consistent with the New York's renewable portfolio standard.

Two consumption and price forecasts are provided: one for the downstate region including New York City, Long Island and Orange, Rockland and Westchester Counties; and the other for the upstate region encompassing the rest of the State (see Figure 3.2).

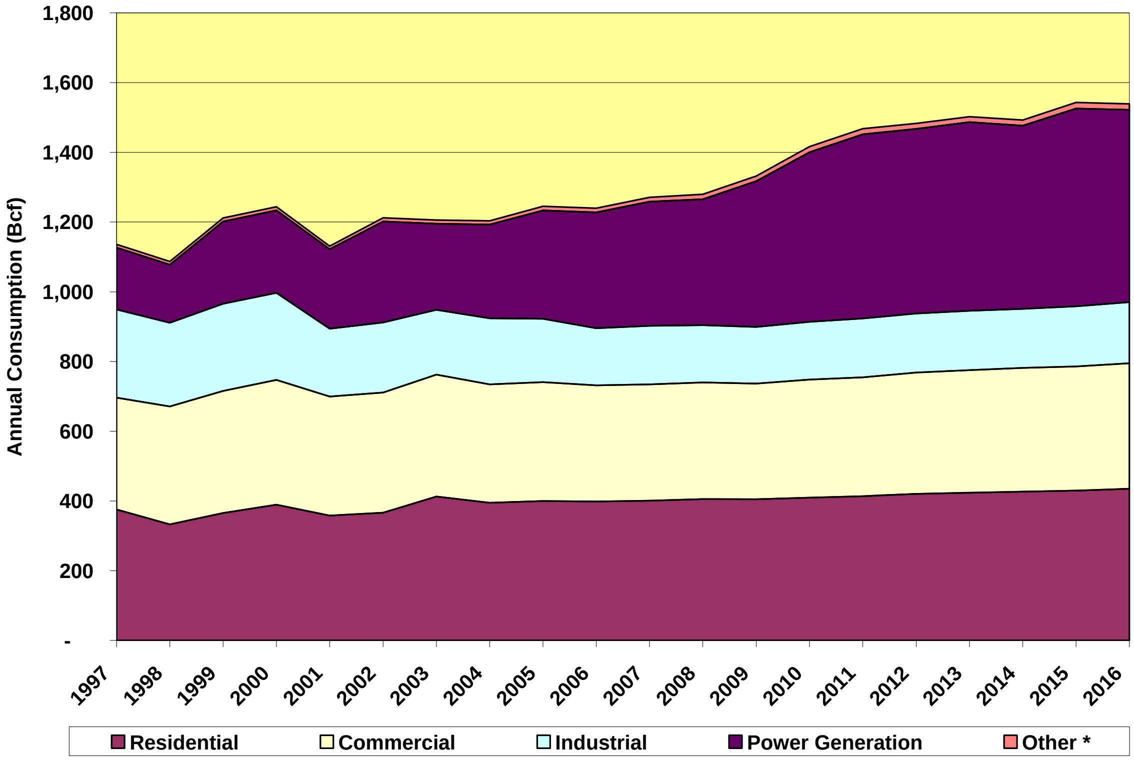
Figure 3.2. New York Gas Service Territories



3.2.2. Demand Forecast Growth by Sector.

In the reference case New York annual gas consumption is forecast to grow by nearly 270 Bcf from 2007 through 2016, to 1.5 Tcf as shown in Figure 3.3. The average annual growth rate from 2007-2016 is 1.9%. In particular gas consumption in the power sector will grow substantially, accounting for 71% of the growth in natural gas consumption through 2016, continuing a trend begun in the late 1990s. This trend is expected to continue in spite of forecasts of high natural gas prices because of the growing demand for electricity in the State and the pressures of stringent environmental regulations. Average annual growth from 2007-2016 in the power sector is estimated to be 4.2%.

Figure 3.3 Projected Growth in N.Y. State Natural Gas Consumption by Market Segment

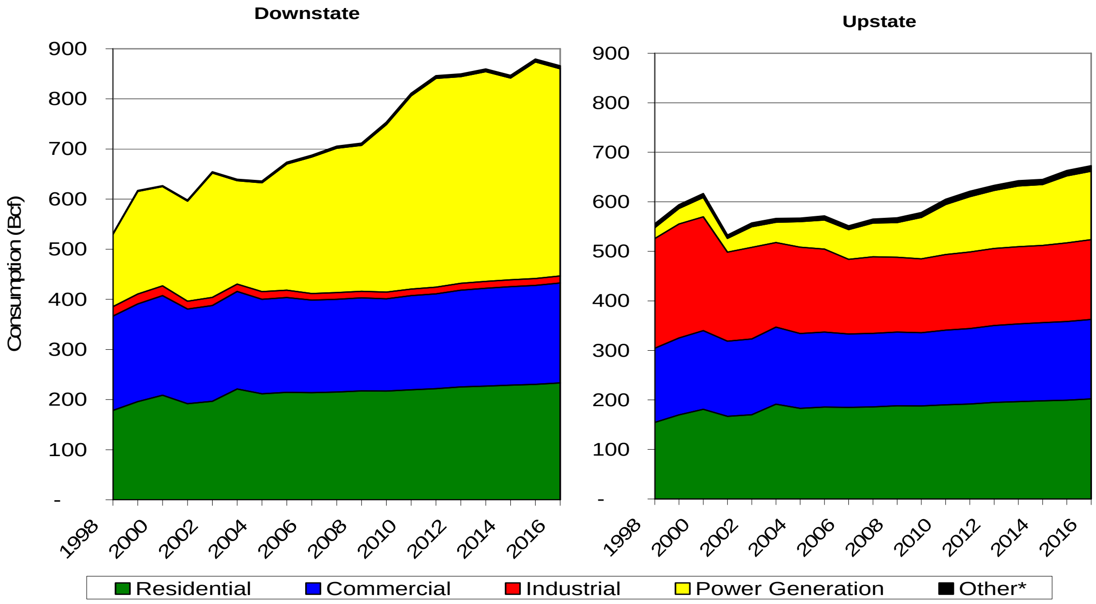


* Other includes lease and plant fuel (natural gas used in well, field, lease operations and as fuel in natural gas processing plants), and fuel consumed in transmission pipeline pumping.

During this period there is modest and steady growth in residential and commercial gas consumption.[41, 42] Fuel switching for these customers was not included in the demand forecast. Average annual 2007-2016 growth in gas consumption is 0.8% for both residential and commercial, and 0.4% for industrial. Industrial consumption is expected to fluctuate around current levels for the forecast period in part because of relative decline in industrial activities in the State and because of persistent high natural gas prices.

The consumption patterns differ significantly between the upstate and downstate regions (Figure 3.4). Nearly 60% of the growth in gas consumption from 2007 to 2016 for New York is concentrated downstate, mainly due to increased consumption in the power generation sector in that area as can be seen in the figure. Power sector consumption grows 100% upstate, though from a smaller base. For industrial consumption, 90% of the growth is upstate, as downstate consumption is nearly flat. Non-power gas consumption grows 8.6% downstate compared to 8.1% upstate.

Figure 3.4 Natural Gas Consumption Forecast, Downstate and Upstate*



* Other includes lease and plant fuel (natural gas used in well, field, lease operations and as fuel in natural gas processing plants), and fuel consumed in transmission pipeline pumping.

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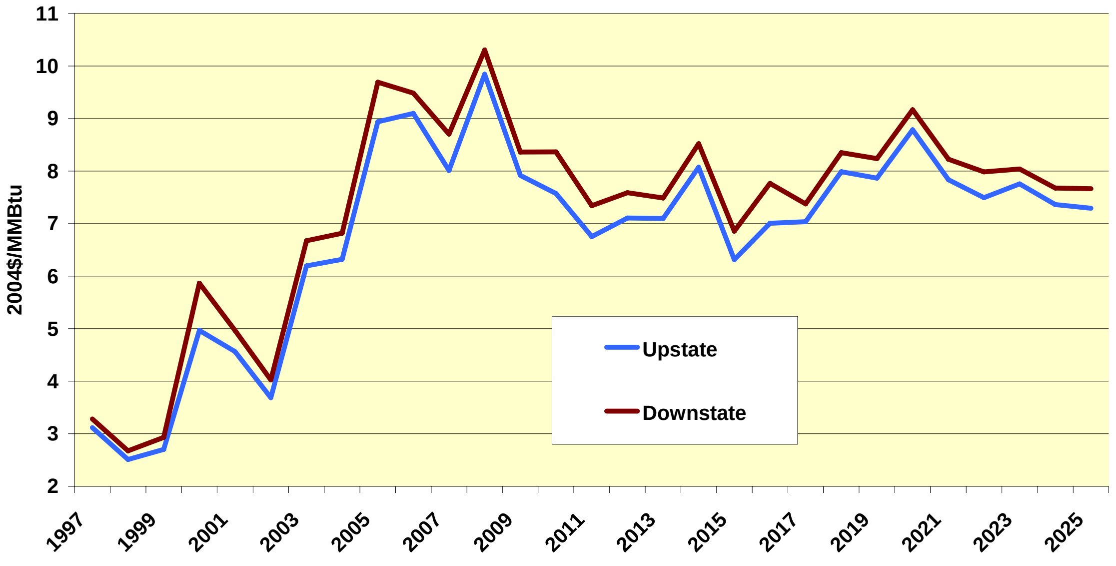
[41] Residential and commercial customer fuel switching from oil to natural gas was not included in the demand forecast.

[42] EIA's reported gas consumption for New York in 2004 is approximately 120 Bcf lower than EEA's consumption estimate. However, EIA also shows a balancing item of -50 Bcf for 2004, indicating that actual consumption may be higher. Regardless of the exact value, the fact that EEA's consumption estimate for 2004 is higher than EIA's reported value does not affect projected demand.

3.2.3. Reference Natural Gas Price Forecast

Based on these assumptions and the projected consumption, the analysis developed a reference forecast of the wholesale prices of natural gas for the downstate region including New York City, Long Island, and Orange, Rockland and Westchester Counties, and for the upstate region encompassing the rest of the State as shown in Figure 3.5. The prices reflect the forecasted North American wholesale price as referenced at the Henry Hub in Louisiana with transportation and congestion charges applied. As the figure indicates, prices are projected to continue to remain high over the next few years before peaking in 2008, and then declining somewhat over the next decade, though continuing to remain at levels significantly higher than experienced during the 1990s.

Figure 3.5 Historical and Reference Forecast Average Annual Wholesale Natural Gas Prices for New York



It is important to keep in mind that these projections include a significant level of uncertainty. Since the North American market is for the most part fully integrated, national events will have a significant impact on future prices of natural gas. Since the reference case was set, several market events have significantly affected natural gas markets. The two most significant have been the 2005 hurricane season that resulted in significant and unprecedented disruptions in production, processing and transportation of natural gas from the Gulf of Mexico. These disruptions, which are persisting longer than most had expected, put significant pressure on natural gas storage levels for the winter of 2005-06. In addition, global prices for oil have remained well above forecasted level, and recent projections from the U.S. Department of Energy's Energy Information Administration in the *Annual Energy Outlook 2006* now see long-term oil prices 64% higher than was forecasted just a year ago. These higher oil prices will provide additional support for continued high natural gas prices.

The biggest uncertainty in natural gas prices however is weather. Until the summer of 2005, the past few years had seen moderate weather thus, depressing demand for natural gas for both winter heating and power generation for peak summer cooling, and in part, masking the tightness of supply that exists in the market. The summer of 2005 was only moderately warmer than normal, however, the number of cooling degree days were over twice those of 2004, which resulted in a late summer spike in natural gas prices resulting from increased electric power demand before any of the major hurricane disruptions. With demand constrained by deliverable supplies of natural gas for the next several years, prices are likely to remain volatile, driven by market wide forces and weather. In the longer-term, prices will be defined by major decisions such siting of future LNG terminals, the timing of the Alaska pipeline construction, and decisions on whether to drill in current moratoria regions on the outer continental self. These decisions, along with global oil prices and weather, are likely to have greater impact on prices than domestic consumption patterns alone.

3.3. AVOIDED GAS AND OTHER RESOURCE COST FORECASTS

The economic evaluation of an energy-efficiency measure requires an estimate of the measure's benefits. The major benefit of gas energy-efficiency programs is the reduction of gas use and associated costs to customers. Costs avoided are generally passed on to customers in the form of lower gas commodity prices.

Electric avoided costs are often computed for a number of cost drivers, such as summer and winter contribution to system peak load, and seasonal energy use for on- and off-peak periods. In the cost-benefit computation, analysts estimate the effect of a proposed measure or program on each of the cost drivers. The benefit of the energy-efficiency proposal is then estimated by multiplying the energy savings for each cost driver by the per-unit avoided cost for that driver, and adding up the benefits for all the drivers. This approach works well for evaluation of electric energy-efficiency programs, simplifying the costs of serving loads for 8,760 hours to a few cost drivers, which can be estimated for the wide variety of electric end uses (*e.g.*, residential and commercial space heating, space cooling, ventilation, water heating, refrigeration, indoor and outdoor lighting, clothes drying, cooking, computers and other plug loads, as well as a range of industrial loads).

Like most detailed analyses of avoided gas costs, this study's calculation of avoided costs is structured differently than that usually used to estimate electric avoided costs. Planning and procurement for natural gas is primarily concerned with daily loads, rather than annual loads, so there are fewer load shapes. There are also fewer end uses for gas than electricity, since very little gas is used for lighting, refrigeration, or residential air conditioning, and no gas is used for computers or ventilation. Hence, it is feasible to compute avoided costs for the load shapes of the few gas end uses. In the cost-benefit analysis, the benefit of each energy-efficiency measure can be estimated as the measure's annual savings times a single load-specific avoided cost.

This load-shape approach to defining avoided costs allows for distinctions between the costs of different end uses that impose different costs, even for similar seasonal usage levels. An end use that does not vary with weather, such as cooking or clothes drying, may use the same amount of gas in the winter as a heating boiler, but the gas to serve the boiler will be more expensive. The boiler will predictably use more gas on very cold days, when gas is most expensive, and less on mild days, when gas is relatively cheap. Serving the boiler requires the reservation of enough pipeline capacity to meet load on typical cold days, and the construction of local transmission-and-distribution capacity and supplemental gas supplied to meet load on extraordinarily cold days. The boiler will use more gas on cold days, when regional gas demand is high and prices are high. The development of avoided cost by load shape allows for the reflection of these differences between loads even within a season or a month.

This estimate of avoided gas costs comprises the following three parts:

- Commodity: The market prices of gas delivered to a utility's citygate in a normal year
- Peaking capacity: The costs of local capacity to cover the difference between normal and design-peak conditions
- Local transmission and distribution (T&D): The utility's cost of building, operating and maintaining the high-pressure transmission and lower-pressure distribution system in its service area

3.3.1. Commodity Cost

This forecast of commodity costs starts with Energy and Environmental Analysis's 2006–2025 forecast of monthly gas prices delivered to the New York City citygate for downstate and to a variety of utility citygates for upstate (Brock 2005) and computes annual commodity costs for the following five load shapes:

- Baseload, including industrial processes, cooking, and clothes drying, modeled as using the same amount of gas every day.
- Residential space heating, modeled as using gas each day in proportion to the difference between 50°F and the average temperature for the day.[43]
- Commercial space heating, modeled as using gas each day in proportion to the difference between 65°F and the average temperature for the day.
- Water heating, modeled as a mix of baseload and space-heating load.
- Space cooling, for the large commercial buildings that cool with gas, modeled as using gas in proportion to cooling degree days, the difference between the average temperature for the day and 65°F.

For weather-sensitive load shapes, the forecast uses data from Central Park weather for downstate and an 80:20 weighting of Rochester and Albany for upstate.

While gas utilities do not purchase a large portion of their supply in the daily spot market, the short-term market in which utilities can procure gas to meet higher-than-expected load, or sell off gas when their supplies exceed their needs determines the value of the gas. Every dekatherm of

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[43] That difference is referred to as heating degree-days, in this case with a 65°F base temperature.

gas that a New York consumer does not use is one more dekatherm that is available to someone in the spot market who is willing to pay the spot price for that gas. Depending on the gas-supply situation and contracts of the consumer's utility (or gas supplier), the utility may avoid buying gas from the spot market, or sell more gas into the spot market, or reduce its use of some longer-term contract. In any case, the resource benefit of the reduced gas use is its value to the new purchaser, buying at spot.

In the longer term, annual and multi-year contracts should average near the spot prices for the same time periods. Estimating the effect of specific load reductions on the supply portfolio and costs of any particular utility or gas supplier is complicated, since the calculation would have to model purchases, sales and usage of a variety of gas supplies, pipeline capacity, storage resources, and supplementary resources. This approach would also require non-public data from competitive gas suppliers. For this report, simulating the portfolio purchase decisions would be further complicated by the fact that each region of the State is served by several utilities and some number of gas suppliers.[44] The spot-market price is a reasonable estimate of the resource benefit from reduced commodity use.

3.3.1.1. Baseload Commodity

For baseload end uses, where use of gas does not vary with weather or the season, the analysis weights the forecast monthly gas price by the number of days in the month.

3.3.1.2. Space-Heating Commodity

The cost of commodity for space heating varies from the cost of baseload in two ways. First, the amount of gas used varies among months, and is concentrated in the higher-cost winter months. Second, within each month, space heating uses more gas on the colder days, when gas tends to be more expensive than the average for the month.

For the first factor, the monthly percentage the study assumed that the monthly use of gas for space heating is proportional to the monthly sum of daily heating degree days (HDDs). Heating degree days are the difference between the day's average temperature and a base temperature, at which space-heating use is assumed to be zero. That base temperature, or balance point, is lower than the temperature maintained by the thermostat, since the building is warmed by sun shining in the windows and by interior gains (waste heat) from lights, appliances, equipment, and people.

For residential space heating the study used the monthly average HDDs with a base of 65° F for 1971–2000 published by National Oceanographic and Atmospheric Administration (National Climatic Data Center 2001a). For commercial space heating, the balance point would be lower, since interior gain tends to be greater in these larger buildings. While the balance point varies from building to building, this analysis assumed an average of 50° F. The National Oceanic and Atmospheric Administration (NOAA) does not publish long-term average monthly HDDs for base

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[44] After concerns were raised regarding the avoided commodity cost, the Con Edison staff reviewing this study were asked whether the Company had a model of its gas-purchasing that could be used to determine the savings from load reductions. The staff did not believe that computation would be feasible.

temperatures other than 65° F. Consequently, to calculate the monthly HDD distribution for other temperature bases, the analysis distributed the annual average HDD figures for the locations (NOAA 2002, 47–7) as per the calculated observed distribution for the years 1999–2004, derived from the average daily temperature data (NOAA 2005).

The second factor, the effect of the intra-month correlation of price and load, reflects the fact that heating loads use more gas on colder days within each month, and that prices tend to be higher on cold days.[45] This correction was computed as the typical ratio of the heating-load-weighted market price to the average daily price for the month. Since the EEA price forecast is for the average daily market price of gas for the month, multiplying that ratio by the EEA price forecast results in an estimate of the price of gas for heating load in the month.

Table 3.1 illustrates the intra-month correlation between daily January heating degrees and daily citygate prices for New York City, for a 65°F base temperature and for a 50°F base temperature.

Table 3.1. Variation with Temperature of January New York City Wholesale Commodity Costs, 1999–2004 ($/Dth)

65° F Heating Base			
Average Temperature	**Days**	**Average HDs**	**Average price**
Less than 15º F	10	52.6	$16.7
15–25º F	36	44.9	$10.5
25–35º F	64	35.2	$7.4
35–45º F	54	25.9	$5.0
45–55º F	18	16.3	$3.2
55–65º F	2	6.5	$2.8
50° F Heating Base			
Average Temperature	**Days**	**Average HDs**	**Average price**
Less than 15º F	—	—	
15–25º F	1	42.0	12.5
25–35º F	27	34.1	12.2
35–45º F	52	24.1	9.1
45–55º F	63	15.3	6.3
55–65º F	31	6.3	3.6

Very high HDD values are rarer with the 50°F base than with the 65°F base, and HDD values between 0°F and 20°F are more common with the lower base. For example, a day averaging 40°F would have 25 HDD with the 65°F base and only 10 HDD with the 50°F base.

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[45] The utility or a gas supplier can meet load in those high-load high-priced days with spot purchases, by reserving storage and associated transportation to the citygate, or by reserving additional pipeline capacity directly to the citygate. All these approaches impose costs that would not be needed for a load that was constant across the days of the month.

The correlations between January daily HDDs and prices are about 0.51 for the 65°F base and 0.50 for the 50°F base. In other words, within January, about half the variation in price is explained just by that day's temperature. Of course, gas prices vary due to factors other than the current day's temperature, including the following:

- Wind and sunshine on that day, since heating load will be higher on a cloudy, windy 40°F day than a sunny calm day with the same air temperature.
- Weather in other parts of North America. A cold snap in California will drive up wellhead prices in Texas and Alberta, and hence prices for deliveries to New York. Cold temperatures in New England or Pennsylvania not only raise wellhead prices, but also market prices for delivery to New York citygates. Conversely, mild weather elsewhere can moderate prices in New York, even when it is cold in New York.[46]
- Weather on other days. High gas demand in earlier days of the same month, or in earlier months, will tend to deplete storage and push prices higher. Forecasts of cold weather will tend to push up price before the cold front hits, as users scramble to put gas into storage.
- Gas in storage, which depends on the weather, other gas demands over the previous year or so, market participants' guesses regarding price tends, and other factors.
- Demand for gas for electric generation, which varies during the month with oil prices and outages of coal and nuclear plants and between years as load grows and supplies change.
- Gas production capacity, which changes within winter months primarily due to freeze-ups of gas wells in producing areas, but changes significantly between years due to depletion and new additions (and sometimes hurricanes).

Several of these factors affect prices for an entire winter, or an entire year. For example, in mid-June of the previous year, well before anything specific was known about January weather, the forward price for January 2003 was about $4, while a year later the forward price for January 2004 was about $6.30. Considering all the factors that affect daily temperatures, it is remarkable that daily temperatures account for half the variation in cost across six years.

For this study, the intra-month price ratio was computed for each calendar month using data across the six years. The analysis computes the ratio of load-weighted to average monthly price for downstate from Transco New York prices and Central Park weather. For upstate, the analysis used a weighted average of 80% of the ratio for Rochester weather and Niagara prices, and 20% of the ratio for Albany weather and Iroquois prices.[47]

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[46] The effect also applies between the two regions of the State. Low temperatures downstate increase upstate prices, and vice versa.

[47] For a small number of days, either price or temperature data was unavailable; those days were omitted from the analysis. Where the denominator of the ratio was zero (because there were no HDDs in the month), the ratio is set to one; since that circumstance occurred only in one month of minimal heating load, the choice of ratio for those months had no material effect.

Equation 1. Intra-Month Heating Price Ratio.

$$\text{intra-month heating price ratio} = \frac{\left[\dfrac{\sum_{month} HD_{day} \times P_{day}}{\sum_{month} HD_{day}}\right]}{\left[\dfrac{\sum_{month} P_{day}}{\text{\# days in the month}}\right]}$$

The ratios tend to be highest in the winter and lower in the shoulder months, higher downstate than upstate and higher with a 50° F balance point than a 65° F balance point. The average of the monthly ratios, weighted by HDDs, is about 1.04 upstate with a 65° F balance point and about 1.20 downstate with a 50° F balance point.

The heating commodity cost for each year is the sum across months of the following product:

EEA monthly price forecast × monthly HDD % × intra-month price ratio

The annual heating commodity cost is significantly greater than the annual baseload commodity cost. The annual residential heating avoided cost, averaged over the period 2006–2025, is 21% greater than average annual baseload downstate and 11% greater than average annual upstate. The commercial heating avoided cost over the same period averages 43% more than baseload downstate and 21% upstate. These differences can largely be explained by the fact that most of the heating usage is in the high-priced months of January, February, and December. Over the period 2006–2025, the downstate residential heating cost averages about 1% less than the average of EEA's forecasts of prices in the three peak winter months.

3.3.1.3. Water-Heating Commodity

Based on previous experience, the analysis assumed that water-heating load is similar in shape to 75% baseload and 25% space-heating load. The heating-like shape is due to a combination of higher standby losses and longer, hotter showers and baths in cold weather.

3.3.1.4. Cooling Commodity

For gas cooling, the analysis assumed that cooling load follows cooling degree days (National Climatic Data Center 2001b; NOAA 2002), which are comparable to heating degree days, except that they are computed for temperatures in excess of 65° F, NOAA's standard. This approach is a gross oversimplification, since many large buildings require cooling at much lower temperatures, especially on sunny days. On the other hand, gas cooling is often used in hybrid systems with electric cooling, with the gas system operating only in the peak hours (when energy rates are high and demand charges would be imposed), and with electric cooling covering off-peak periods and supplementing the gas chiller at peak. Because these factors act in opposing directions, use of cooling degree days is a reasonable approximation.

The computation of avoided commodity for cooling load mirrors that for space-heating load.

3.3.1.5. Commodity-Cost Summary

Table 3.2 shows avoided commodity costs for the two regions and the five load shapes. The relationships among the prices for the various load shapes are as expected. Downstate prices are consistently higher than upstate prices. For each region, the commercial heating cost is higher than the residential heating cost, which is higher than the water-heating cost, which is higher than the baseload cost, which is in turn higher than the cooling cost (except in 2006).

The average costs of utility gas supplies, which serve large amounts of heating load, tend to be much higher than the flat year-round gas supplies reflected in the baseload commodity costs or the EEA annual average price. The average avoided commodity cost will similarly be more expensive than the avoided commodity cost for a flat year-round gas supply.

Table 3.2. Avoided Commodity Costs (2005$/Dth)

	Downstate (NYC)					**Upstate (80% Rochester, 20% Albany)**				
	Heating w/ Base		*Baseload*	*Water Heating*	*Cooling*	*Heating w/ Base*		*Baseload*	*Water Heating*	*Cooling*
	65°F	50°F				65°F	50°F			
2006	$12.23	$14.96	$9.79	$10.40	$9.88	$10.85	$12.77	$9.38	$9.75	$9.61
2007	$10.53	$12.27	$9.00	$9.38	$8.69	$8.64	$9.15	$8.28	$8.37	$8.26
2008	$11.76	$13.03	$10.66	$10.93	$9.55	$10.51	$10.67	$10.18	$10.26	$8.98
2009	$11.20	$13.26	$8.64	$9.28	$6.86	$9.77	$10.97	$8.17	$8.57	$6.46
2010	$10.67	$12.59	$8.65	$9.15	$7.45	$8.51	$9.07	$7.83	$8.00	$6.96
2011	$9.54	$11.57	$7.58	$8.07	$7.33	$7.77	$8.80	$6.97	$7.17	$7.09
2012	$9.18	$10.59	$7.85	$8.18	$7.08	$7.81	$8.23	$7.35	$7.46	$6.72
2013	$9.42	$11.00	$7.73	$8.15	$6.76	$8.23	$9.02	$7.33	$7.55	$6.38
2014	$10.29	$11.78	$8.81	$9.18	$7.92	$8.97	$9.46	$8.35	$8.50	$7.52
2015	$9.71	$12.15	$7.08	$7.74	$6.48	$7.93	$9.47	$6.51	$6.87	$6.31
2016	$9.86	$11.85	$8.02	$8.48	$7.38	$7.66	$8.26	$7.23	$7.34	$7.06
2017	$9.47	$10.93	$7.61	$8.08	$5.92	$8.38	$9.10	$7.26	$7.54	$5.53
2018	$9.98	$11.47	$8.63	$8.97	$7.98	$8.86	$9.48	$8.25	$8.40	$7.61
2019	$10.34	$12.17	$8.51	$8.96	$7.80	$9.11	$10.10	$8.12	$8.37	$7.46
2020	$10.93	$12.56	$9.47	$9.84	$8.74	$9.72	$10.40	$9.08	$9.24	$8.34
2021	$10.53	$12.47	$8.49	$9.00	$7.55	$9.21	$10.26	$8.09	$8.37	$7.24
2022	$10.01	$11.82	$8.25	$8.69	$7.37	$8.48	$9.26	$7.74	$7.92	$7.04
2023	$9.67	$11.09	$8.30	$8.65	$7.50	$8.71	$9.36	$8.01	$8.19	$7.17
2024	$9.56	$11.28	$7.93	$8.34	$7.39	$8.45	$9.38	$7.61	$7.82	$7.13
2025	$9.59	$11.23	$7.91	$8.33	$6.86	$8.36	$9.12	$7.53	$7.74	$6.54

3.3.2. Peaking Capacity Cost

In addition to buying and delivering the gas required in a normal year, a gas utility must be prepared to meet much higher loads on an extremely cold (design-peak) day.[48] The prices for gas in a normal year (which EEA assumes for its gas-price forecast) do not include the costs of

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[48] Energy supplies must also be sufficient to meet colder-than-normal weather for days or weeks at a time.

reserving capacity and supplies to meet design-day conditions. Those design loads are normally met by local storage (compressed natural gas or liquefied natural gas); injection of a mixture of propane and air into the distribution system; or peaking off-system storage and associated transportation. New York gas utilities use the latter approach for most of their incremental peaking supplies.

New York State Gas and Electric (NYSEG) provided an estimate of the cost of its incremental peaking capacity contract.[49] NYSEG estimates a peaking capacity contract cost based on the cost of its Seneca Lake storage facility, of approximately $83/Dth-day in year-2000 dollars, or approximately $94/Dth-day in the 2005 dollars used in this report.

While New York gas utilities primarily use storage (including contracts) for peaking services, the analysis examined the cost of propane as a check of the estimated peaking cost services. Based on a review of a number of gas-utility marginal-cost studies (Boston Gas Company 1993; Vermont Gas Systems 1994; Brock 2005; Harrison 2001), the analysis estimated that propane-air equipment would cost about $250/Dth-day of capacity for capital costs and $45/year/Dth-day for O&M.[50] Based on other recent estimates by Con Edison, the real levelized carrying charges, covering depreciation, return, income taxes and property taxes, would be about 10% per annum, which results in a cost of $70/year/Dth-day for typical sites.[51] Given the costs of downstate land, and the special problems of building in most of that congested region, the analysis assumed a 20% locational adder, bringing the cost to $84/year/Dth-day. Despite the small estimated cost advantage of the propane supply, the New York utilities rely primarily on storage for peaking supplies, so the analysis used the storage estimate, rounded to $100/year/Dth-day.

Since baseload and cooling loads have no increment of sendout on the design peak over average conditions, they would not have any peaking capacity charges.

While actual gas-system supply planning is quite complex, the problem was simplified by assuming that peaking capacity is required for the difference between sendout on a design peak day and on the average January day. It was assumed the design day was equivalent to the day with the highest number of heating degrees in the period 1995–2004, for which daily temperature data were readily available. The analysis estimated the peaking cost per Dth of annual sendout as the annual capacity cost times the difference in heating degrees between average January day and design day, divided by the annual HDD.[52] Table 3.3 shows the resulting peaking cost in dollars per Dth.

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[49] Harrison 2001. National Gas Fuel provided the cost of one peaking supply (Nexen, at $60/Dth-day), but was not clear about whether pipeline charges would be incurred to connect to the supply (Clark 2004).

[50] The propane estimated cost used by NYSEG is much higher, about $1,000/Dth-day. Hence, storage appears to be the least-cost peaking alternative.

[51] The analysis did not include carrying charges on the inventory of propane at the injection plants.

[52] For example, for downstate residential heating, the average daily heating degrees in January was 32.5, while the maximum was 57 heating degrees, for a difference of 24.5 heating degrees. Annual heating-degree days averaged 4,754. The estimated peaking cost was 24.5 × $100 ÷ 4,754 = $0.51/Dth.

Table 3.3. Peaking Costs (2005$/Dth)

	Downstate	Upstate
Space Heating 65°F Base	$0.51	$0.40
Space Heating 50°F Base	$1.24	$0.73
Water Heating	$0.13	$0.10

3.3.3. Avoided T&D Cost

As peak loads grow, local distribution companies need to expand their internal transmission and distribution systems by adding parallel mains, looping, adding compression and increasing operating pressures, and increasing the size of new and replacement lines. Expenses for compression may also increase. The expenditures vary across each utility's service area and over time. Typically relatively small increments of load require expensive upgrades, while other load areas have excess capacity for many years resulting in no expansion costs.

Marginal or avoided T&D costs are therefore generally estimated by comparing growth-related costs to peak load growth over a period of several years. For downstate, the latest Con Edison analysis found a marginal T&D cost of $1.105/Dth (Con Edison 2003). That cost reflects a mix of temperature-sensitive and baseload demands. Based on a review of Con Edison's daily sendout, its sales appear to be half baseload and half weather-following load. A cost of $130/Dth-day of capacity, allocated over the average annual usage of that mix of sales, produces Con Edison's estimated per Dth.

For upstate, estimates of marginal T&D costs were available from NYSEG (Harrison 2001), Niagara Mohawk (NiMo) (Maron 1997), Orange and Rockland (O&R) (Nihill), and National Fuel Gas (NFG) (Clark 2004).[53] Two of the estimates relied on non-standard methodologies: NiMo's study was based on a theoretical allocation to demand of a portion of the costs of serving new service territories, and NFG's analysis was adjusted to reflect the slow growth in its load. From the studies, adjusted to 2005 dollars, the following were selected:

- Total investment of $677/Dth-day of growth (from a range of $232 to $2,269).
- Total carrying charge of 10.65% (from a range of 10.00% to 15.13%).
- O&M of $51/ Dth-day (from a range of $3 to $73)

The results of NYSEG and O&R, from the standard approaches, are generally close to the values selected. The total avoided cost estimated from these inputs is $123/Dth-day. Due to the uncertainty in combining estimates from such different methods, a value of $100/Dth-day for the upstate utilities was chosen.

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[53] O&R service area T&D resembles that of the other upstate utilities. O&R marginal T&D estimates were used in the upstate calculations to provide another data point. The downstate avoided T&D is not significantly effected by the exclusion of O&R since O&R's load is so small compared to Con Edison and KeySpan.

T&D costs are largely driven by design-day conditions. Unlike peaking supply, T&D plant (mains, compressors, take stations) must be sized to meet the total design peak. Therefore, for space heating, the avoided T&D cost per Dth is the annual cost times the maximum daily heating degrees, divided by annual HDD.[54] For baseload, the avoided T&D cost per Dth is the annual cost divided by 365 days.[55] Table 3.4 shows the resulting T&D costs per Dth.

Table 3.4. Transmission and Distribution Costs (2005$/Dth)

	Downstate	Upstate
Space Heating 65°F Base	$1.56	$1.11
Space Heating 50°F Base	$2.95	$1.79
Baseload	$0.36	$0.30
Water Heating	$0.66	$0.50

3.3.4. Summary

Total avoided gas costs, in 2005 dollars, are summarized by year and load shape in Table 3.5.[56]

These avoided costs are for firm loads. Avoided costs for interruptible loads would be lower than these avoided costs for firm loads. Various types of interruptible customers, using different alternative fuels, on different tariffs, different interruption priorities, and different contractual arrangements with the utility, will have different avoided costs, consisting of different combinations of gas and oil (or propane) costs. Development of this range of avoided costs was beyond the scope of this project.

Interruptible avoided costs should be developed, and measures screened, prior to implementing the gas energy-efficiency program for interruptible customers. Some measures might not pass screening against the various costs and benefits that would apply to different priorities of interruptibles using different fuels.[57]

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[54] Again, the analysis used only the 65° F HDD computation for T&D loads.

[55] Adding cooling load can impose some localized distribution costs in particular locations, but these costs are too variable to be included in avoided costs. Where applicable, as in new construction in areas with limited existing gas supply for heating load, the incremental distribution costs should be included as project costs for screening purposes.

[56] Some stakeholders expressed concerns regarding the adjustment of the commodity costs based on HDD, peaking cost values, and T&D cost values. The authors relied on the best available information provided by the LDC's and DPS. To address stakeholder's concerns about accuracy of the avoided cost estimate, the study included an analysis of the economic potential and program scenario potential with avoided costs 25% lower and 25% higher than the reference avoided costs.

[57] A method must also be developed for recovering the portion of the program costs expended for interruptible customers, who are usually charged a variable rate consistent with the price of the customer's alternative fuel. Approaches could include requiring interruptible customers to agree to a surcharge to cover program costs, or recovering those costs from the interruptible margins now split between utilities and ratepayers.

Table 3.5. Total Avoided Gas Costs (2005$/Dth)

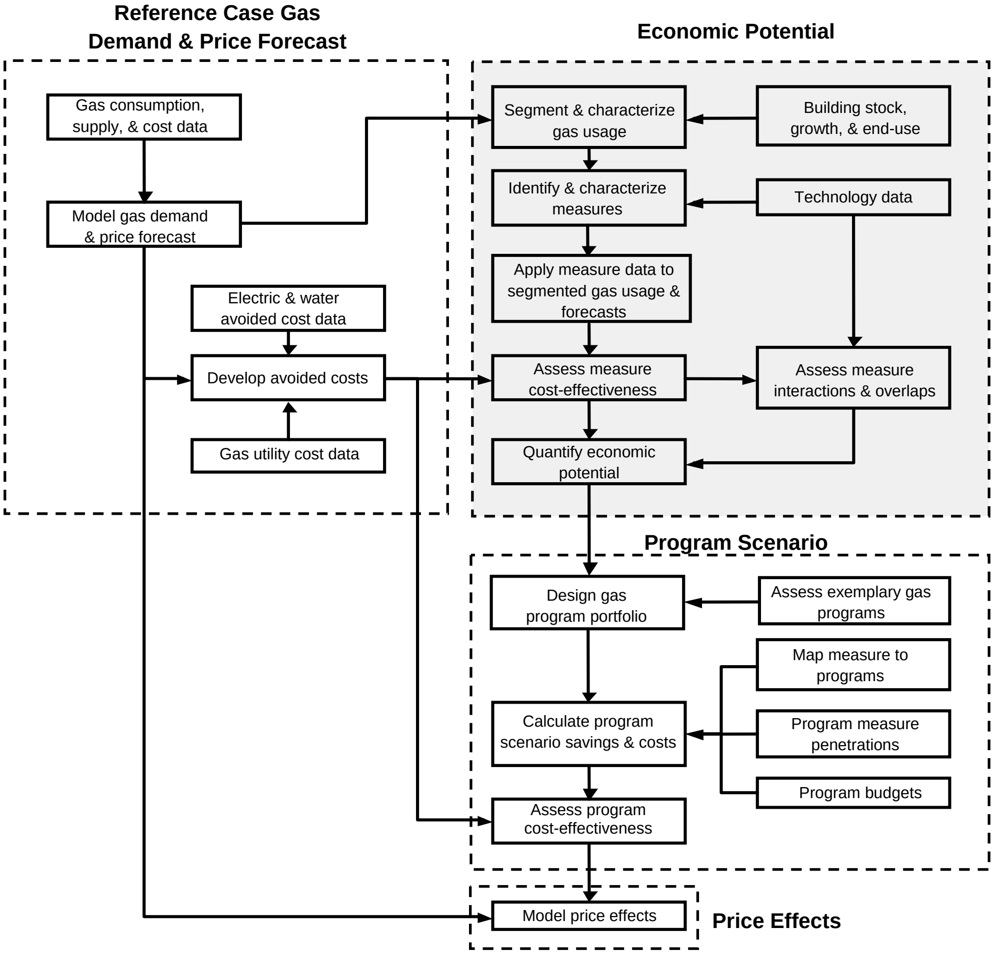
	Downstate (NYC)					**Upstate (80% Rochester, 20% Albany)**				
	Heating w/ Base		*Baseload*	*Water Heating*	*Cooling*	*Heating w/ Base*		*Baseload*	*Water Heating*	*Cooling*
	65°F	50°F				65°F	50°F			
2006	$14.31	$19.15	$10.14	$11.18	$9.88	$12.40	$15.27	$9.68	$10.36	$9.61
2007	$12.60	$16.46	$9.36	$10.17	$8.69	$10.19	$11.65	$8.58	$8.99	$8.26
2008	$13.84	$17.22	$11.01	$11.72	$9.55	$12.06	$13.17	$10.48	$10.88	$8.98
2009	$13.27	$17.45	$8.99	$10.06	$6.86	$11.32	$13.47	$8.47	$9.19	$6.46
2010	$12.74	$16.78	$9.01	$9.94	$7.45	$10.06	$11.57	$8.13	$8.61	$6.96
2011	$11.62	$15.76	$7.94	$8.86	$7.33	$9.33	$11.30	$7.27	$7.79	$7.09
2012	$11.26	$14.78	$8.20	$8.97	$7.08	$9.36	$10.73	$7.65	$8.08	$6.72
2013	$11.49	$15.19	$8.09	$8.94	$6.76	$9.78	$11.53	$7.63	$8.17	$6.38
2014	$12.37	$15.97	$9.17	$9.97	$7.92	$10.53	$11.96	$8.65	$9.12	$7.52
2015	$11.79	$16.34	$7.43	$8.52	$6.48	$9.48	$11.97	$6.81	$7.48	$6.31
2016	$11.93	$16.04	$8.38	$9.27	$7.38	$9.21	$10.76	$7.54	$7.95	$7.06
2017	$11.54	$15.12	$7.97	$8.86	$5.92	$9.93	$11.60	$7.56	$8.15	$5.53
2018	$12.05	$15.66	$8.98	$9.75	$7.98	$10.41	$11.98	$8.55	$9.02	$7.61
2019	$12.41	$16.36	$8.86	$9.75	$7.80	$10.66	$12.60	$8.42	$8.98	$7.46
2020	$13.00	$16.75	$9.83	$10.62	$8.74	$11.27	$12.90	$9.38	$9.85	$8.34
2021	$12.60	$16.66	$8.85	$9.79	$7.55	$10.76	$12.76	$8.39	$8.98	$7.24
2022	$12.09	$16.01	$8.61	$9.48	$7.37	$10.03	$11.76	$8.04	$8.54	$7.04
2023	$11.75	$15.28	$8.66	$9.43	$7.50	$10.26	$11.86	$8.31	$8.80	$7.17
2024	$11.63	$15.47	$8.29	$9.12	$7.39	$10.00	$11.88	$7.91	$8.43	$7.13
2025	$11.67	$15.42	$8.27	$9.12	$6.86	$9.91	$11.62	$7.83	$8.35	$6.54
post-2025	$12.07	$15.88	$8.67	$9.52	$7.45	$10.24	$11.97	$8.19	$8.71	$7.11

4. ECONOMIC POTENTIAL

4.1. BASIC METHODS COMMON FOR ALL SECTORS

This study analyzed the energy-efficiency potential of a portfolio of gas efficiency programs in the residential, commercial, and industrial sectors for a 10-year period, from 2007 to 2016. Figure 4.1 shows how the economic potential analysis relates to the overall project.

Figure 4.1. Project Flow: Economic Potential



This section of the report summarizes the basic methodology used to assess energy efficiency potential in the three sectors, focusing on the following common areas of analysis:

- Market segmentation
- Technology and practice selection
- Measure characterization
- Data integration and economic analysis

Following the overview of the methodology, additional discussions of the analysis and results for the residential, commercial, and industrial sectors are presented.

4.1.1. Market Segmentation

The study examined energy-efficiency potential for three types of market events: (1) new construction and major renovation; (2) natural turnover of existing energy-using products, equipment, and facilities; and (3) discretionary retrofit. The residential, commercial, and industrial sector analyses all address the first two of these three efficiency market opportunities, which constitute the classic “lost-opportunity” or “market-driven” resources. These situations present short-lived opportunities to make efficiency choices offering significant, long-lived savings at relatively low incremental costs compared with the overall costs of building new homes, buildings, and/or facilities, and/or purchasing new products and/or equipment.

The third type of market event, efficiency retrofit opportunities, are discretionary in that they can be made at any time. In other words, they are unrelated to the construction, equipment, and product market cycles. Retrofits consist of two distinct types of technology investments: (1) application of supplemental measures, such as installations of heat recovery systems; and (2) early replacement of operational equipment, such as removal of existing inefficient water heaters and replacement with new high-efficiency equipment. The residential and the commercial analyses examined efficiency potential in all three efficiency market segments. The industrial analysis was confined to the two lost-opportunity markets (new construction and natural equipment turnover) because industrial customers can rarely be induced to undertake efficiency investments outside their normal product and investment cycles.[58]

Markets in each sector were segmented differently for assessing efficiency potential. The residential analysis segmented markets by building type (single vs. multifamily) and according to new construction, market-driven equipment replacement, and retrofit. The commercial analysis

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[58] A simplified characterization was necessary for the purposes of the analysis. In general, it is difficult to engage industrial customers in significant efficiency investments when they are not already considering investment in their plants. However, application of supplemental measures (the first example of retrofit opportunities) was included for industrial facilities based on estimated timing and natural product and market cycle investments.

distinguished between new and existing buildings and among ten building types, including large multifamily buildings with central systems.[59]

Due to differences in market structure and data availability the analysis of each sector's savings potential employed a different approach to estimating the size of the underlying population for each market segment. The starting point for analysis was the reference case downstate and upstate forecasts of sector-level gas consumption. All three sectors supplemented this data with additional public and private data to disaggregate gas usage according to their respective market segmentation schemes, which are discussed in the sections that follow this overview.

In short, the analyses estimated the quantity of existing equipment – or equipment gas usage – by facility type, the likely natural replacements over time, and purchases for new construction. Broadly, the residential analysis relied primarily on a bottom-up approach, applying individual measure characterizations to the estimated numbers and saturations of equipment in each sector. The commercial and industrial analyses, detailed data on numbers and sizes of equipment in each facility type are not available. As a result, the commercial and industrial analyses combined bottom-up and top-down approaches. From the top, gas usage was disaggregated for each segment and then by end use. Bottom-up detailed measure characterizations were then applied to the applicable disaggregated consumption estimates.

4.1.2. <u>Technology and Practice Selection</u>

A comprehensive list of efficiency technologies and practices addressing all end uses, markets, and building segments was developed from review of possible existing and emerging technologies. For each measure, the baseline, (or existing stock in the case of retrofit measures) and the efficient alternatives were characterized. Fuel switching measures, electric generation, and combined heat and power technologies were excluded. These categories likely offer significant additional overall efficiency potential, however, in many cases they would result in an increase in gas usage, while reducing electric usage.

The initial measure list was qualitatively screened to eliminate measures where: the potential opportunity for efficiency would be very small; the measure was almost certainly not cost-effective; or efforts to promote the measure through efficiency initiatives were unlikely to offer significant benefits.

4.1.3. <u>Measure Characterization</u>

For those measures that remained, the analysis characterized the performance of individual efficiency technologies or grouped sets of technologies in terms of their costs, gas savings (both annual and peak-day) and expected lifetimes. Individual measure characterizations were done on the technology basis and also by market and building segment, resulting in analysis of thousands of individual measures.

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[59] For reporting purposes, all multifamily data is included within the residential sector for economic potential. Under the program scenario, large multifamily buildings with central systems are included in the C&I programs.

In the new construction, major renovation, and natural turnover for equipment replacement market segments, costs were estimated on an incremental basis compared to baseline efficiency levels. In the case of discretionary early-retirement retrofit opportunities, costs reflect the full cost including labor and equipment of installing new measures. Included in estimates of efficiency costs were capital, fuel, and O&M impacts, such as changes in equipment maintenance and component replacement costs.

Savings included gas impacts, and reductions and increases in the use of other resources, including electric and water consumption. For example, high-efficiency clothes washers often save both electricity and water in homes with electric-fired water heaters.[60] Some commercial building shell and heating, ventilation and air conditioning (HVAC) optimization measures provide substantial electric benefits due to reduced cooling requirements. The application of some technologies and practices, particularly in the industrial sector, often produces non-resource benefits, such as productivity and product quality improvements. Such benefits were not quantified nor included in the economic potential assessment, because they are subjective and hard to quantify.

Measure characterizations were developed using data from prior potential assessments, published research, market assessment and evaluation studies, engineering calculations, and building simulation modeling. Baseline penetrations were based on existing baseline studies in the region, published market assessments, and professional judgment based on discussion with industry professionals. Baseline penetrations assumed no on-going gas programs existed in New York. They assumed existing electric programs would continue and took into consideration existing and likely future codes and standards.

4.1.4. Data Integration and Economic Analysis

Application of the per-unit technology costs and savings and estimated baseline penetrations to the estimated existing and future market segment gas loads yielded the total potential for each measure. The economic potential consists of measures where the total resource costs are less than their benefits. However, total potential and economic value are critically dependent on the timing with which measure adoption takes place, the type of market the measure applies to, and the interactions between measures. The total economic potential is also less than the sum of individual measure savings because of interactions between measures. The analysis addressed the following effects:

- Timing of measure adoptions by market that result in changing building and equipment stock and affect future opportunities for savings
- Changes to early replacement retrofit measure savings and costs over time and the economic effect of them
- Recognizing when multiple measures are mutually exclusive

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

- Interactions between measures that result in lower measure savings depending on what other measures are already installed

Estimates of the existing stocks of equipment and systems over time were adjusted to account for changes caused by other assumed efficiency activity. This is necessary because installation of a measure can diminish opportunities for other measures in the future. For example, installation of a retrofit measure permanently alters the replacement cycle for that measure over time, thus shifting the time when the expected equipment would naturally be replaced, thereby reducing opportunities for future market-driven measures. Therefore the opportunities for market-driven measures were reduced based on the pattern of retrofit measure penetration. Similarly, major renovation projects result in replacement of equipment and also alter replacement cycles, both eliminating the opportunity for implementing retrofit measures and reducing natural replacement opportunities. The analysis took into account all these shifts in stocks and equipment vintages, to properly characterize both the timing and magnitude of opportunities in each market segment and prevent double counting. The timing of installations has effects on the savings resulting because efficiency of existing equipment is dependent on its vintage, and also effects the economic value because benefits in the future are worth less than benefits today.

The economic potential consists of the total potential remaining after removing the measures with costs (including O&M and other resource costs) in excess of avoided gas costs. In screening for cost effectiveness, the analysis took careful account of timing impacts that can shift costs and benefits. In the case of early retirement retrofits the economic potential analysis reflected two important but often overlooked timing elements:

- The first timing element is the “baseline shift.” Existing equipment is generally less efficient than standard efficiency (baseline) new equipment. When a measure is replaced early, initial savings are the difference between the existing equipment efficiency and that of the new efficient equipment. However, over time the existing equipment would have reached the end of its life and been replaced with baseline new equipment, thus naturally capturing a portion of the initial measure savings. This shifting baseline causes the initial measure savings to drop over time to a lower savings. The analysis incorporates this baseline shift and assumes the average existing equipment has expended half of its lifetime at the time of early replacement.
- The second timing element is the “deferral cost credit.” By interrupting the natural equipment replacement cycle early retirement permanently postpones the future equipment replacement cycle. As a result, the end user no longer has to replace existing equipment as soon. This deferral of future capital costs has economic benefits because of the time value of money. The economic potential analysis of energy efficiency resources explicitly accounts for both the baseline shift and the equipment replacement deferral cost credit associated with early retirement efficiency retrofits.

After removing non-cost-effective measures, the analysis adjusted for mutually exclusive and interacting measures. The total economic potential is substantially less than the sum of independent individual measure impacts for two reasons. First, some measures are mutually exclusive – you either install one or another. For example, one can install a high efficiency condensing tank-type water heater, an integrated hot water tank connected to a high efficiency boiler, or point-of-use water heaters in a commercial building but likely not all three. For mutually exclusive measures, priority is given to the measure that is the most cost-effective or provides the greatest customer savings. Based on this ranking, the next measure would then capture all remaining opportunities (for example, not all customers could necessarily adopt the first measure because of technical or other feasibility reasons), and so on.

The second reason total savings are less than the sum of each measure's savings is because measures interact. The adoption of one measure can have a dramatic impact on the savings provided by another measure. For example, installing high performance windows will reduce the heating load in a building, thereby reducing the savings available from a high efficiency boiler. Again, priority is given to those measures offering the greatest net benefits or customer savings. The next measure in the ranking is then selected and adjusted for the impacts of the first, and so on, until all interactions are accounted for.

4.2. RESIDENTIAL SECTOR ANALYSIS

4.2.1. Overview of Results

The savings potential from the residential sector is depicted graphically in the supply curves in Figure 4.2 and Figure 4.3. The economic potential is estimated at 120,616 thousand Dth in 2016, or 26.9% of forecast gas consumption. Peak-day impacts are 795.2 thousand Dth in 2016. This savings potential is for the entire residential sector, including both individually-metered and master-metered buildings.[61]

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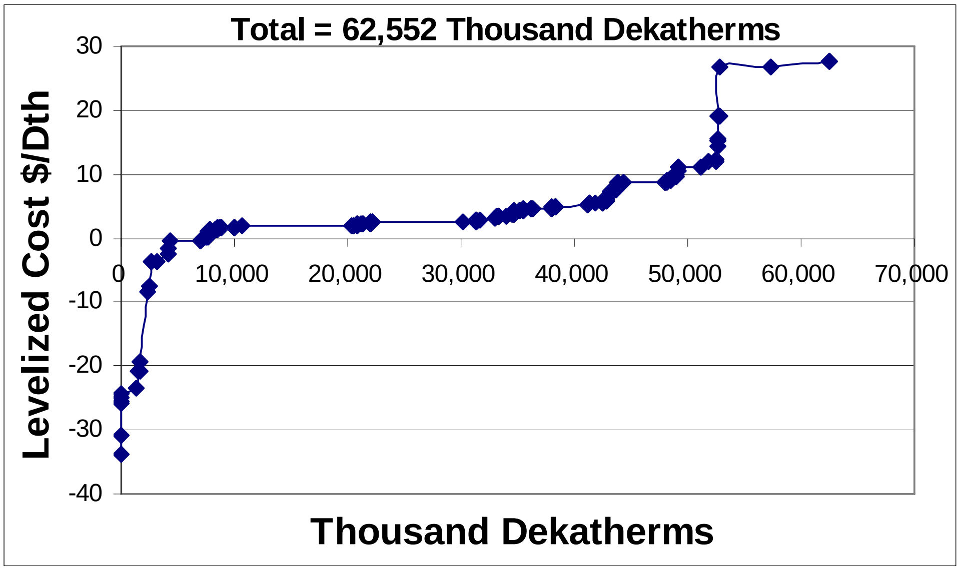
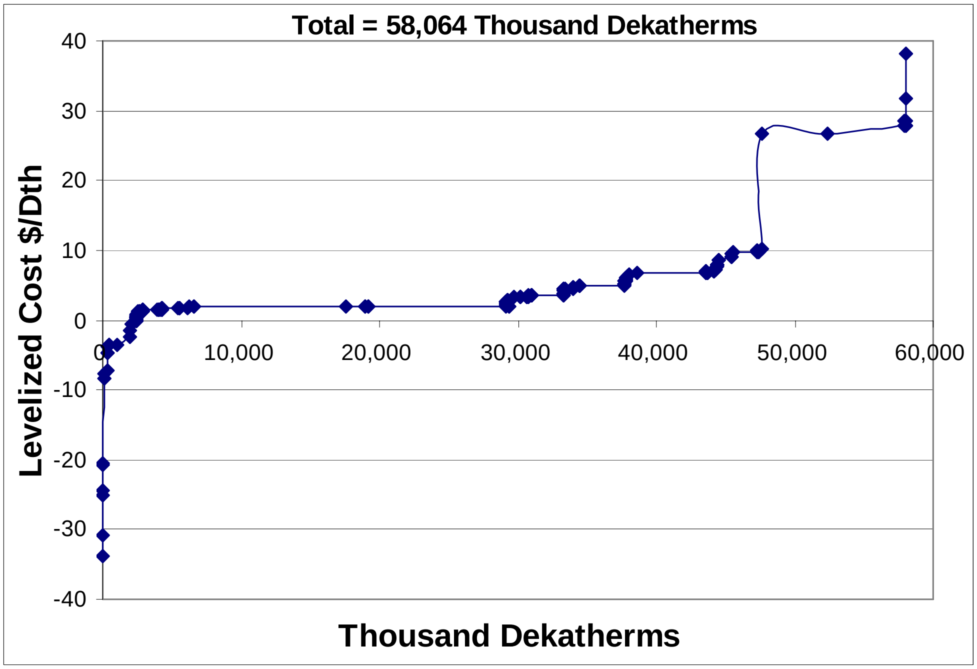
[61] Individually-metered buildings are those in which every housing unit has its own heating system, has its gas use routinely measured, and pays its own gas bill. Master-metered buildings are those with central heating systems which serve multiple housing units, with gas bills for the entire building paid by owner or manager of the building. The terms “centrally heated multifamily” and “master-metered multifamily” are used synonymously.

Figure 4.2. Residential Sector Economic Potential Supply Curve by 2016 – Downstate



Note: Combined statewide figures are not available because each zone must be analyzed with a separate cost-effectiveness screening tool.

Figure 4.3. Residential Sector Economic Potential Supply Curve by 2016 – Upstate



Note: Combined statewide figures are not available because each zone must be analyzed with a separate cost-effectiveness screening tool.

Figure 4.5, Figure 4.6 and Figure 4.7 show this economic potential in terms of building type, major market and significant end use type.

Figure 4.4. Economic Potential Residential Energy Savings by Building Type by 2016

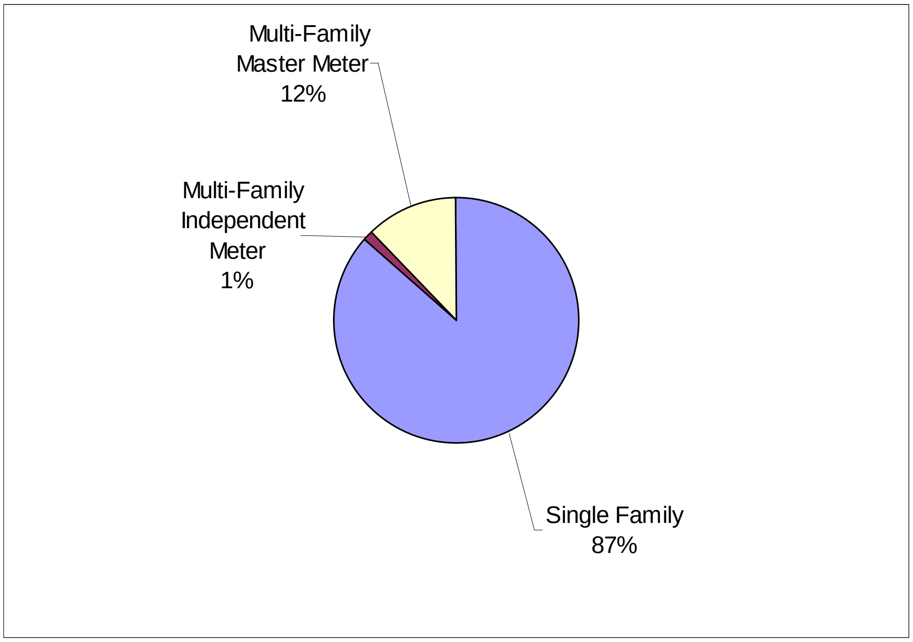


Figure 4.5. Economic Potential Residential Energy Savings by Market by 2016

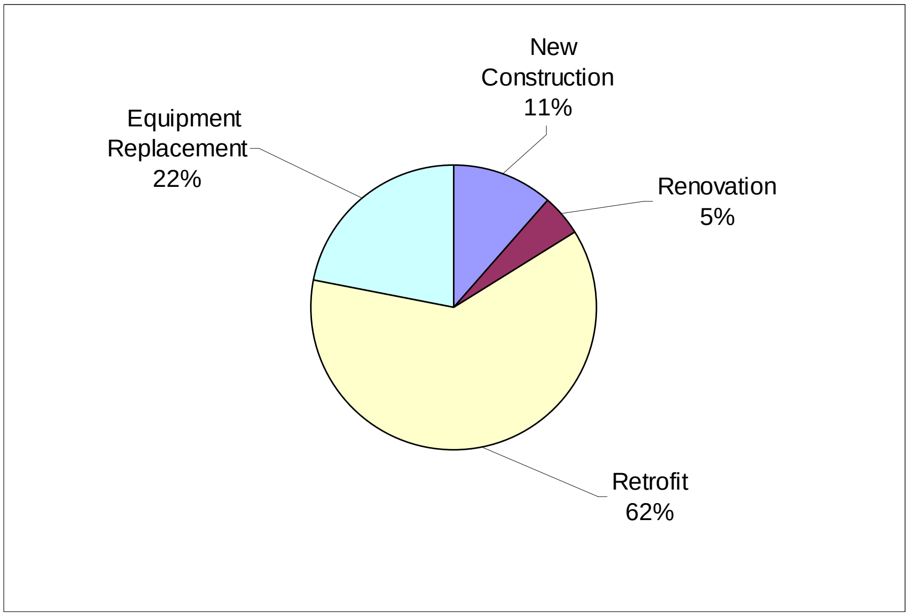
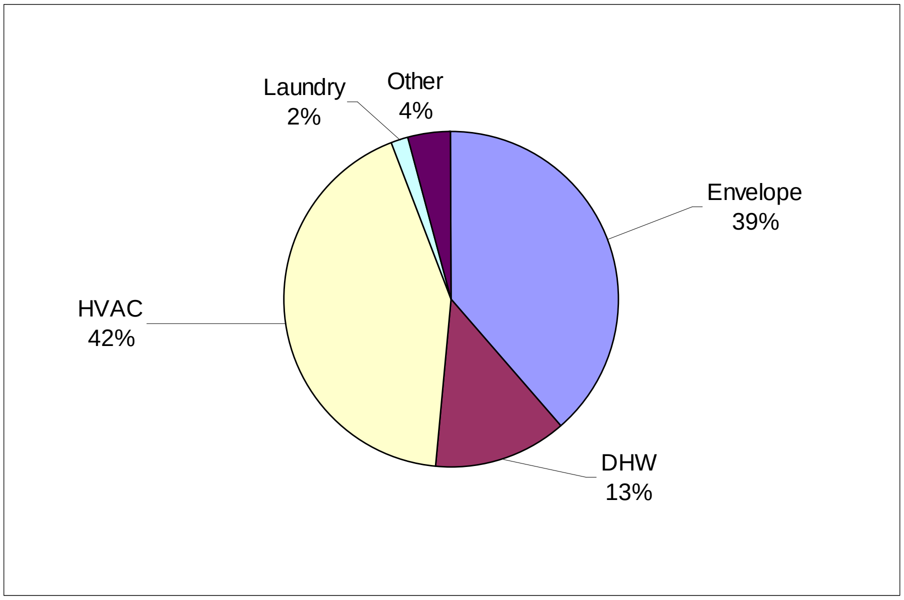


Figure 4.6. Economic Potential Residential Energy Saving by End Use by 2016



4.2.2. Analysis Approach

Savings potentials for individually–metered buildings and master-metered buildings were analyzed differently. Because of both the characteristics of the buildings and the programs that would likely address them, analysis of savings potential in master-metered multifamily buildings was consistent with the analytical approach used for commercial buildings. Thus, although savings from all residential building types are included in the figures presented above, the *approach* to assessment of savings potential in master-metered buildings is addressed in Section 4.3. The approach discussed in the remainder of this section (*i.e.*, sub-sections 4.2.2 through 4.2.7) is the approach used to assess individually-metered homes, the overwhelming majority of which are single-family.

The analysis estimated savings for 34 efficiency measures for two different buildings types (single family and individually metered multifamily) and – in most cases – four different markets (*e.g.*, some insulation upgrade measures did not apply to new construction because all new homes were assumed to have certain minimum insulation levels). For each combination of technology, building type and market, measure characterizations (life, per unit savings and incremental cost), eligible markets and baseline market penetrations were developed.

The residential analysis uses a "bottom-up" approach to estimating savings potential. It generally proceeded along the following steps:

- Building an end-use disaggregation of current sales for the upstate and downstate regions of the State
- Developing measure characterizations (per unit savings, per unit incremental costs, measure lives)

- Estimating the size of the market for each efficiency measure
- Estimating baseline market penetrations for each efficiency measure
- Calculating economic potential

Building and end-use disaggregation served as the basis for assumptions of both per unit savings and the size of most efficiency measure markets, thereby ensuring that savings estimates were calibrated to available sales and end-use saturation data. In general, savings potential for each efficiency measure was estimated using Equation 2. A more detailed explanation of the key components of this approach follows.

Equation 2. Residential Savings Equation

(per unit savings) x (size of market) x (1 – baseline measure penetration)

4.2.3. End-use Disaggregation

The analysis estimated the portion of households and sales associated with master-metered multifamily buildings. Definitive data on the number of master-metered buildings was unavailable. Census data regarding the number of buildings of different sizes and the project team's experience with such buildings were used to develop estimates. The analysis assumed that 100% of all buildings with 20 or more housing units, 75% of buildings with 10 to 19 units, and 50% of buildings with 5 to 9 units were master-metered. Master-metered multifamily building end use consumption was based on data from a variety of sources, including the Commercial Building Energy Use Consumption Survey (CBECS), Con Edison, New York Power Authority, Orange and Rockland and building simulation modeling. More detail on the master-metered multifamily analysis is contained in the commercial section. While all multifamily savings are reported here, the analysis of master-metered multifamily buildings followed the commercial methodology because the available data and relevant technologies relate more closely to other commercial buildings.

For individually-metered residential buildings, the reported number of residential customers for each New York gas utility and the accompanying sales data (adjusting for estimated consumption by master-metered buildings) were separated into upstate and downstate regions. The number of customers and amount of sales reported by the utilities were adjusted slightly to be consistent with the residential forecast to being used.[62] This is important because our forecast of future savings potential needed to be calibrated to that baseline sales forecast. Data from the Public Use Microdata Set (PUMS) from the Census Bureau,[63] results of appliance saturation studies conducted by Niagara Mohawk (2000) and National Fuel (2004), Optimal Energy's recent analysis

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[62] Several different factors may have contributed to the small difference between the sum of utility reported sales and the forecast we were using. For example it appears as if a small number of New York customers had elected to be retail customers of out-of-state gas companies. Also, with the exception of Con Ed, the utility sales data to which we had access were not broken down in a way that would enable definitive determinations as to the customer class to which some customers' gas consumption was allocated.

[63] PUMS allows cross-tabulation of heating fuel by building type and size.

of the Con Ed service territory, and the Energy Information Administration's Residential Energy Consumption Survey (RECS) were together used to break down average household consumption into a variety of end uses for the downstate and upstate markets. Adjustments also were made to weather-normalize consumption. The end result of the adjustments provided the basis for developing weighted average consumption by end-use for both building types for the downstate and upstate zones.

Based on these sources, the analysis estimated that, statewide, approximately 4.3 million single-family residential households use gas, with almost 2.7 million of those using gas for space heating and slightly fewer using gas for water heating. Approximately 1.8 million households use gas for cooking and roughly 1.3 million have gas clothes dryers. Statewide estimates of single family gas consumption by end use are shown in Table 4.1.

Table 4.1. Estimated End-Use Statewide Disaggregation for Single Family Homes

End Use	Homes with End Use		Average Therms	Weighted Average Therms
Space Heating	62.3%	2,673,700	945	588
Fireplace	9.0%	386,397	375	34
Water Heating	60.0%	2,575,040	179	107
Cooking	68.1%	1,809,638	35	24
Pool Heating	2.2%	96,220	1,000	22
Drying	44.5%	1,315,460	85	38
Total	**-**	**-**	**-**	**776**

The end-use disaggregation served as the starting point for estimates of savings potential in the three markets affecting existing buildings: equipment replacement, renovation and retrofit. Estimates of consumption from new construction from the sales forecasts were broken down by building type and end use based largely on historical building permit data, information provided by the City of New York, a recent new construction baseline study that Optimal Energy conducted for the Long Island Power Authority, and RECS data.

4.2.4. Measure Characterizations

As noted above, 34 different efficiency measures were analyzed. These are identified in Table 4.2. After accounting for adjustments for different building types and different markets, the analysis included approximately 240 measure permutations. Some of the measures are competing measures, such as upgrades from different base levels of insulation. In such cases, the analysis allowed only the measure with the greatest net benefits to be considered in estimates of economic potential.

Table 4.2. Residential Efficiency Measures Analyzed

HVAC Measures
- Upgrade standard furnace to condensing model
- Upgrade standard boiler to sealed combustion/direct vent model
- Upgrade atmospheric fireplace to direct vent model
- Insulate, seal and balance ducts in unconditioned space
- Seal, balance ducts in conditioned space
- Place ducts within thermal envelope (RNC only)
- Upgrade manual thermostat to programmable model

Thermal Envelope Measures
- Upgrade attic insulation from R-11 to R-49
- Upgrade attic insulation from R-19 to R-49
- Upgrade attic insulation from R-27 to R-49
- Insulate uninsulated wall to R-15
- Insulate uninsulated wall to R-19
- Insulate uninsulated wall to R-21
- Insulate uninsulated basement walls to R-1-0
- Insulate uninsulated basement/crawl space ceiling to R-19
- Smart air sealing
- Upgrade to insulated exterior door
- Upgrade to insulated attic hatch
- Install storm window for single glazed window
- Upgrade single-glazed window with storm to double-glazed
- Upgrade double-glazed window to double-glazed with low-e coating
- Upgrade double-glazed window with low-e coating to double-glazed with low-e and argon gas

DHW Measures
- Upgrade from standard (0.59 EF 50 gallon tank) to efficient (0.63 EF) stand-alonge water heater
- Upgrade form efficient (0.63 EF) stand-alone water heater to indirectly-fired storage tank
- Upgrade from efficient (0.63 EF) stand-alone water heater to tankless water heater
- Upgrade from tankless goil to indirectly-fired storage tank water heating
- Solar water heater
- Solar water heating for pools/hot tubs
- Turn down water heater temperature setting
- Install low flow devices (showerheads, faucet aerators)
- Install gravity-film exchange waste water heat recover (*e.g.,* GFX)

Other Measures
- Upgrade from standard to super-efficient (MEF 1.80) clothes washer
- Upgrade gas dryer to model with humidity sensor control
- Install cover for pools/spas

For each measure permutation, assumptions were developed for per unit savings, per unit incremental cost, measure life and the various other characteristics necessary for cost-effectiveness screening. Per unit savings assumptions were calibrated to the end-use disaggregation. Savings from upgrading heating or water heating efficiency at the normal time of replacement were assumed to be lower (about 30% lower in the case of furnaces) than savings from early retirement of existing equipment. This difference addressed the fact that even a new standard piece of equipment (the baseline in the replacement market) would be more efficient than an older piece of equipment still operating in a home. In general, savings estimates for efficient equipment were based on engineering calculations applied to the adjusted disaggregated consumption estimates. Savings assumptions for thermal envelope measures were based on engineering estimates, adjusted downward by 35% based on years of experience that suggests actual savings are much lower than pure engineering assumptions indicate. Savings assumptions for various other measures, such as hot water conservation measures, pool covers, and programmable thermostats, were based on a variety of sources including U.S. Department of Energy documents, NYSERDA program data, the Efficiency Vermont technical reference manual, and professional experience and judgment.

Assumptions regarding incremental costs and measure lives came from retailers, Technical Support Documents for various U.S. Department of Energy rulemakings on minimum federal efficiency standards, NYSERDA data, the Efficiency Vermont reference manual, and professional experience and judgment.

4.2.5. Market Size

As noted above, the end-use disaggregation served as the starting point for most estimates of market sizes for different efficiency measures. For the equipment replacement market, the number of furnaces, boilers, water heaters, washers and other types of equipment sold each year was assumed to be equal to the number of households multiplied by the percent of households estimated to have the particular piece of equipment divided by the measure life (*i.e.,* if a standard stand-alone water heater has a 13 year life, one-thirteenth – or 7.7% – of existing water heaters were assumed to be replaced each year).

For the renovation market, the analysis assumed that, each year, between 1% and 2% of all homes would undergo the kind of major renovation that might involve consideration of significant efficiency upgrades (*i.e.,* to be conservative, it was assumed that kitchen or bath remodels are not likely to lead to consideration of replacing a furnace early or upgrading insulation levels). Professional judgment and the project team's experience in the New York area were also used to make further assumptions regarding the percentage of those homes undergoing major renovations that are likely to have low levels of insulation, very leaky ducts, etc.

For the retrofit market, the analysis started with the entire population of residential customers and then adjusted down by (1) eliminating as candidates for early retirement of existing heating, water heating or other equipment, all homes projected to replace equipment over the 10-year analysis period (to eliminate any overlap between the retrofit and replacement markets); (2) eliminating as candidates for both early equipment retirement and other efficiency upgrades, all homes projected to undergo major renovations in the 10-year analysis period; (3) applying adjustment factors, based largely on professional judgment, to reflect the reality that many homes cannot be candidates for some efficiency measures either because they already have them or because the measure is not physically applicable (*e.g.,* not all homes are candidates for basement wall insulation because not all homes have basements).

Estimates of the size of the new construction market were not based on the end-use disaggregation for existing homes. For this market, the analysis started with forecasted growth in residential sales. The forecast assumed declining per household energy consumption for existing homes. It was further assumed that the end-use consumption of new homes would be the same as for existing homes. Although new homes are generally more efficient than existing homes, they are also bigger, and these two factors were assumed to offset each other. Using both historical permit and PUMS data, adjusted for information provided by the City of New York regarding expected new affordable multifamily housing construction (9,000 units per year for the next decade), the team was able to estimate the fraction of new homes that were single family and multifamily. All new homes that become gas customers were assumed to use gas for both space heating and water heating. Discussion of the new construction forecast for large multifamily buildings with central systems is included in the commercial section and is shown in Appendices B and C.

4.2.6. Baseline Market Penetrations

Sources used to estimate baseline market penetrations included industry data, Technical Support Documents for the U.S. Department of Energy's rulemakings on equipment efficiency standards, LIPA's residential new construction baseline study and other similar evaluations, and professional judgment. It was generally assumed that current baseline market penetrations would increase over time. For example, with respect to purchases of new residential furnaces, the baseline market share for condensing (*i.e.,* AFUE of 90% or greater) models was assumed to be 35%, a figure consistent with GAMA data for the State of New York from the mid-1990s through the early 2000s. However, the analysis assumed that market share would increase by 0.5 percentage points each year in the absence of market interventions.

Past and likely future electric efficiency program activities in New York were considered to ensure that savings estimates did not result in double counting of gas savings that may accrue from electric programs.[64] In the residential sector, two programs in particular warranted examination: (1) Home Performance with ENERGY STAR®, a program addressing retrofit opportunities in existing buildings; and (2) the ENERGY STAR® New Homes program. Data available from NYSERDA and LIPA at the time of this writing suggested approximately 3,300 statewide gas heating customers will be served by the Home Performance program and approximately 1300 statewide gas heated new homes will participate in the ENERGY STAR® New Homes program in 2006. Based on information from NYSERDA and LIPA, the upstate growth in Home Performance with ENERGY STAR participation will be about 10% annually, and perhaps 20% downstate. The ENERGY STAR New Homes program is expected to have a growth rate of approximately 10% annually. The effects of these programs are explicitly captured in the analysis of savings potential. That is, without them, estimates of savings potential would be higher by roughly 1% of forecast sales in 2016.

4.2.7. Economic Potential Calculations

After identifying the measures that passed cost-effectiveness screening using the Total Resource Cost test, an adjustment was made for interactive effects. For example, the analysis adjusted downward per unit savings from heating equipment up-grades to reflect the fact that there were a large number of thermal envelope and duct efficiency measures that passed screening. Those measures will reduce thermal loads in residential buildings and, therefore, the amount of gas available to be saved through equipment upgrades. Per unit savings from duct measures were

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[64] Some electric efficiency programs provide fossil fuel savings as well as electric savings. This analysis assumed that such electric programs were part of the baseline. In other words, our estimates of gas savings potential are meant to be potential over and above what both natural market forces and electric DSM would produce.

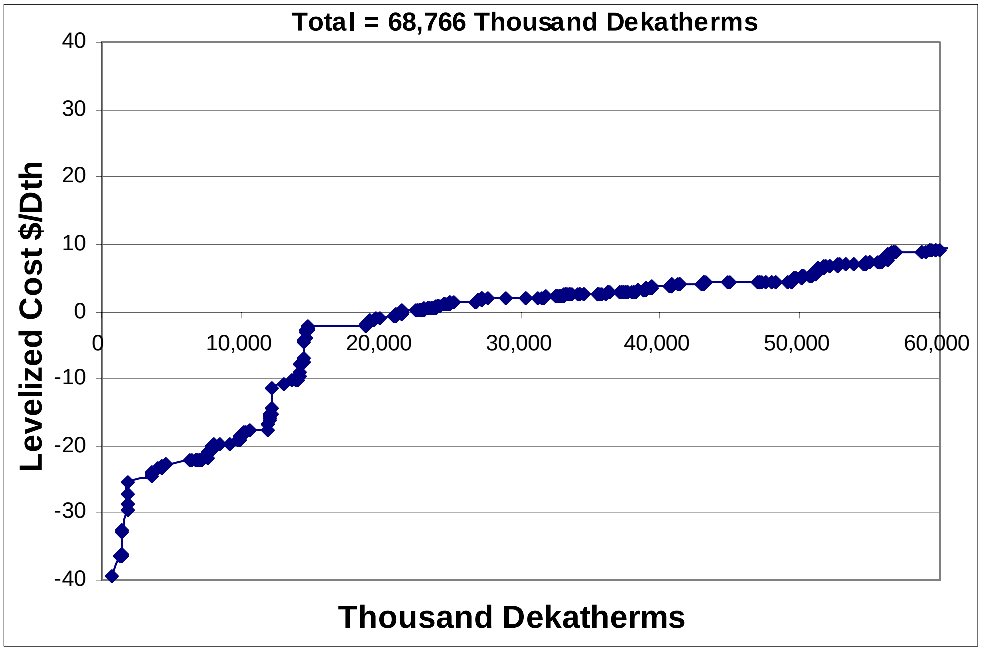
adjusted for the effects of thermal envelope improvements.[65] Per unit savings from water heating equipment measures were adjusted to account for effects of both efficient clothes washers using less hot water and other hot water conservations measures.

4.3. COMMERCIAL SECTOR ANALYSIS

4.3.1. Overview of Results

The savings potential from commercial efficiency measures is shown in the commercial supply curves in Figure 4.7 and Figure 4.8. The economic potential is estimated at 123,339 MDth in 2016, or 33% of forecasted commercial gas consumption. Peak-day impacts are 1,155 MDth in 2016.

Figure 4.7. Commercial Sector Economic Potential Supply Curve by 2016 - Downstate



Note: Combined statewide figures are not available because each zone must be analyzed with a separate cost-effectiveness screening tool.

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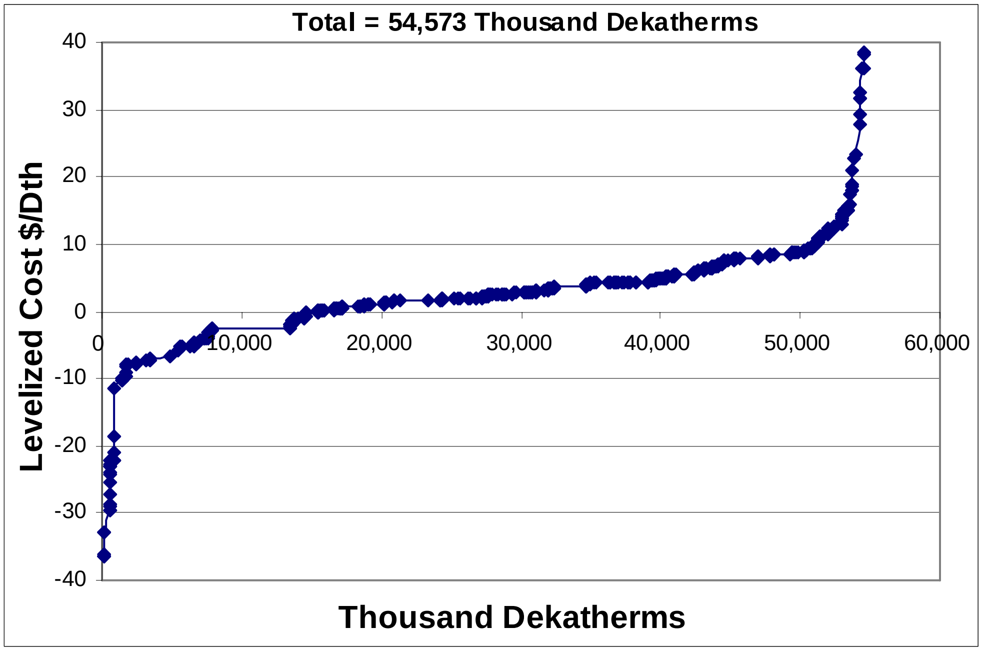
[65] Adjustments were made as follows. Thermal envelope measures came first and needed no adjustments. Duct measures came second and the per unit gas savings were adjusted down to account for improvements in thermal envelope. Heating equipment measures followed and the per unit gas savings were adjusted down to account for improvements to both thermal envelope and ducts. Changes in the order of adjustment would have had no significant effect on the ultimate results because all major envelope, duct, and equipment measures pass screening after adjustments.

Figure 4.8. Commercial Sector Economic Potential Supply Curve by 2016 - Upstate



Note: Combined statewide figures are not available because each zone must be analyzed with a separate cost-effectiveness screening tool.

Figure 4.9, Figure 4.10, and Figure 4.11 show the potential savings by market, end-use, and building segment. By market, the largest opportunities lie in replacement and remodeling that account for roughly half of the overall potential. The next biggest opportunities are in retrofit, with 30% of the overall economic potential.[66] New construction and major renovation are approximately equal, at about 10% each of total potential.

By end use, space heating accounts for 55% of the potential and another 14% of savings come from measures that address the whole building (total) such as commissioning and retrocommissioning. These also largely affect space heating. The next highest end use is water heating at 20%. Cooking offers 10% of the potential, while cooling accounts for less than 1%.

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[66] See Section 2 for a discussion of ordering of retrofit and replacement opportunities. If the analysis had targeted all retrofit opportunities first in 2007, rather than giving priority to waiting until natural replacement cycles occur over the planning horizon, most of the replacement potential would shift to retrofit. While priority was given to market-driven opportunities, a substantial portion of savings still results from retrofit because over the 10-year analysis period much existing equipment will not naturally be replaced. In addition, some measures only apply to the retrofit market.

Figure 4.9. Economic Potential Commercial Savings by Market by 2016

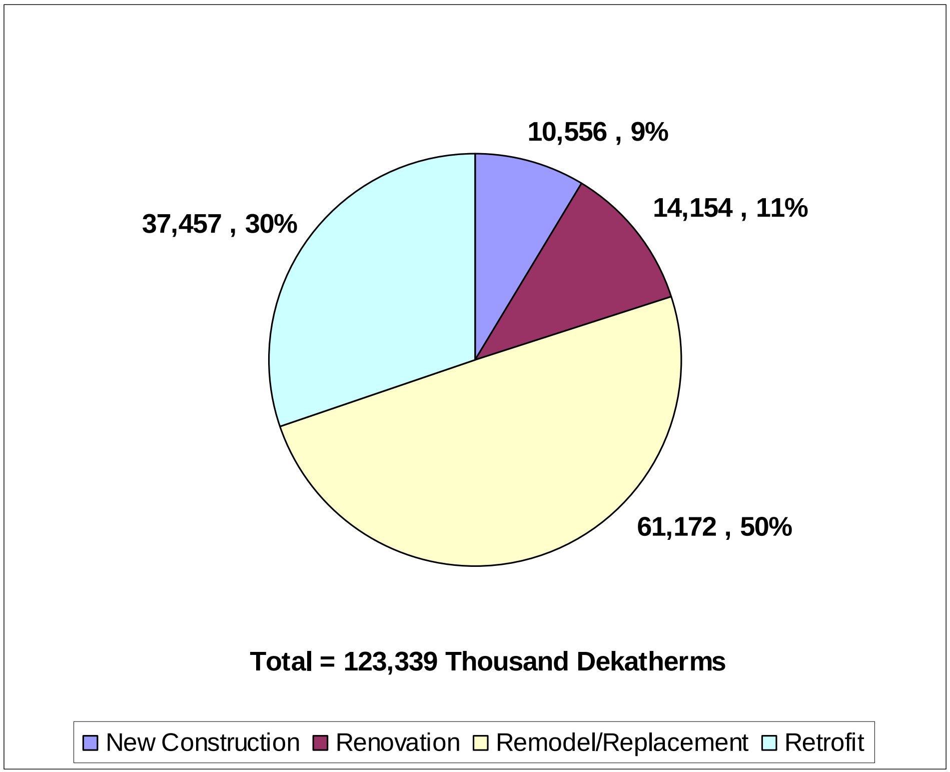
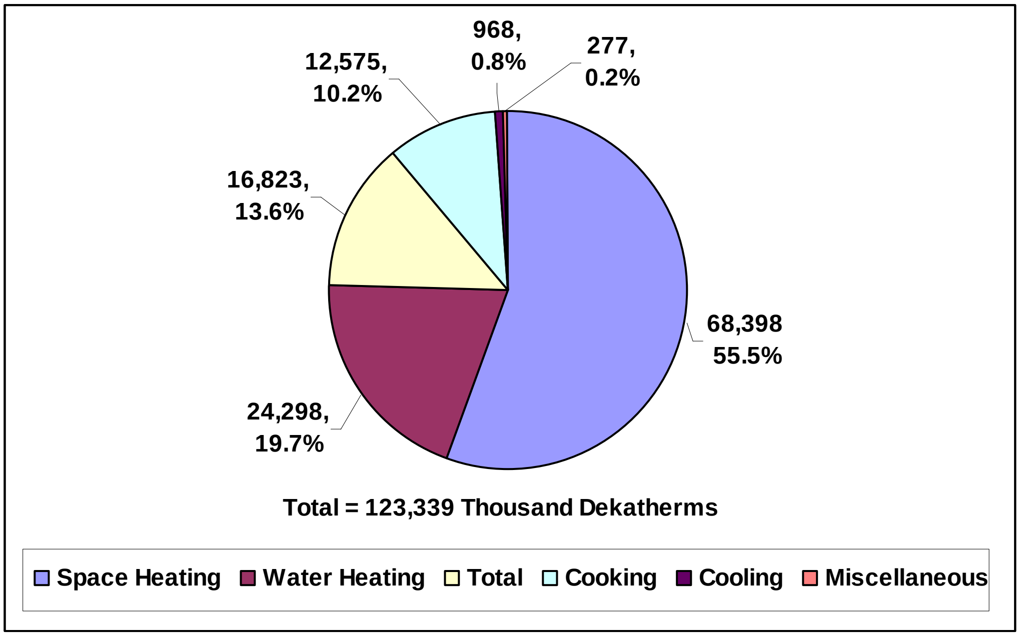
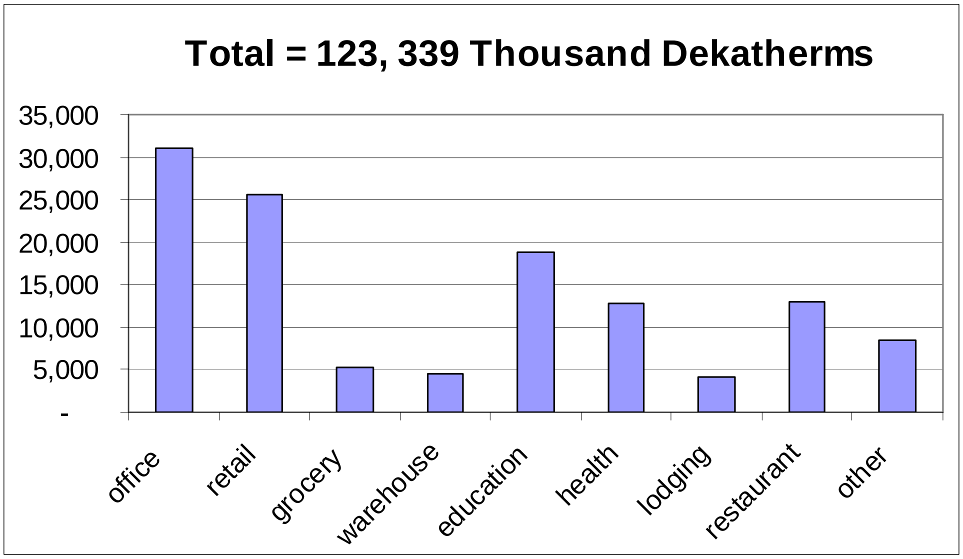


Figure 4.10. Economic Potential Commercial Savings by End Use by 2016



By building type, the greatest opportunities are in offices and retail establishments which, when combined, account for roughly half of the potential. Education, healthcare and restaurants also offer substantial opportunities — approximately a third of the total combined. The remaining 4 building types (grocery, warehouse, lodging and other) account for only about 15-20% of the total.[67]

Figure 4.11. Economic Potential Commercial Savings by Building Type by 2016



4.3.2. Analysis Approach

The analysis estimated savings for 40 efficiency technologies or bundles of technologies for ten building types in the four separate markets. For each combination of technology, building type, and market (approximately 980 individual measures), separate measure costs, performance characteristics, and annual penetrations were estimated for baseline, economic, and program potential scenarios.[68]

The commercial analysis used a combination of "top-down" and "bottom-up" approaches. Gas sales were broken down into component parts applicable to different technologies (top-down), while individual technology performance and cost characteristics by building type were developed and applied to the applicable gas loads (bottom-up). The process began with existing and forecasted commercial gas sales that were disaggregated by building type and end use. The disaggregated loads were further defined in terms of the portion feasibly applicable to each

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[67] While master-metered multifamily buildings were analyzed based on opportunities from typical commercial measures, savings are reported under residential.

[68] Not every technology applies to every market or building type. For example, retrocommissioning does not apply to new construction.

technology in each year for each market. The energy-savings potential for each measure as a percent of baseline measure gas consumption was then multiplied by the existing or expected consumption attributable to that measure for each building type to arrive at first-year measure potential. Finally, base-case and economic potential penetrations were applied to each measure, over time, to capture annual impacts for each of the 980 measures. The following is an overview of this process and the major factors, assumptions and data sources used.

4.3.2.1. Commercial Sector Potential Simplified Equation

Various technology factors were applied to the forecasted new and existing building-type/end-use sales by year to derive economic potential for each of the 980 separate measures for each year. The basic method for developing savings by measure is summarized by the equation shown in Table 4.3. The product of these factors provides measure-level Dth savings by year.

Table 4.3. Commercial Sector Potential Simplified Central Equation

Annual Measure Potential	=	Building End Use Dth Consumption/Year	X	Applicability Factor	X	Feasibility Factor	X	Turnover Factor*	X	Savings Factor	X	Annual Net Penetration**

*Existing Market Driven only
** Base Case Economic Potential

Where:

- **Building End Use Dekatherm Consumption Per Year** is the amount of gas used in a given year for a given building type for a given end use (for example, gas consumption in 2007 for office building space heat).
- **Applicability Factor** is the fraction of the end-use consumption for each building type attributable to equipment that could be replaced by the high-efficiency measure. For example, for a stand-alone water heater, it is the portion of water heating gas usage consumed by stand-alone systems.
- **Feasibility Factor** is the fraction of the end use attributable to a given measure that could technically be converted to the high-efficiency technology. Numbers less than 100% reflect engineering and other technical barriers that preclude adoption of the measure. For example, condensing boilers are difficult to install in buildings where the return water temperature is too high and the installed radiation is not sufficient to allow dropping the return water temperature significantly.
- **Turnover Factor** is the portion of existing equipment that will be naturally replaced each year due to failure, remodeling, and renovation. This factor applies only to the renovation and replacement markets.
- **Savings Fraction** is the percent savings of each measure.
- **Annual Net Penetration** is the difference between the base-case measure penetrations the measure penetrations assumed for economic potential (100%).

Below are details on the development of each step.

4.3.2.2. **Market Segmentation**

Current and forecasted commercial gas usage data were the starting point for characterizing the commercial market. The analysis began by identifying the commercial downstate and upstate existing and forecasted gas consumption. These data were further disaggregated into new and existing construction, based on the inputs to the reference case forecast model.

Overall commercial gas usage is expected to grow by 0.85% per year from 2007-2016 with a slightly higher growth rate for new construction than existing buildings. Average annual new construction growth is based on EEA reference case model inputs for new commercial square footage in the Mid-Atlantic region and is expected to be approximately 0.8% per year from 2007-2011 and 1.0% per year from 2012-2016.

4.3.2.2.1. Building Type Segmentation

Once historical sales data were developed, they were disaggregated into ten building types.[69] New York data on gas usage by building type was not available. As a result, the analysis started with electric disaggregated load by building type.[70] Based on average existing building energy intensities per square foot by building type for electricity and gas, the analysis estimated the natural gas consumption by building type.[71] Figure 4.12 shows 2007 gas usage building type segmentation.

Master-metered multifamily buildings are included under residential results. However, because the gas efficiency opportunities are similar to other commercial buildings (*e.g.,* large central boiler and water heating systems), they are analyzed under the commercial approach. Existing and forecast gas usage of master-metered multifamily buildings were estimated based on LDC data and New York City housing construction forecasts.[72]

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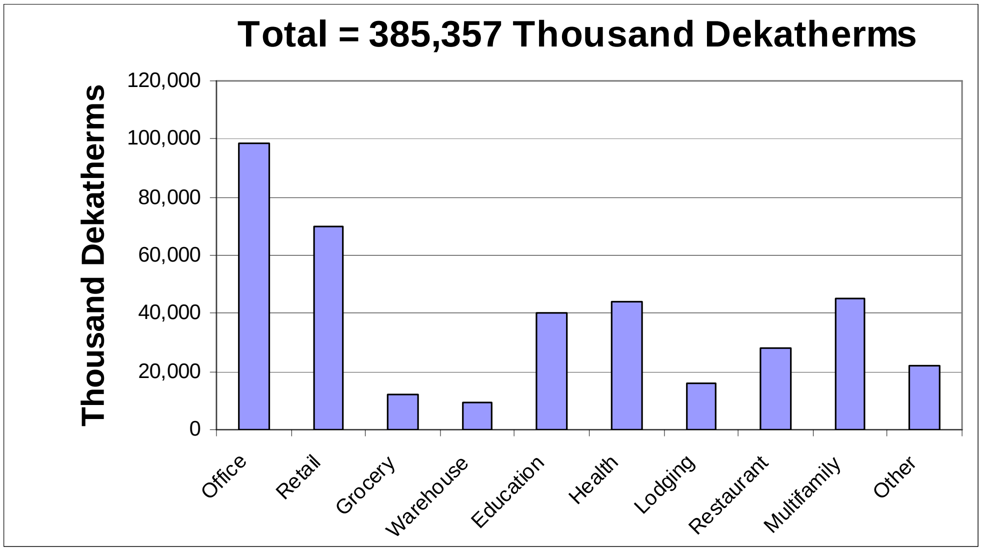
[69] Education, grocery, healthcare, lodging, office, restaurant, retail, warehouse, multifamily, and other.

[70] Optimal Energy, New York Electric Efficiency and Renewable Potential, prepared for New York Energy Research and Development Authority, 2003.

[71] Energy intensities were provided by Regional Economic Research and were based on modeling of prototypical buildings with downstate (New York City) and upstate (Albany) weather.

[72] In addition to customers on multifamily rates, the analysis assumed half of public authority gas usage is for public housing. In addition, New York City plans significant new construction of affordable public housing over the next ten years (approximately 9,000 housing units per year). These estimates were included in new multifamily construction.

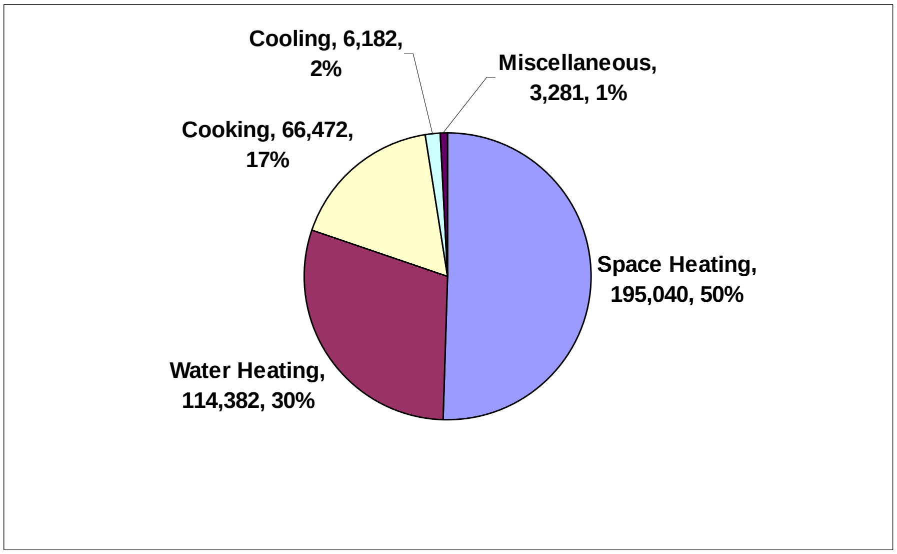
Figure 4.12. 2007 Existing Commercial Forecasted Sales Disaggregated by Building Type



4.3.2.2.2. End-Use Segmentation

Building-type forecasts were disaggregated into five separate end uses, using end-use energy intensities (Dth/sq. ft.) by building type supplied by Regional Economic Research (RER). These are based on RER modeling of a database of thousands of existing commercial facilities audits using New York City's Kennedy Airport (downstate) and Albany (upstate) weather stations. Figure 4.13 shows 2007 estimated existing commercial construction gas usage by end use. Existing and new commercial gas consumption for 2007 and future year growth factors are provided in Appendices B and C for downstate and upstate, respectively.

Figure 4.13. 2007 Existing Commercial Sales Forecast by End Use



4.3.2.3. Turnover of Market Opportunities

The opportunities for market-driven efficiency investments in existing buildings are driven by the turnover rates of existing equipment. The turnover factor is the portion of existing equipment that will be naturally replaced each year due to failure, remodeling, and renovation. Turnover factors for the replacement/remodeling market are based on the lives of the equipment. Estimated measure lives reflect engineering service life and estimated remodeling activity. In general, turnover factors are assumed to be 1 divided by the measure life. For example, a measure with a 10-year estimated life will have a turnover rate of 10% (1/10) of the existing stock of equipment each year.

Four percent of existing building square footage is assumed to undergo major renovation each year, based on a comparison of NYSERDA new construction and renovation data with the NYSERDA electric growth forecast.[73] Major renovation is defined as gut rehab, complete replacement of HVAC, or replacement of multiple energy systems within a building. Appendix B shows the measure turnover factors.

4.3.2.4. Eligible Stock Adjustments

New measures can be installed in existing buildings on an early retirement (retrofit) basis, at the time of natural replacement due to failure, or at the time of renovation or remodeling. To prevent double counting, the methodology tracks the eligible stock of equipment over time for each building type and end-use based on the assumed measure penetrations for each existing construction market. In this way, activity in one market will lower the opportunities for efficiency in other markets. For example, if 60% of existing water heaters are retrofitted with high-efficiency models in 2007, then only 40% of the original population of water heaters remain eligible for efficiency upgrades in non-retrofit (market-driven) markets during 2008 and beyond until the measure life of the retrofitted measures is exceeded. If the water heaters had only a five-year measure life, the original 60% of water heaters retrofitted in 2007 would again become eligible for replacement in 2012 (five years after original installation date). Similarly, once a building is renovated or remodeled, or equipment replaced at time of planned investment, the opportunity for retrofit is diminished until the end of the measure lives for those measures installed under the market-driven scenarios. This eligible stock adjustment methodology is particularly significant for the economic potential analysis, where 100% penetration in one market can eliminate opportunities in other markets for the life of the measure.

4.3.3. Measures Analyzed

Forty separate technologies or practices covering space heating, cooling, service water heating, building shell, cooking, whole building (such as commissioning and retrocommissioning) and miscellaneous (such as pool covers) were analyzed. The analysis included those technologies that

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[73] NYSERDA, Alternate Commercial Energy Code Standards for New York, prepared by Steven Winter Associates Inc. 1999, p. 42 indicates square footage undergoing renovation each year is approximately five times the rate of new construction. The new construction average annual growth rate is approximately 0.8% based on EIA mid-Atlantic forecast of new construction and changes in existing and new energy intensities.

are widely commercially available, typically offer cost-effective savings, and have wide applicability among commercial markets. Emerging technologies expected to meet this criteria within 5-years are also included. In some cases, technologies were included only for certain markets, either because they were most feasible and appropriate for those markets (for example, integrated building design was included only for new construction; retrocommissioning only for retrofit); or because they typically were not cost-effective in certain applications (for example, certain shell measures were excluded for retrofit). In addition, some technologies apply only to specific building types (for example, pool covers apply only to institutional and lodging building types; cooking equipment to institutional, lodging and restaurants). Table 4.4 shows the list of technologies or technology bundles, along with the markets analyzed for each. Appendices B and C provide more detailed lists of the measures along with descriptions of each high-efficiency and related baseline technology. In some cases, a technology is repeated so that it shows under each applicable end-use category.

Because higher and higher levels of efficiency are typically more costly to realize -- and often more difficult to effectively promote even when eliminating economic barriers -- in some cases the analysis separated measures into two or more efficiency “tiers.” This delineation ensured that if some of the higher tier measures were not cost-effective, the analysis did not eliminate all the potential for the technology in the economic potential scenario. All measures that have two or more tiers are treated incrementally. For example, high efficiency glazing Tier I in the office sector represents glazing that is approximately 11% more efficient than baseline new glazing efficiencies, at a typical cost of $27.37 per annual Dth saved. Office-sector high efficiency glazing Tier II equipment is approximately an *additional* 4% efficiency improvement, at an *additional* annual cost of $135.70/Dth.

Table 4.4. Commercial Technology and Market by End Use

END USE / TECHNOLOGY	MARKET TYPE
NC = New Construction RENO = Renovation RR = Remodel/Replacement RET = Retrofit	
SPACE HEATING	
Exhaust Hood Makeup Air	NC/RR
Air Sealing	NC//RENO/RET
Improved heating system high efficiency unit - Tier 1	NC/RR/RET
Improved heating system condensing unit - Tier 2	NC/RR/RET
Programmable Thermostat	RR/RENO/RET
Demand-Controlled Ventilation (controller, sensor)	NC/RR/RET
Outdoor Air Reset	NC/RR/RET
High Performance Glazing double pane, low-E, low conductivity frame - Tier 1	NC/RENO
High Performance Glazing triple pane, low-E, low conductivity frame - Tier 2	NC/RENO
Improved wall insulation	NC/RENO
Improved below-grade insulation	NC/RENO
Improved roof insulation	NC/RENO
Sensible Heat Recovery	NC/RR/RET
Pipe insulation	RR/RENO/RET
Steam trap Maintenance	RET
Oxygen Trim	NC/RR/RET
Infrared Heater	RR/RET
WATER HEATING	
Pre-Rinse Spray Valve	RET
Refrigeration heat recovery	NC/RR/RET
Condensing DHW stand-alone tank	NC/RR/RET
Faucet aerator	RET
Graywater heat exchanger/GFX	NC/RR/RET
Indirect-fired DHW off space heating boiler	NC/RR/RET
Instantaneous. High-Modulating Water Heater	NC/RR/RENO/RET
Low-flow shower heads	NC/RR/RET
Pipe insulation	NC//RENO/RET
Tank insulation	NC/RR/RET
Energy Star washer	NC/RR/RET
COOKING	
Direct fired convection range/oven	NC/RR
High efficiency ENERGY STAR fryer	NC/RR
High efficiency ENERGY STAR steam cooker	NC/RR/RET
High efficiency griddle	NC/RR
COOLING	
Cooling system chilled water reset	NC/RR/RET
Cooling system water side economizer	NC/RR/RET
Cooling system oversized cooling tower	NC/RR/RET
WHOLE BUILDING	
Commissioning	NC/RR/RENO
Retrocommissioning	RET
Integrated Design - High Performance (30% > codes) - Tier 1	NC
Integrated Design - High Performance (50% > codes) Tier 2	NC
MISCELLANEOUS	
Swimming pool/spa covers	NC/RR/RET

4.3.4. Development of Measure Factors

Measure factors are shown in Appendices B and C for downstate and upstate, respectively.

Applicability factors represent the share of end-use level gas usage that is attributable to a particular technology. The analysis drew on a variety of sources to develop applicability factors for each measure by building type. In general, data on market shares for different types and sizes of technologies are weighted based on overall energy consumption or capacity. For example, the applicability factor for condensing boilers reflects the share of total commercial square feet heated by gas that uses hot water boilers of less than approximately 3 million British thermal units per hour (Btuh) capacity. This reflects that condensing boilers are only applicable for hydronic (not steam) systems, and are currently available only up to about 3 million Btuh capacity. Where possible, separate applicability factors for each building type were developed. Where building type data was not available, average data for the total commercial market was used for all building types. New York data was used when available. Alternatively, data from the Northeast or Mid-Atlantic states were used if possible. These data reflect a variety of baseline and market assessment data, including studies done for Long Island Power Authority (LIPA), NYSERDA, proprietary analyses for a number of New York and New Jersey utilities, the Commercial Building Energy Consumption Survey (CBECS) developed by EIA, ACEEE, and published market assessments and other potential studies.

Feasibility factors are the fraction of the applicable end use technically feasible for conversion to the high-efficiency technology. Feasibility is not reduced for economic or behavioral barriers. Rather, feasibility reflects only technical or physical constraints that would make measure adoption inappropriate. For example, it is not feasible to install refrigeration heat recovery to supplement domestic hot water usage in buildings that do not have walk-in or other large refrigeration systems and relatively constant hot water loads. In most cases, it is feasible to replace baseline technology with an efficient alternative, resulting in a 100% feasibility factor. These data are based on various studies or engineering judgment. Major sources of data include a number of proprietary U.S. potential studies conducted in the past five years.

Measure savings factors are calculated based on individual measure data and assumptions about existing stock efficiency (for retrofit measures), standard practice for new construction and equipment purchases (for market-driven measures), and high-efficiency options. Measure-savings characteristics were developed using public and private information sources, including NYSERDA, CBECS, California Energy Commission, Efficiency Vermont, American Council for an Energy Efficient Economy (ACEEE), Lawrence Berkeley Laboratory (LBL), National Fenestration Rating Council (NFRC), various Northeastern U.S. baseline and market assessment studies, recent gas potential studies, and communications with manufacturers and vendors. Measure savings are expressed in % of baseline energy usage.

Baseline adjustment factors were used to adjust long term savings downward for retrofit measures. The initial savings for retrofit measures is the difference between the typical existing stock efficiency and the high-efficiency alternative. However, the long-term savings are the difference between the typical baseline efficiency of new construction and equipment and the high-efficiency alternative, which is typically lower. If retrofits were not considered, the existing stock eventually would get replaced with new baseline efficiency measures anyway. In most cases, the current baseline efficiency is more efficient than the average existing stock. For example, clothes washing equipment meeting U.S. Energy Policy Act (EPAct) efficiency levels are baseline for new clothes washer purchases. However, the average efficiency of clothes washers existing today in commercial buildings falls short of EPAct levels. The baseline adjustment factor adjusts the savings downward in future years for retrofit measures. The analysis assumes the vintage of all measures replaced in retrofit markets is half of its estimated measure life. Therefore, the baseline adjustment applies in the year immediately following half of the measure life. Baseline adjustment factors were developed based on the relative baseline efficiencies of new and existing stock, from current and historical technology, baseline and market assessment studies. Baseline adjustment factors are expressed in % of first year energy savings.

Electric and water savings factors (kWh/Dth-yr) and (gallons/Dth-yr) were developed based on engineering calculations or simulation modeling to calculate non-gas resource impacts.

Annual to peak-day ratios were used to estimate the measure peak-day impacts. The analysis relies on 8,760 hourly end-use and building-type specific load shape data to estimate these ratios, separately for each building type and measure. Load shape data is from Regional Economic Research.

Measure lives were developed from various sources including prior potential studies, NYSERDA, DOE, EPA, ACEEE, ASHRAE, Efficiency Vermont, NFRC, equipment manufacturers and professional judgment. The estimated measure lives reflect both engineering service life and estimated remodel activity.

Measure costs for each of the 40 technologies were developed based on a variety of sources, including but not limited to proprietary studies or data from northeastern United States utilities, R.S. Means, Efficiency Vermont, Grainger, and a California Energy Commission database of equipment costs (DEER database), and discussions with equipment vendors. Measure costs obtained outside the Northeast region were adjusted based on R.S. Means location factors to better reflect New York costs. Retrofit measure costs include the total material and labor cost. Market-driven measure costs reflect the incremental material and labor cost of high efficiency as compared to standard practice.

Measure costs per Dth annual savings ($/Dth) were developed for each building type for each of the 40 technologies analyzed, based on building-type-specific data, and the market applied to.

O&M cost impacts are considered in addition to measure installation costs. These reflect any incremental effects on O&M costs for each measure over its lifetime. O&M cost impacts reflect changes in measure and replacement component lives and costs for both the high- and standard-efficiency options.

Deferral cost credits were captured to properly estimate the long-term societal costs of retrofit measures. Related to O&M costs, the analysis accounts for the time value of permanently deferring the equipment purchase cycle for early-retirement (retrofit) measures. For example, a high-efficiency space heating unit typically lasts 25-years. If an existing space heating unit expected to last another ten years is retrofitted with a new, high-efficiency model, the customer no longer has to purchase a new one in ten years. Rather, the next space heating purchase will be in 25-years. Thus, all future space heating purchases have now been shifted out by fifteen years in perpetuity. This deferment of future capital investments provides a societal benefit by lowering present-value replacement costs. This societal value is captured through a "deferral credit." The analysis assumed the remaining life of all existing measures to be retrofitted was, on average, equal to one half of the total measure life (for example, for an HVAC unit with a 25 year life, it was assumed the average existing unit was 12.5 years old and would normally be replaced 12.5 years hence).

Base-case penetrations were used to estimate the current and future market penetration of measures without any program intervention. The potential efficiency for any given measure is a function of the size of the market, the measure characteristics and the base-case penetration that would occur absent any market intervention. Base-case penetrations for each of the 40 technologies were separately estimated. In some cases, differing estimates by building-type are used, but in many cases, this level of disaggregation was not supported by the data. The base-case represents the existing and forecast measure penetrations that are assumed to underlie the forecast, which assumes no gas program interventions, but does take into account current and expected codes and standards, as well as current and expected New York electric efficiency programs. For retrofit measures, 5% of existing stock is assumed to likely be modified for retrofit reasons over the 10-year planning horizon (equivalent to assuming a 5% freeridership for the economic potential). Base-case penetrations for each of the market-driven measures were estimated to reflect expectations about likely market adoptions, based on expert judgment, review of market assessments, and knowledge of likely codes and standards changes over the planning period.

"Not complete" factors were used to eliminate any opportunities in the retrofit market where efficient equipment already exists rather than relying on base-case penetrations. These factors represent the remaining share of existing stock that has not already adopted the efficient measures. In other words, if 10% of existing buildings have condensing furnaces, the not complete factor for this measure would be 90%. Therefore, for retrofit measures base-case penetrations start at 0%.

Competing Technologies are accounted for with the economic potential penetrations. For the economic potential, by definition, 100% penetration is assumed whenever a measure is applicable and feasible. However, some of the technologies modeled are mutually exclusive -- that is, one or the other could be installed, but not both. For example, water heaters can be replaced with a stand-alone unit, an integrated system off a boiler, or point-of-use heaters. When two or more measures compete with one another, the adoption of the measure offering the highest per-unit savings or greatest anticipated cost-effectiveness is counted first. The penetration of the next competing measure was then estimated based on the remaining potential, taking into account the applicability, feasibility, and achievable penetration of the first measure. In other words, if 100% of water heaters could be replaced with condensing stand-alone units (and this measure is considered first), then 0% penetration opportunity remains for the other competing measures.

Interactions factors were used to account for interactions among measures. Individual measure savings are not additive. Because of interactions between measures, the total potential for all measures is less than the sum of individual measure opportunities taken independently. For example, installing high performance windows will reduce heating load and therefore lower the savings opportunities from installing a condensing boiler. Interaction factors are separately estimated for retrofit, existing building market-driven, and new construction markets. This is because some measures only apply to one market. For example, integrated high efficiency design applies only for new construction, retro-commissioning applies only for retrofit. As a result, the measures that interact with each other differ for each market. The measures within a group that interact, typically by end-use, are ranked based on priority. Although some measures, such as commissioning, interact with all end uses. This ranking is based on per unit savings, or judgment about what measures are typically most cost-effective and likely to offer the greatest customer benefit. Each subsequent interacting measure is then adjusted for the potential savings captured by the prior measure.

It should be noted that the rank order does not affect ultimate total potential savings. However, it does effect the per measure savings and cost-effectiveness. A measure further down in the ranking would still cost the same amount to install, but is assumed to save less because of prior measures already assumed to be installed.

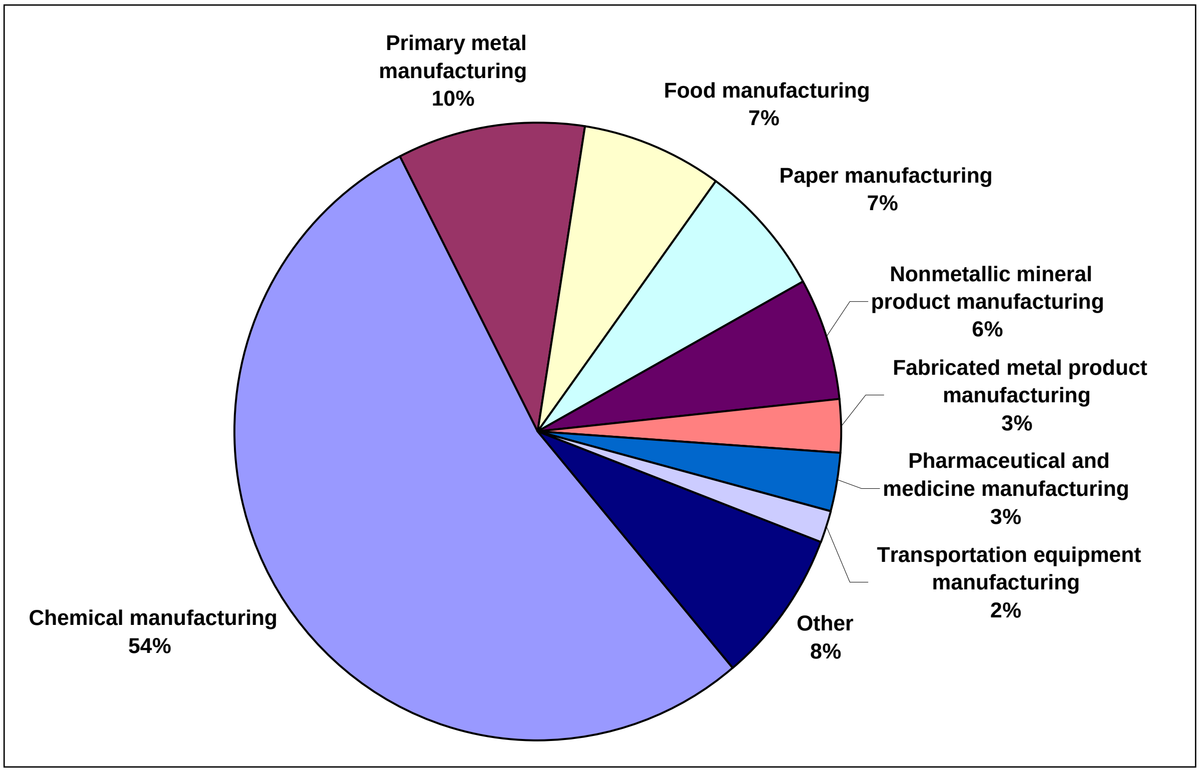
Note that both competing measure issues and interactions are not considered for the program scenario potential estimate. This is because the program scenario is sufficiently lower than likely maximum achievable potential that penetrations are not high enough to assume most customers are pursuing numerous measures at once.

4.4. INDUSTRIAL SECTOR ANALYSIS

4.4.1. Overview of Results

Industrial natural gas consumption is concentrated in a few industries in the State (Figure 4.14). Industrial natural gas use differs significantly between the upstate and downstate regions. Most industrial gas consumption is concentrated in the upstate region with consumption concentrated in several important gas-intensive industries: chemicals, primary metals, paper, and glass. In addition, food processing and fabricated metals have more importance statewide. Industrial gas consumption in the downstate region is focused primarily in light manufacturing such as apparel and metals fabrication and food products such as bakeries and processed meat facilities.

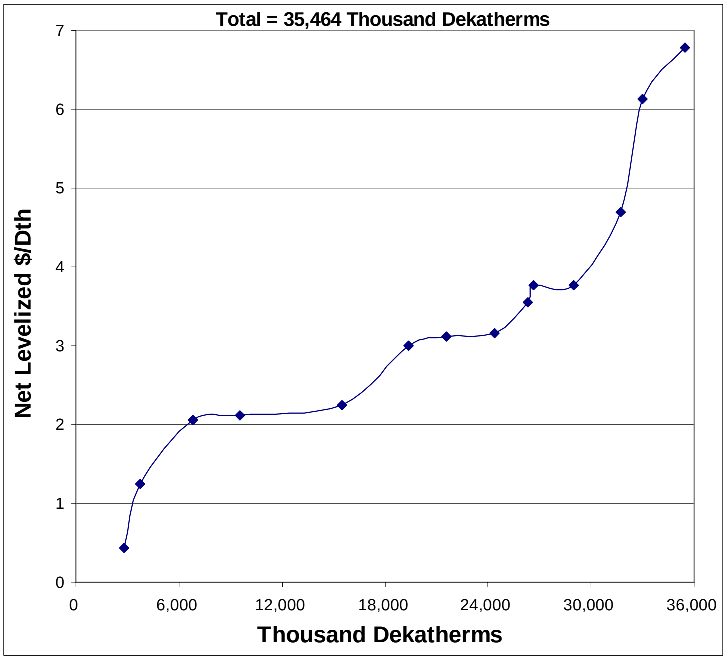
Figure 4.14. Distribution of Industrial Gas Consumption in New York



The analysis assessed an array of 16 natural gas efficiency measures, with the majority focused on industrial steam and hot water use – the most important end uses. Disaggregated state industrial energy use was applied to appropriate energy efficiency measures to develop an estimate of the technical potential for energy savings that could be made by fully adopting all the measures without regard to economic impacts. The analysis then applied economic criteria to these savings estimates and determined the level of efficiency that could be cost justified.

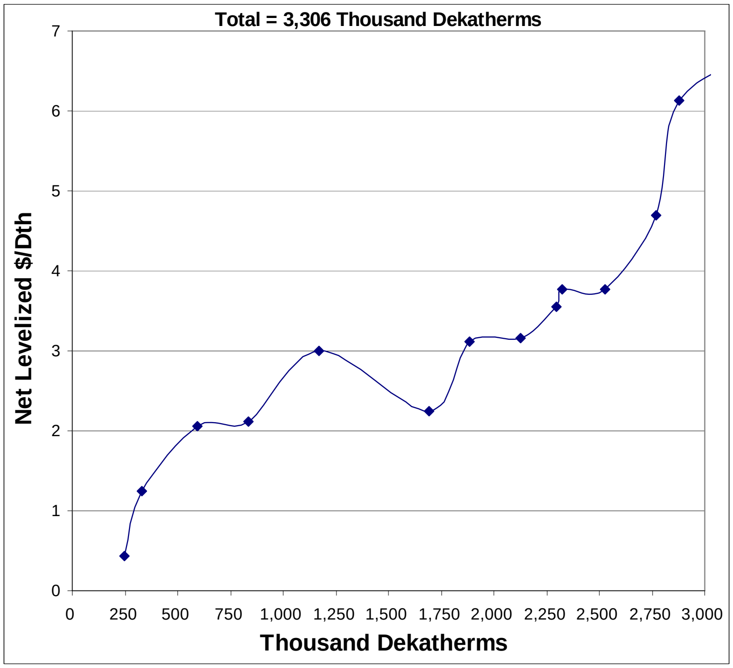
Fourteen of the 16 measures were cost-effective in the upstate and downstate regions for a statewide economic potential of about 39,000 MDth in 2016 as is shown in the supply curves presented in Figure 4.15 and Figure 4.16. Peak day 2016 potential is 119 MDth. While the potential for industrial natural gas savings is significant in the upstate region, in the downstate region the potential is less than in residential and commercial sectors because industrial natural gas use in this region is quite modest.

Figure 4.15 Industrial Sector Economic Potential Supply Curve by 2016 - Upstate



Note: Combined statewide figures are not available because each zone must be analyzed with a separate cost-effectiveness screening tool.

Figure 4.16 Industrial Sector Economic Potential Supply Curve by 2016 - Downstate

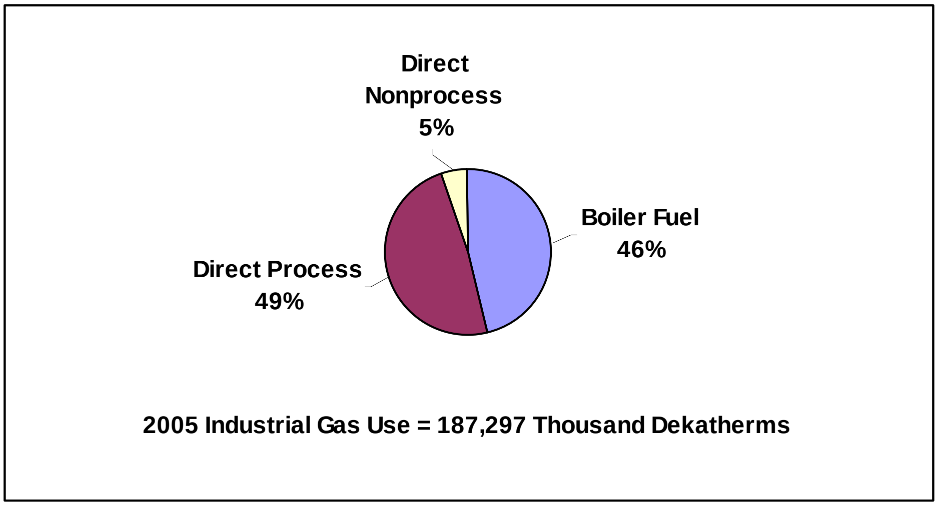


Note: Combined statewide figures are not available because each zone must be analyzed with a separate cost-effectiveness screening tool.

4.4.2. End-Use Disaggregation

Industrial natural gas use can be grouped into three broad categories, as shown in Figure 4.17: boiler fuel used to produce steam and hot water that is used in industrial process and for conditioning the industrial buildings; direct process heating application such as to cooking, baking, melting or drying; and direct non-process applications which are almost exclusively natural gas fired unit space heaters. While direct process application are very site specific, the boiler and direct non-process applications cut across industrial, and many commercial facilities as well. Because of the significant boiler-related measures that cut across all industrial sectors as well as many commercial, it appears that this potential can be best realized through an application program rather than a more segmented individual industry market focused approach as has been commonly used for electricity energy efficiency measures. The process-specific measures would require a more focused approach as is discussed in the program discussions.

Figure 4.17 Disaggregation of Industrial Natural Gas by End Use



4.4.3. Measures Analyzed

The measures are broken down into three categories that approximate the broad end-use groupings: steam, hot water, space heating and direct process heating (see Table 4.5). These measures include both technology measures such as feedwater preheaters and insulation and practice measures such as improved steam trap maintenance. As a result, the life of the measures range from just 2 years for practice measures to 30 years for large capital measures such as boilers. For the shorter lived measures, the analysis assumes they will need to be re-implemented at regular intervals as the savings depreciate.

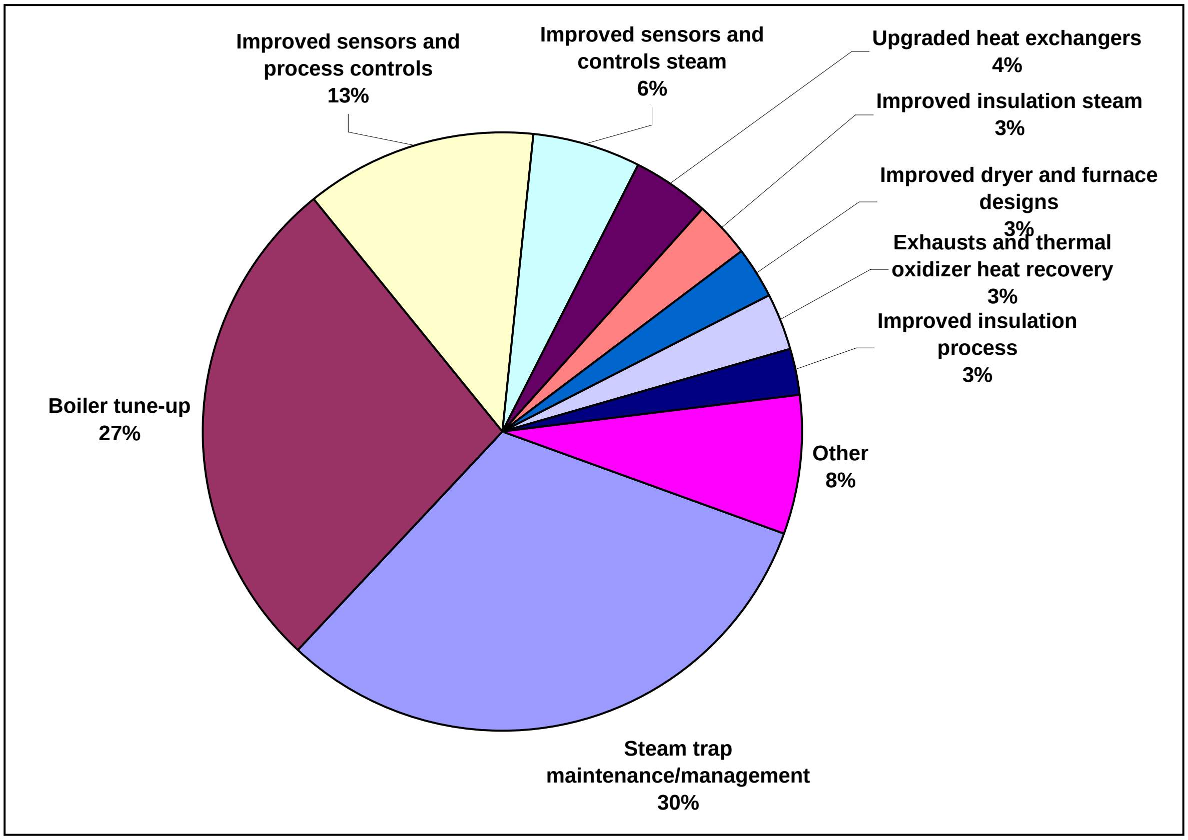
In addition to measure life, Table 4.5 presents estimates of the applicability of the measure to the end-use category, the maximum savings that could be expected from the measure and the net technical saving potential for the measures.

Table 4.5. Industrial Natural Gas Energy Efficiency Measures Analyzed

#	End-Use	Measures (Technology)	Measure Lifetime (years)	Measure Applicability Coefficient (of end-use)	Maximum measure savings	Net Technical Savings Potential (of end-use)
1	Steam	Steam trap maintenance/ management	2	80.0%	5.0%	4.0%
2	Steam & Hot Water	Boiler Replacement	30	40.0%	20.0%	8.0%
3	Steam & Hot Water	Boiler tune-up	2	85.0%	7.5%	6.4%
4	Steam & Hot Water	Improved sensors and controls	5	75.0%	5.0%	3.8%
5	Steam	Economizers and feedwater preheaters	10	35.0%	5.0%	1.8%
6	Steam & Hot Water	Upgraded heat exchangers	10	35.0%	15.0%	5.3%
7	Steam & Hot Water	Improved heat exchanger maintenance	2	60.0%	5.0%	3.0%
8	Steam & Hot Water	Improved insulation	10	75.0%	5.0%	3.8%
9	Hot Water	Condensing hot water heaters	10	15.0%	20.0%	3.0%
10	Hot Water	Hot water conservation	2	15.0%	3.0%	0.5%
11	Space Heating	Improved unit space heaters	19	25.0%	5.0%	1.3%
12	Space Heating	Improved insulation	10	85.0%	5.0%	4.3%
13	Direct Process Heating	Improved sensors and process controls	5	75.0%	10.0%	7.5%
14	Direct Process Heating	Improved dryer and furnace designs	20	35.0%	20.0%	7.0%
15	Direct Process Heating	Heat recovery from dryer and furnace exhausts and thermal oxidizers	10	35.0%	10.0%	3.5%
16	Direct Process Heating	Improved insulation	10	60.0%	5.0%	3.0%

Applying the measures to the industrial end-use categories and assessing the economic viability of each measure reveals that three of the measures – improved boiler sensors and controls, water conservation and heat exchanger maintenance – are not cost-effective. The resulting economic potential is 39,000 MDth in 2016. As shown in Figure 4.18, almost three-fifths of the economic savings potential flows from boiler tune-up and steam trap maintenance measures. Improved process sensors and controls offer an additional 13% of the savings, and improved steam system sensors and controls offer 6%. The balance of the measures each offer 4% or less of the total savings.

Figure 4.18 Economic Potential Industrial Energy Savings by Efficiency Measure by 2016



4.4.4. Market Segmentation

The majority (92%) of natural gas consumed by the industrial sector in New York is consumed in eight industrial subsectors: chemicals, primary metals, food, paper, nonmetallic minerals, fabricated metal products, pharmaceuticals, and transportation equipment. More than half (54%) of the natural gas consumed by the industrial sector in New York is attributed to the chemical industry. The natural gas consumption breakdown for the industrial sector is shown in Figure 4.14.

The end uses for natural gas within the industrial segments fall almost equally between boiler fuel (46%) and direct process (49%), with a small remainder (5%) attributable to non-process use as shown in Figure 4.17. Because accurate data for calculating the natural gas consumption by industrial sub-sector was not available for the downstate region, downstate subsector estimates were based on NYSERDA’s previously published study of electrical efficiency potential.

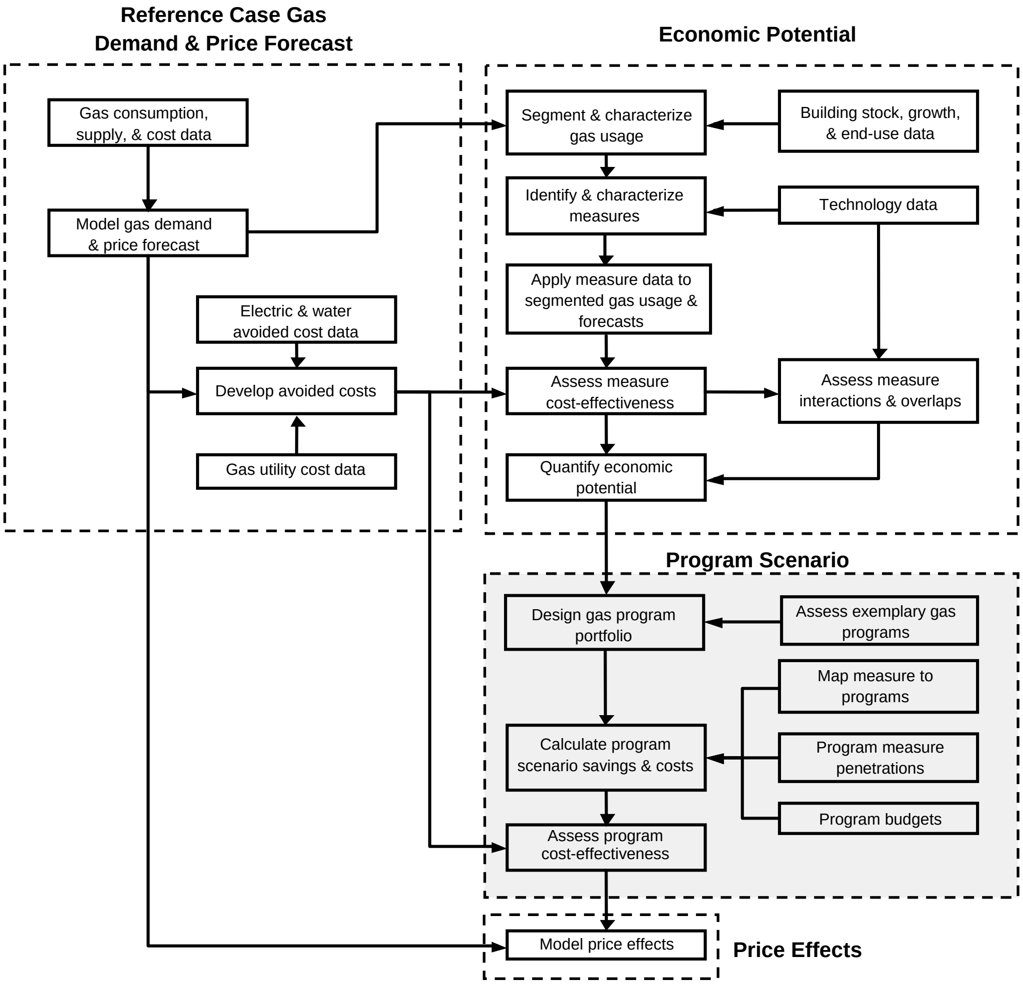
5. PROGRAM SCENARIO

5.1. PROGRAM DESIGN AND DEVELOPMENT

5.1.1. Introduction

This section describes the design and development of a portfolio of suggested programs for the program scenario. This task used the results of the economic potential to identify important opportunities for efficiency, combined with a review of successful programs throughout North America, to develop programs. It then analyzed the program costs and savings and screened them for cost-effectiveness using the results of the economic potential and avoided cost analyses. Figure 5.1 shows how the program scenario task relates to the overall project.

Figure 5.1 Project Flow: Program Scenario



5.1.2. Establishment of Funding Levels

The analysis of the program scenario potential in New York assumed an average annual energy efficiency budget of $80 million for a five-year program period. The funding level was set by NYSERDA in consultation with New York Department of Public Service staff. A funding level of approximately 0.75% of 2004 sales revenue would generate $80 million and was determined to be a reasonable statewide gas energy efficiency funding level for analytical purposes.[74] As explained in Sections 1 and 2, the funding level should not be interpreted as a recommended funding level; it could be adjusted. The program scenario potential analysis is provided to inform and guide future decisions about funding levels and programs.

The $80 million average annual budget was allocated to the different sectors – residential, commercial, and industrial – in proportion to their statewide sector-level gas consumption.[75] As Table 5.1 shows, about 44% of the budget would be focused on residential customers and the remainder on commercial and industrial customers.[76,77] Fifty percent of the residential program spending was allocated specifically for low-income customers. That is comparable to the portion of electric SBC funding dedicated to low-income customers.[78]

Table 5.1. Energy Efficiency Budget by Sector

Sector	2007 Gas Consumption		Energy Efficiency Budget ($ Millions)
	(Billion Cubic Feet)	(%)	
Residential	401	44.43%	$35.55
Commercial & Industrial	501	55.57%	$44.45
Total	902	100.00%	$80.00

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[74] The New York electric system benefit charge, as a percent of sales revenues, was 0.76% for SBC1 and 1.31% for SBC2. The estimate is 1.52% for SBC3.

[75] In estimating economic potential by sector centrally-heated multifamily buildings are included in the "residential sector." However, for the purpose of estimating the portion of an efficiency budget that would be allocated to the residential sector, centrally-heated multifamily building consumption is included in the commercial sector. This is because the strategies to address such buildings are more consistent with commercial and industrial program designs than residential program designs.

[76] Commercial and industrial customers are consolidated here because programs to address commercial customers are also available to industrial customers.

[77] The study assumes that all gas ratepayers in the State, except power generators, pay into the program funding and are eligible to participate in the programs. It has been noted by DPS staff that including interruptible customers may be difficult due to their rate structure which is set on a value of service basis.

[78] Note that many low income customers likely live in master-metered multifamily buildings. However, because the programs are offered to, and decisions about efficiency are made by, building owners and ratepayers, the low income funding is dedicated to the residential programs. As a result, low income customers would likely benefit from the C&I programs as well, where larger multifamily buildings with centralized systems are addressed.

5.1.3. Program Portfolio Development

Once funding levels were established, the next step in estimating program scenario potentials was to develop the portfolio of programs to analyze. The approach to developing the portfolio had four major steps:

- Reviewing exemplary gas energy efficiency programs from across North America to identify candidate programs for New York
- Reviewing existing electric energy efficiency programs in New York to identify opportunities to leverage current efforts
- Developing a design philosophy and a set of policy objectives that the portfolio of programs would be designed to meet
- Selecting a mix of programs that balanced the desire for demonstrated success, leveraging of existing efforts and serving multiple policy objectives

5.1.3.1. Review of Exemplary Gas and New York Electric Programs

5.1.3.1.1. Background: Exemplary Natural Gas Efficiency Programs

Energy efficiency programs have been offered in various forms for more than twenty years. Such programs have taken a wide range of approaches—from efforts that tended to provide only information to the era of demand-side management (DSM), which viewed energy efficiency as a resource that could be acquired, generally by providing customers financial incentives for purchasing energy-efficient products. Throughout the past decade, market-transformation programs have been used to make strategic interventions in statewide, and sometimes regional, markets to cause fundamental changes in customer choices of energy-efficient products and services. Today's best programs draw upon this rich history of program experiences.

In 2003, the American Council for an Energy-Efficient Economy (ACEEE) initiated the first of three related projects to identify and profile some of America's leading energy efficiency programs (York and Kushler 2003). A main objective of these projects was to provide examples of programs worthy of emulation. ACEEE conducted national searches in each project to identify candidate programs. Once ACEEE had identified a set of candidate programs, an expert panel reviewed the nominations and selected those programs that they judged as exemplary and, in some cases, honorable mention. The first exemplary programs review focused primarily on programs targeting electricity savings and included about 60 programs across all customer sectors (*i.e.* residential, commercial, industrial) and end-uses (*e.g.,* lighting, space heating, cooling, appliances, and industrial processes).

Later in 2003, ACEEE initiated its second best programs review—this time focusing exclusively on natural gas energy efficiency programs (Kushler, York and Witte 2003). This project was a response to the developing natural gas crisis (soaring prices and constrained supplies that were first felt in the early 2000s). The goal of the project was to provide practical and successful program models for states and utilities to initiate and expand natural gas energy efficiency efforts. This project provided a rich source of program information from which to develop program proposals for New York. The third ACEEE best programs review, completed in September 2005, targeted low-income energy efficiency programs, another area of interest for natural gas efficiency programs (Kushler, York and Witte 2005).

In the natural gas best programs project, ACEEE selected and profiled 29 exemplary natural gas efficiency programs along with 5 special case studies that are examples of comprehensive program portfolios and multi-party collaboratives. Together this set of 34 profiles paints a comprehensive picture of the types of energy efficiency programs available to assist natural gas customers.

This report discusses the characteristics and common traits among exemplary natural gas energy efficiency programs in order to help frame the development of the program proposals for New York. This study's conclusions are similar to those presented in an evaluation recently completed for NYSERDA (Zabetakis 2005).

5.1.3.1.2. Program Characteristics and Common Traits of Exemplary Natural Gas Energy Efficiency Programs

ACEEE's natural gas exemplary program study found that integrated packages of services are common among leading natural gas efficiency programs. This is true across program types, from those serving low-income residential households to those serving large industrial customers. The integrated package of services may include marketing; consumer education; technical assistance, such as audits, economic/technical analysis of efficiency options, and design recommendations; financial incentives (principally rebates or financing); and quality assurance and verification of results. The best programs tend to have a single point of contact with customers. The customer may work only with a single person or small, well-coordinated team to access the full range of products and services available, rather than having to contact one person for one service and another for a different service. Integration of services within a single program is common, but the study found this trait among leading portfolios of programs offered by single organizations. The emphasis is always on having a single point of contact for program services.

Most residential programs have historically tended toward a prescriptive approach to services and financial incentive amounts. For marketing and incentive programs, such as promotion of energy-efficient furnaces, generally the programs are entirely prescriptive; to get financial incentives customers must purchase one of a set of qualified units. This approach makes sense for mass market products that service a common niche among targeted customers.

Leading-edge programs in this sector, however, have begun to feature a somewhat more sophisticated approach, including incorporating elements such as sizing and installation quality of furnaces and boilers which helps produce additional savings. Increasingly, the trend is toward programs that feature a whole-house approach and encompass services such as blower door assisted infiltration reduction, duct sealing and insulation, in addition to traditional key measures of high efficiency furnaces and building shell insulation. In addition to generating more savings, whole-house approaches address health, safety, comfort, durability and other issues that are often important to consumers.

Commercial/industrial (C/I) programs typically are more flexible and customized, particularly for larger customers. Programs for small commercial customers tend to be more prescriptive—like residential programs—because their energy use characteristics mirror those of households: relatively simple, standard applications of appliances and equipment (office products, heating and cooling equipment, and lighting).

Programs targeting large C/I customers tend to offer more custom options. For example, rather than prescriptive incentives based on specific measures, incentives may be paid on the basis of \$/Dth or \$/kWh savings. Flexible, customized approaches are especially important for large customers, who tend to have more complex needs than smaller customers.

Financial incentives are a common feature to affect customer purchase decisions— for both residential and commercial/industrial customers. High efficiency technologies for natural gas applications—furnaces, boilers, process equipment, and controls—generally still carry a price premium relative to other technologies. While customers may recognize the long-term value of investing in more efficient technologies, program experience is that financial incentives remain very helpful in motivating customers to purchase the technologies. This seems to be true for all customer types, from the homeowner replacing a furnace to the industrial facility manager replacing a boiler. As the markets for such technologies develop and mature, incentive levels may be reduced or even eliminated entirely. The efficiency of qualifying technologies and units also may be periodically increased as standard equipment becomes more efficient through adoption of standards and market forces.

Another common feature among leading programs is the prevalence of strategic partnerships and collaborations, which can improve program effectiveness and leverage resources. The most successful programs effectively work with key market actors, such as distributors, local suppliers/retailers, contractors, manufacturers, and allied organizations, such as government agencies, non-profit service organizations, and trade groups. By combining resources and working toward common objectives, these programs reach and serve more customers and yield greater savings.

Related to strategic partnerships and collaborations are training and education as part of the program services. Many of the programs selected in ACEEE's studies offer training and education for suppliers, retailers, and contractors, including those programs primarily offering financial incentives as their key service.

Credibility is also an important factor. In many markets consumers have no easy way to differentiate among builders, contractors and other professionals who provide efficient and high quality products and services from those that do not. Many successful programs have succeeded in helping consumers identify the better service providers. At the same time, programs have helped key trade allies to differentiate themselves in the market.

Evaluation is a critical element of successful programs. The programs selected and profiled in ACEEE's studies often represent several years of program evolution. The programs used evaluations to assess performance and made improvements based on the feedback and analysis provided by such evaluations. Exemplary programs use evaluation strategically to support program goals and explicitly include evaluation plans within program plans. Early in a program's life, the emphasis may be on process evaluation—assessing the quality of services and customers' responses to them, while later in the program's life the focus may shift to impact evaluation—measuring total energy savings and other indicators of program performance, such as market share.

The research and evaluation conducted by Zabetakis (2005) yielded findings similar to those of the ACEEE studies and identified the following features of successful natural gas energy efficiency programs:

- Strong relationships among contractors, retailers, and trade allies
- Strong training programs
- Well designed and executed program management and monitoring practices
- Results-based marketing and promotion
- Consistent delivery of marketing and promotional messages
- Stability of regulatory treatment over time so that programs have continuity with key market actors
- Responsiveness to customers and quality of service
- Appropriate incentive levels for service providers and consumers

5.1.3.1.3. A Portfolio of Exemplary Natural Gas Energy Efficiency Programs

In developing proposals for natural gas energy efficiency programs in New York, the study first considered what would comprise a model portfolio of natural gas energy efficiency programs. Model portfolio in this context includes a comprehensive set of programs that spans customer markets and principal customer end-uses of natural gas. The study developed the portfolio with the understanding that New York has a significant winter heating demand for natural gas as a fuel for space heating of both residential and commercial buildings.

Three dimensions can be used to define programs:

- Customer sector: residential, commercial and industrial
- Major end-uses: space heating, water heating/hot water systems, food service equipment, and process heating
- Market segment: new construction/major renovation, planned product replacement at end of its life, and discretionary retrofit of existing equipment explicitly to save energy

Customer sectors define the principal categories of customers who use natural gas as a fuel. End-uses define the applications of products and services that require natural gas as a fuel. Market segments define the principal needs that drive customers to purchase new products and equipment.

Successful energy efficiency programs address customer and service provider needs and work to address the myriad market barriers that exist for energy-efficient technologies and services. The bases for building a model portfolio of programs, therefore, is examining the market segments and identifying the barriers.

In new construction and planned equipment replacement, potential barriers to energy efficiency investments include:

- High first costs
- Lack of familiarity with technologies and design practices on the part of architects, engineers, vendors, and contractors
- Lack of awareness, familiarity, or comfort on part of customers with the energy and non-energy benefits of technologies or design practices
- Lack of quantification of the cash value of energy and non-energy benefits relative to other elements of the project's cash flow
- The need to make very quick decisions, which can inhibit consideration of some energy efficiency options that represent departures from normal practices

Additional obstacles to discretionary retrofit projects include:

- The full cost of projects are borne by customers[79]
- Introducing new technologies and design practices in a situation where the existing technologies are still functioning creates risk and uncertainty for customers

The exemplary programs identified and profiled here have successfully addressed these common barriers. Examination of leading programs shows that they fall into categories largely defined by customer type and market segment, with some possible further designation according to targeted end-use. In looking at these programs, however, there are still some areas for improvement:

- Better integration of electricity and natural gas energy efficiency measures into single program offerings. Programs should present customers and service providers with a complete assessment and set of choices that cover all major energy end-uses—principally electric and natural gas.
- A stronger emphasis on holistic, integrated approaches for the administration and implementation of programs as well as the specific customer and service provider

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[79] Consider, for example, the cost of upgrading to an efficient furnace. In a retrofit context, the consumer must pay the full cost of replacing a still operating furnace with a new condensing model. In contrast, in an equipment replacement decision, the consumer is already buying a new furnace so the cost of efficiency is simply the (much lower) incremental cost of upgrading from a new standard efficiency model to a condensing model.

applications and interactions. Programs should treat the buildings and facilities as a complete, integrated set of end-use applications, equipment and systems.

- Program administration and delivery of services should be integrated to provide customers and service providers with a single, seamless interface for all eligible and applicable programs and services.

As the study developed program concepts and designs for New York, the emphasis on integration of fuel types, customer applications, program services and program administration served as a guiding principle. New York has a strong portfolio of existing energy efficiency programs, primarily through the public benefits programs offered by NYSERDA and LIPA. Some of the existing State programs provide technical assistance to analyze and recommend measures to customers that would increase the energy efficiency of selected natural gas end-uses. Discounted financing for natural gas efficiency improvements is available for certain measures. While some natural gas energy efficiency measures are included, the State's existing programs principally address electric end-uses.

Expanding existing electric programs to address natural gas end-uses offers a number of potential benefits, including:

- An established program identity or brand
- Established marketing and communications channels
- Customer and service provider experience and familiarity with the programs
- Experienced program staff and contractors
- Established infrastructure for delivering program services
- Single points of contact, thereby reducing consumers' and service providers' transaction costs, increasing customer service and benefits, and increasing the likelihood customers would participate

These advantages can yield program cost savings since some program start-up costs are avoided. There are also possible on-going cost savings from joint marketing and other services. Zabetakis (2005) examined a similar question with respect to the desirability of expanding NYSERDA's existing programs to include increased coverage of natural gas energy efficiency options. The report concluded:

> "Since NYSERDA already has an effective energy efficiency program infrastructure, it can expedite natural gas efficiency gains for New York and provide a clear, manageable "energy" efficiency model for all stakeholders. NYSERDA is well positioned to promote and defend fuel neutral efficiency programs that can take advantage of existing New York Energy\$mart℠ brand."

Expansion of the State's portfolio may not be sufficient to address all key natural gas end-uses and market segments, however. In the next section, the report presents major findings from a review of the State's electric efficiency portfolio relative to including natural gas energy efficiency.

5.1.3.1.4. Opportunities for Leveraging Existing New York Efficiency Programs for Addressing Natural Gas Energy Efficiency

The State offers an extensive portfolio of energy efficiency programs that are successfully addressing customer needs to improve energy efficiency and reduce energy costs (NYSERDA, 2005). And while some of the existing programs clearly are ready to integrate natural gas energy efficiency components, a few natural gas market segments would easily be captured by expanding existing State programs. Before identifying and discussing these market segments, however, the report presents three key overall principles that should guide the design and development of programs to address natural gas energy efficiency, whether in expanding existing state programs and services or in creating entirely new programs. These are:

- Programs should provide an integrated, seamless delivery of services to customers and markets, regardless of how programs are listed and tracked.
- Program offerings generally should address all end-uses and fuels in a "one-stop-shop" fashion, rather than requiring customers and service providers to identify and pursue different avenues to different programs. There may be specific end-uses and technologies for which a targeted program would be the most appropriate, but if it is easier for customers and service providers to address all potential measures via a single program or contact, the likelihood is greater they would implement applicable measures.
- Financial incentives are necessary in some markets to achieve significant adoption of energy-efficient technologies, especially for products and end-uses for which cost differences are significant between standard and high-efficiency products.

In the context of these overarching program principles, the study next identified opportunities in New York's existing portfolio of programs that could readily be expanded to address natural gas energy efficiency.

5.1.3.1.5. Residential Programs

5.1.3.1.5.1. Residential Audit/Information Program

No program of this type is currently offered by NYSERDA.[80] Audit and information-only programs do not lead to significant levels of energy savings. Achievement of such savings requires linkages to programs and services that provide customers sufficient incentives and assistance to customers to implement measures recommended by audits.

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[80] LIPA does currently have a customer education program which encourages customers to participate in other programs such as Lighting and Appliances and Cool Homes, programs that provide rebates for the purchase of efficient products and equipment.

5.1.3.1.5.2. Residential Space Heating Equipment Program

The State's approach to residential mass markets generally follows a market-transformation model of working with manufacturers and retailers to increase sales of energy-efficient products, such as ENERGY STAR® products. NYSERDA's residential products programs, unlike LIPA's, do not generally include financial incentives such as rebates or discounted financing, although electric and natural gas appliances and equipment are promoted to residential customers.

ACEEE's review of exemplary programs found that programs to increase sales of high efficiency (>90% AFUE) natural gas furnaces and boilers generally rely on rebates to increase sales. These products still command a price premium that is not easily overcome without incentives. Experience suggests that the offer of incentives can not only generate near term savings, but lead to market transformation as well. A commonly-cited example is the program to promote efficient furnaces in Wisconsin. Wisconsin natural gas utilities offered rebates on high efficiency furnaces from 1980s into the 1990s. Wisconsin's natural gas furnace market is now transformed—high efficiency furnaces are the norm for both new construction and replacement markets (greater than a 75% market share compared to standard efficiency models). By contrast, standard efficiency furnaces are the norm and high efficiency furnaces have only about 40% of the market in the neighboring state of Michigan. Wisconsin's public benefits program, which has replaced utility programs, continues to offer rebates on selected high efficiency furnaces.

5.1.3.1.5.3. Residential High Efficiency Windows Program

While neither NYSERDA nor LIPA offers a program specifically targeting high efficiency windows, they are addressed as part of the New York ENERGY STAR® Labeled New Homes Program and the Home Performance with ENERGY STAR® existing homes programs.

5.1.3.1.5.4. Residential New Construction Program

Neither NYSERDA's nor LIPA's ENERGY STAR® new homes programs provide specific incentives to customers to encourage the purchase of high efficiency natural gas furnaces, water heaters and appliances. While the whole house ENERGY STAR® standard for new homes is increasing in 2006, there are still opportunities for additional natural gas savings from natural gas appliances and equipment that exceed the requirements of ENERGY STAR® standards. There also will be federal tax credits available for two years, beginning in 2006, for purchase of high efficiency appliances.

5.1.3.1.5.5. Residential Technical Assistance—Multifamily Buildings

This NYSERDA program links to the **New York Energy $mart** Loan Program, but provides no other incentives for residential technical assistance.

5.1.3.1.6. Commercial/Industrial Programs

5.1.3.1.6.1. Small Business Program

Program services are offered through different programs. No single package of small business services is available. Because market barriers to acquiring efficiency services are substantial for small businesses, integration of the varied offerings into a single, simple to use, fuel-neutral service would enhance customer service, increase customer participation, and reduce program costs through increased economies of scale.

5.1.3.1.6.2. Commercial Cooking Equipment Program

No specific program is offered by NYSERDA. In theory, this equipment qualifies as custom measures under the C&I New Construction program. However, a successful effort requires more focus, including upstream marketing and perhaps financial incentives to vendors, distributors and manufacturers, as well as engagement with trade associations.

5.1.3.1.6.3. Commercial/Industrial Building and Equipment Retrofit Programs

NYSERDA offers no full-fledged programs specifically targeting early retirement of existing inefficient equipment boilers, furnaces or other natural gas heating equipment. However, it is piloting such a program for the Con Edison service area.

Because of the significantly different economics associated with discretionary retrofit markets versus lost opportunity markets, as well as the nature of how retrofit projects are initiated, New York could consider focusing on this market by engaging with trade allies and offering financial incentives to customers.

5.1.3.1.6.4. Industrial Process Efficiency Program

Industrial programs typically offer customized services—from technical assistance to identify and analyze measures to financing the projects. Customers must be self-motivated and direct much of their program involvement. There are no programs that specifically target common technologies (like natural gas boilers—see above) or specific industries that have high natural gas use. One program opportunity would be to target marketing and program promotion to customers with high potential. Another would be to promote selected high efficiency technologies that are common to industrial and some commercial customers.

In theory, the C&I New Construction Program custom track can address many of these opportunities not presently addressed in existing programs. However, it requires customers or their vendors and contractors to make the links from one program to another and be proactive in pursuing participation. To the extent New York program administrators can integrate these programs seamlessly as a single set of services that address all barriers simultaneously, participation and comprehensiveness could be improved.

5.1.3.2. Recommendations and Priorities for Expanding Existing Program Portfolios

Both NYSERDA and LIPA have large portfolios of programs that address a wide range of customer types, end-uses and technologies. The focus of these programs is electricity since the

State public benefits program was created in association with restructuring New York's electric utility industry. These portfolios of programs provide a solid foundation upon which to expand programs and services to an additional emphasis on natural gas energy efficiency. Many of the existing programs could easily be expanded in this manner. This study does not presuppose any particular organization as a program administrator for gas efficiency programs. It discusses the benefits and potential drawbacks of centralized administration, regardless of who the administrator might be. The study offers two main suggestions to guide expansion of the existing portfolios.

First, the State should consider expanding existing public benefits programs to integrate natural gas energy efficiency with current electric efficiency programs as a primary step to target and achieve significant levels of natural gas savings.

Second, New York should consider some targeted natural gas programs and services that address principal natural gas end-uses, such as residential and small commercial and industrial furnaces and boilers and food service equipment. These targeted efforts might still be structured under the umbrella of existing programs, but specific marketing and other strategies, specifically targeted at upstream market actors would be needed to get customers to implement energy efficiency measures. The objective of these targeted efforts would be to quickly reach high numbers of customers and quickly provide services to enable them to make changes to achieve significant natural gas savings.

Existing NYSERDA and LIPA programs could be expanded to be more broadly available to gas customers statewide, as is being done with selected pilot programs. It also would be possible for a third party to run separate, more targeted programs coordinated with the electric efficiency programs currently offered by NYSERDA and LIPA. We discuss in more detail the pros and cons of different administration and integration options below in Section 5.3

Expansion of existing programs is an especially attractive option given the recent dramatic increases in natural gas prices and the forecasts for continuing high prices in the near and long-term. Therefore, having aggressive programs that can reach large numbers of customers quickly and effectively influence energy efficiency improvements in primary natural gas end-uses, such as space heating, is important. As discussed above, some excellent examples are available. NYSERDA's portfolio, for example, emphasizes facilitation of long-term, fundamental changes in customer markets so that energy-efficient products and services become well accepted and achieve large market shares. Some programs in LIPA's portfolio have the same market transformation emphasis. The current tight natural gas conditions suggest that a long-term strategy could be complemented with rapid deployment of high volume programs and services and can reach large numbers of customers quickly. Such efforts could have very immediate impacts on their natural gas use and associated costs. They constitute the primary new opportunity for expanding services in the State's existing portfolio of programs.

5.1.3.3. **Design Philosophy and Policy Objectives**

5.1.3.3.1. Design Philosophy

The study's design philosophy has the following key components:

- Organizing programs around markets
- Maximizing leveraging of existing electric programs
- Promoting comprehensiveness in the treatment of efficiency opportunities

Both the review of exemplary programs and the project team's direct experiences with delivering programs in the field suggest that energy efficiency programs are most effective if they are designed around markets for the products and services whose sale they are designed to influence. A number of important implications inform this approach. To begin with, programs usually need to be multifaceted and simultaneously implement a variety of strategies (*e.g.,* financial incentives, outreach to key trade allies, technical training or other technical support, and marketing) necessary to address barriers in markets that are often fairly complex. At the same time, participation needs to be as easy as possible for trade allies and customers. Thus, a small number of large comprehensive programs is preferable to a large number of small programs organized around specific technologies or sub-markets. Larger programs tend to reduce transaction costs to trade allies and customers by offering single points of contact and greater flexibility to address a variety of needs. Finally, key trade allies often provide products and services to multiple markets. To maximize effectiveness, programs must address that complexity. Some programs would be most effective if they address multiple sectors. For example, HVAC contractors sell boilers to both industrial and commercial customers. Similarly, many contractors sell furnaces and boilers to residential and small commercial customers. Thus, to the extent possible, programs should be designed to cross sectoral boundaries just as the market actors they are designed to influence do.

The analysis assumed that gas energy efficiency efforts would be integrated with electric energy efficiency efforts where feasible and practical. Many efficiency technologies save both gas and electricity and many market actors one must influence to be effective with gas energy efficiency are also important to electric energy efficiency efforts.

Programs that promote comprehensive treatment of efficiency opportunities sometimes cost more in the near term, but their longer-term pay-offs are often substantially greater than programs focused primarily on maximizing near-term savings per dollar of spending. The short-term costs of comprehensive approaches can also be effectively managed through careful structuring of incentive offerings and other promotions (*e.g.,* by understanding incremental costs and, where appropriate, offering performance-based incentives), strong emphasis on getting to know key market actors' businesses and other elements of the markets approach discussed above, and leveraging other resources such as electric efficiency programs and federal tax credits.

5.1.3.3.2. Policy Objectives

Efficiency program portfolios can address a variety of policy objectives. Chief among these are:

- Maximizing near-term savings
- Promoting longer-term market transformation
- Distributing benefits equitably among various customers

Different levels of emphasis on these or other objectives can lead to very different program portfolios. The portfolio developed for this study strikes a fairly even balance between these three objectives.

Most of the programs selected for analysis (and described below) had the potential for both short-term resource acquisition and long-term market transformation. For example, wherever appropriate, program designs included and budgeted for strategies that included significant outreach to and training of trade allies.

The portfolio addresses equity concerns in several ways. Perhaps most important is the allocation of funding to the residential, commercial and industrial sectors in proportion to their gas consumption. Also, 50% of the residential sector budget for services to low-income customers. Finally, the portfolio addressed as many major end uses for as many building types and sub-markets as possible.

5.1.3.4. Portfolio Selected for Analysis

The energy efficiency portfolio analyzed has six programs. They are:

- ENERGY STAR® Homes (residential new construction)
- Small Heating and Water Heating Equipment (residential and small commercial equipment sales)
- Low-income Weatherization (residential retrofit)
- Commercial and Industrial New Construction
- Commercial and Industrial Existing Buildings (C&I planned equipment replacement and retrofit)
- Food Service and Processing (commercial kitchens and industrial food processing sectors)

These programs collectively address most of the major gas efficiency opportunities for most buildings types, with non-low income retrofits being the major exception. The programs analyzed for this study are the same as those analyzed in Optimal Energy's previous analysis of program potential for Con Edison with one important exception: a Home Performance with Energy Star Program was omitted from this study. Although that program has great merit as a potential program for gas co-funding, funding limitations dictated that it could not be included in this statewide assessment. The situation in the Con Edison analysis was different because that analysis assumed that 20% of residential program spending would be for low income customers, considerably less than the 50% assumed for this analysis. In addition, the Con Edison study excluded transportation customers who are a large portion of the Con Edison gas load. As a result the selected program funding for the Con Edison study could be allocated to more programs.

Descriptions of each of the six programs analyzed in this study are provided in the next section.

5.1.4. Program descriptions

5.1.4.1. Residential New Construction

5.1.4.1.1. Overview

The residential new construction program would be an expansion of NYSERDA's and LIPA's current ENERGY STAR® Labeled Homes residential new construction programs. It would promote the construction of high performance homes, with the long-term goal of transforming the market to one in which most new homes are built at least as efficiently as the current ENERGY STAR® standard. The program would need to overcome various market barriers to achieve this goal. Key among these are: (1) split incentives between builders (who make investment decisions) and home-buyers (who pay the energy bills); (2) lack of information on the benefits of efficiency (on the part of consumers, builders, lenders, appraisers, realtors and others); (3) limited technical skills to address key elements of efficiency (*e.g.,* air leakage, duct leakage, proper HVAC system installation); and (4) inability of consumers, lenders, appraisers, realtors and others to differentiate between efficient and standard new homes.

The program would employ the following strategies to address these barriers:

- Marketing assistance to builders of efficient homes (promoting the ENERGY STAR® label)
- Technical assistance to builders and their subcontractors
- ENERGY STAR® certification to qualified homes, either through Home Energy Ratings or through pre-designed packages of efficiency measures with on-site verification
- Financial incentives to builders to construct homes to program standards – expanded beyond current incentive offerings to generate greater participation statewide and greater penetration of important gas efficiency measures

5.1.4.1.2. Target Market/Eligibility

The program targets all construction of all new residential dwellings – single family or multifamily – with individual heating systems. Multifamily buildings with central heating systems would be addressed through the commercial and industrial new construction program.

5.1.4.1.3. Efficiency Measures/Standards

The program promotes construction of homes to the new ENERGY STAR® standard that will go into effect in July 2006. That standard gives builders two options: (1) to install a prescriptive list of efficiency measures, or (2) to construct custom packages of measures that achieve comparable levels of performance. Consistent with current discussions by the New York ENERGY STAR®

Labeled Homes working group,[81] a score of 84 points or higher under the new expanded Home Energy Rating System (HERS) system (*i.e.,* under REM Rate Version 12.0) would be needed to participate through the performance path. In either case, on-site testing would be required to ensure compliance with air leakage, duct leakage, and other technical specifications.

Particular emphasis would be placed on promotion of measures that save gas, including efficient tankless water heaters (which are not required under the current federal program).

5.1.4.1.4. Program Strategies

- **Technical assistance**. The program would provide extensive and comprehensive technical support to builders and their subcontractors – in reviewing designs, recommending design modifications, identifying vendors of efficient products, providing on-site guidance regarding installation of efficiency measures and other support as needed.
- **ENERGY STAR® certification**. The program would provide ENERGY STAR® certification to homes that meet the ENERGY STAR® standard.
- **Financial incentives.** The program would provide incentives to builders or their home-buyers for homes that meet the ENERGY STAR® standard. Initially, the study assumes the average incentive would be approximately $500 for single family homes and $250 per multifamily dwelling unit (over and above existing electric incentives), plus additional incentives for installation of ENERGY STAR® gas heating equipment and efficient gas tankless water heaters. The program would also pay for the cost of an energy rating or on-site inspection. Additional federal tax credits ($2000) would be available to builders who construct to even greater levels of efficiency (approximately 50% greater heating and cooling efficiency than 2004 IECC code requirements).
- **Marketing assistance.** The program would assist participating builders in marketing the program to home-buyers. This could include substantial support for show-casing efficiency features of model homes, co-op advertising with builders and/or general program marketing through local Home Shows and other venues.

5.1.4.1.5. Joint/Coordinated Delivery

Program services could ideally be integrated with other programs to maximize effectiveness and eliminate redundancy. In particular, the program could be integrated with the existing ENERGY STAR® Labeled Homes program.

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[81] This working group is comprised of NYSERDA staff, LIPA staff and consultants, and staff from both NYSERDA's and LIPA's program delivery contractor.

5.1.4.1.6. Program Budget

. This program analysis assumes a budget of approximately $6.6 million in real 2005 dollars, over and above the existing electric program’s contributions, for over the five year program period.

5.1.4.2. Small Heating & Water Heating Equipment

5.1.4.2.1. Overview

The Small Heating and Water Heating Program promotes the sale and purchase of efficient small scale (*i.e.,* residential and small commercial) heating equipment and water heaters. Its long-term goal is to transform the market to one in which high efficiency equipment becomes the market standard. The program must overcome several key market barriers to achieve this goal: (1) consumers lack of information on the magnitude of the benefits of efficiency; (2) HVAC contractors’ misperception of the reliability of efficient heating equipment; (3) HVAC contractors lack of skill/tools for selling efficiency; (4) split incentives between builders and homebuyers, and between owners and renters; and (5) higher costs than standard efficiency equipment related, in part, to lower sales volumes for efficient equipment. The program employs several strategies to address these barriers:

- Incentives for the sale and purchase of efficient equipment
- Consumer marketing campaigns on the benefits of efficiency
- Extensive outreach and marketing of program services to HVAC distributors, HVAC contractors and retailers who sell targeted equipment
- Sales training for contractors and retail sales staff
- Technical training for contractors on how to install efficient gas heating equipment

5.1.4.2.2. Target Market/Eligibility

The program targets all existing and new residential dwellings and small commercial customers into which a new gas furnace, gas boiler, rooftop unit, infrared heater, or water heater can be installed. The study envisions furnaces and boilers above about 200,000 Btuh capacity would be addressed under the C&I New and Existing Construction programs. Furnaces and boilers larger than 200,000 Btuh are larger than those sold in residential markets, and often involve a different set of vendors and contractors. The exact cut-off point would be determined by market research into the current make up of the upstream market actors. Builders or buyers of new homes or commercial buildings may participate in either this program or the residential or commercial new construction programs, but not both. The analysis envisions that customers participating in other programs would take advantage of this program in a seamless, integrated way through their primary program channel. The study suggests a separate program, however, because separate upstream strategies are necessary to effect long-term market transformation and capture high penetration rates.

5.1.4.2.3. Efficiency Measures/Standards

The program promotes heating equipment meeting the ENERGY STAR® efficiency standard for furnaces and boilers. The program would also promote high efficiency rooftop units. Efficiency criteria should be selected based on promoting the highest cost-effective tier of efficiency, with consideration of the number of units and manufacturers making them, and also pairing the gas heating side with current air conditioning efficiency standards currently promoted in New York. Both infrared heating units and high efficiency unit heaters that meet the forthcoming EPACT standard would be promoted. The program would also promote tankless water heaters (typically with energy ratings of 30% or more relative to standard units built to the current federal water heater standard).

5.1.4.2.4. Program Strategies

- **Financial incentives**. The program offers incentives equal to approximately 50% of the incremental cost of efficient heating and water heating equipment (*e.g.*, approximately $200 for an ENERGY STAR® furnace or tankless water heater).[82] Incentives could be payable to the consumer, the HVAC contractor or the builder.
- **Consumer Education**. The program would use a variety of vehicles for educating consumers about the benefits of efficient heating and water heating systems including distribution of an educational materials through a website, contractors interested in promoting the program, and point of purchase materials in retail stores that sell targeted products (*e.g.*, Sears, Home Depot, Lowe’s). Yellow page ads and other advertising venues would also be considered. Finally, the program would explore options for marketing and co-branding partnerships with manufacturers, distributors, local HVAC contractors and/or retailers that leverage marketing dollars by requiring industry contributions.
- **HVAC Industry Outreach and Training**. The program would include regular meetings with local HVAC distributors and contractors to explain the program (and other related programs), encourage industry partners to actively participate in and promote the program to consumers, supply educational materials to distribute to consumers, recruit for sales and technical training classes related to efficient equipment, and obtain feedback on both how the program is perceived and the effects it is having in the market.
- **Retailer outreach**. The program would also include outreach to Sears, Home Depot, Lowe’s and other retailers that sell heating equipment and water heating equipment. Such outreach would include provision of point-of-purchase displays and on-site promotions.

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[82] Tankless water heaters would likely also be eligible for federal tax credits.

5.1.4.2.5. Joint/Coordinated Delivery

Program services would ideally be integrated with delivery of other programs (Residential New Construction, C&I New Construction, C&I Existing Buildings, Home Performance with ENERGY STAR® and Low-income) wherever appropriate to maximize effectiveness and eliminate redundancy. There should be opportunities for such integration since all of these programs involve significant interaction with some of the same trade allies.

5.1.4.2.6. Program Budget

The program analysis assumes spending of $72.4 million in real 2005 dollars for the five-year period.

5.1.4.3. Low-Income Retrofit

5.1.4.3.1. Overview

The Low-income retrofit program is designed to improve energy affordability for low-income customers. To achieve this objective, it must overcome several key market barriers: (1) lack of information on either how to improve efficiency or the benefits of efficiency; (2) low-income customers do not have the capital necessary to invest in efficiency measures or even, in many cases, keep up with regular bills; (3) low-income customers are the least likely target of market-based residential service providers due to perceptions of less capital, credit risk and/or high transaction costs; and (4) split incentives between renters and landlords.

The program would address these barriers through:

- Direct installation of all cost-effective energy efficiency measures at no cost to the owner or occupant of the building
- Comprehensive personalized customer education and counseling

5.1.4.3.2. Target Market/Eligibility

The program is available to all customers with income at or below either 150% of the federal poverty guideline or 80% of median income for the county in which they reside (whichever is higher). Customers must be also responsible for paying for gas heat to be eligible.

5.1.4.3.3. Efficiency Measures/Standards

All cost-effective efficiency measures would be installed in each home, with no cost cap. Cost-effectiveness would be assessed on a site-specific basis using simple protocols. Among the measures to be considered for each home are:

- Hot water conservation measures (tank wraps, pipe wrap, tank temperature turn-down, low flow showerheads and low flow faucet aerators)
- Programmable thermostats
- Insulation up-grades (*e.g.,* attic, wall, basement, ducts)

- Blower-door guided air sealing
- Duct sealing and repair
- Heating equipment maintenance, repair and/or replacement
- Other custom measures

Ideally, electric efficiency measures would also be installed, with funding for those measures coming from other programs.

5.1.4.3.4. Program Strategies

- **Customized building efficiency assessments.** Each home visited through the program would receive a thorough assessment and identification of all cost-effective efficiency opportunities. Simple field protocols would be used to determine site-specific cost-effectiveness.
- **Free direct installation of all cost-effective efficiency measures.** There would be no cap on spending per home, as long as all measures are cost-effective.
- **Customer education**. Each participant would receive advice on options to further reduce energy use through behavioral changes that would not involve significant sacrifices in amenity. Particular emphasis would be placed on use of thermostats.

5.1.4.3.5. Joint/Coordinated Delivery

To the extent possible and appropriate, the program would coordinate with the delivery of the federal low-income weatherization and other low-income programs.

5.1.4.3.6. Program Budget

The program analysis assumes a budget of approximately $78.9 million in real 2005 dollars over the five-year program period.

5.1.4.4. C&I New Construction

5.1.4.4.1. Overview

The C&I new construction program would be an expansion of NYSERDA's current program targeting this market. Such programs currently include the Energy Smart C&I New Construction program. The construction of high performance business facilities would be promoted, with the long-term goal of transforming markets such that most new buildings take advantage of appropriate high efficiency equipment and design. The program would have to overcome various market barriers to achieve this goal. Key among these are: (1) split incentives between developers and builders who often make investment decisions and occupants who pay the energy bills; (2) lack of information on the benefits of efficiency on the part of consumers, developers, builders, tenants, lenders, appraisers and realtors; (3) limited technical skills to address key elements of efficiency; (4) institutional barriers related to government and other entities that create disincentives to adopt efficiency; (5) perception of risk that efficiency technologies may not perform as expected; (6) an inordinate focus on first costs rather than long term operating costs; and (7) inability of consumers, tenants, lenders, appraisers and realtors to differentiate between efficient and standard new buildings.

The program would employ a number of strategies to address these barriers:

- Marketing and outreach to design professionals, vendors, contractors, developers, builders, lenders, and building occupants to identify new construction opportunities prior to the start of the design phase and build interest in relevant market allies throughout the design and construction process
- Technical and design assistance and training to design professionals, vendors, contractors, developers, builders, and building occupants
- Financial incentives to design professionals to cover incremental design and analysis costs, developers, builders, and ultimately occupants to construct high performance buildings. Incentives structures would be similar to current incentive offerings for electric efficiency
- Facilitation services to coordinate efficiency efforts, identify opportunities, and overcome unique barriers of specific market segments such as in New York City which will be funding substantial affordable multifamily housing construction, where the program administrator would work closely with the New York City Department of Housing Preservation and Development).

5.1.4.4.2. Target Market/Eligibility

The program targets new construction and major renovation of commercial and industrial facilities. Multifamily building construction with central heating systems would also be addressed through this program. Of particular note are New York City's plans to build approximately 90,000 affordable housing units over the next ten years. The program would include specific features to overcome many of the unique barriers this market will pose.

5.1.4.4.3. Efficiency Measures/Standards

This program would promote all cost-effective gas efficiency measures if they are cost-effective based on all costs and benefits, including electric savings. The integration of gas and electric programs is likely to allow more efficiency measures to be promoted than individual programs because some C&I measures offer savings in gas and electricity, but are not cost-effective when assessed only against a single fuel.

The program would promote some standard efficiency measures through standard, or "prescriptive," offerings that might include high efficiency heating and hot water systems and various controls and other measures that are generally cost-effective. All other cost-effective opportunities would be promoted as custom measures, based on site-specific analyses.

5.1.4.4.4. Program Strategies

- **Marketing and outreach.** The program would aggressively identify new construction activity prior to the design phase when possible, through building networks and relationships with design professionals, developers, builders, and major customers, and through various data sources such as Dodge and Works in Progress. When those approaches are not possible, the program would begin engagement with customers after the design phase has already begun. However, this approach often limits options and inhibits promoting comprehensive, integrated design measures throughout the building.

- **Technical and design assistance**. The program would provide extensive and comprehensive technical and design support to design professionals, developers, builders, contractors, and customers. Such assistance would include reviewing designs, recommending design modifications, identifying efficient products and their vendors and providing guidance regarding installation of efficiency measures. The program would seek to use existing market professionals, including a customer's own design team, to perform analyses to build awareness and capability.
- **Financial incentives.** The program would provide incentives to customers and service providers to offset incremental design, analysis, and construction costs. Incentives would cover 50% of incremental efficiency costs. The program would also integrate EPACT efficiency criteria and incentives. For example, a customer achieving 50% improvement over baseline practices could qualify for federal incentives.
- **Training.** The program would promote market transformation through training offered to architects, engineers, and contractors on various types of equipment, design, and building practices.
- **Commissioning.** The program would promote third-party commissioning services to ensure that new buildings operate and achieve the intended efficiencies.

5.1.4.4.5. Joint/Coordinated Delivery

Program services would be integrated with other programs and, in particular, with existing programs serving C&I new construction and the Small Heating and Water Heating program.

5.1.4.4.6. Program Budget

This program analysis is based on a budget of $42.7 million (2005$) for the five year program period.

5.1.4.5. C&I Existing Buildings

5.1.4.5.1. Overview

The C&I Existing Buildings program would be an extension of NYSERDA's current programs targeting existing C&I facilities and would promote the installation of high efficiency equipment and systems in existing business facilities both at the time of planned (market-driven) investments and for discretionary retrofits, with the program's long-term goal is transforming markets such that most consumers and contractors take advantage of currently deployable high efficiency equipment and design. The program would seek to overcome various market barriers to achieve this goal including: (1) split incentives between building owners who often make investment decisions and occupants who pay the energy bills; (2) lack of information on the benefits of efficiency on the part of consumers, contractors, engineers, and vendors; (3) limited technical skills to address key elements of efficiency; (4) perception that efficiency technologies may not perform as expected; and (5) focus on first costs rather than long term operating costs.

The program would employ a number of important strategies to address these barriers:

- Marketing and outreach to design professionals, vendors, contractors, ESCOs, and consumers to engage with relevant market allies throughout the specification, design and installation process
- Technical assistance to design professionals, vendors, contractors, ESCOs, and consumers to assist in analyzing efficiency opportunities and educating decision makers about the technical and financial aspects of efficiency
- Financial incentives similar to current incentive offerings for electric efficiency consumers and service providers to offset the first costs of efficiency.

5.1.4.5.2. Target Market/Eligibility

The program would target all existing commercial and industrial facilities. Multifamily buildings with central heating systems would be addressed through this program. For the industrial sector, key sub-sectors (*i.e.* chemicals, primary metals, food, paper) would be targeted. The program would address retrofit and market-driven opportunities. The program would need to address the continuum from pure discretionary retrofit to pure market-driven opportunities, and the need for program administrators to make clean distinctions, as appropriate.

5.1.4.5.3. Efficiency Measures/Standards

This program would promote cost-effective gas efficiency measures, at the time of planned investment and on a discretionary retrofit basis. Measures would be promoted if they are cost-effective based on all costs and benefits, including electric savings. The integration of gas and electric programs is likely to allow more efficiency measures to be promoted than individual programs because many C&I measures offer savings in both gas and electricity, but are not cost-effective when assessed only against a single fuel, particularly for building shell measures.

The program would promote some standard efficiency measures through standard or “prescriptive” offerings. Such measures would include high efficiency heating and hot water systems, various controls, and other measures that are generally cost-effective and with incremental costs that do not vary significantly among buildings. All other cost-effective opportunities would be promoted as custom measures, based on site-specific analyses.

5.1.4.5.4. Program Strategies

- **Marketing and outreach.** The program would aggressively market to customers and other relevant market allies, including vendors, contractors, and designers. A key strategy for larger commercial and industrial customers would be “key customer representatives” who build long-term relationships with customers. Because it is often difficult to time intervention when a customer is planning an investment, building long-term relationships is critical to success in this market. For larger commercial and industrial customers, the goal is to engage them with program administrators whenever opportunities are investigated. The program would also have "market managers" to build similar relationships with key market actors such as distributor and contractors to ensure high efficiency equipment is stocked, available and promoted.

- **Technical and design assistance**. The program would provide extensive and comprehensive technical assistance to consumers, contractors, designers and specifiers. Such assistance would include reviewing specifications, recommending modifications, identifying efficient products and their vendors and providing guidance regarding installation of efficiency measures.

- **Financial incentives.** The program would provide incentives to customers and service providers to offset incremental design, analysis, and construction costs. The analysis assumes incentives would cover 50% of incremental efficiency costs for market-driven measures and 25% of full installed cost for retrofit measures. The program would also integrate EPACT efficiency criteria and incentives. For example, a customer achieving 50% improvement of a whole building or HVAC system over baseline practices could qualify for federal incentives.

5.1.4.5.5. Joint/Coordinated Delivery

Program services would be integrated with other programs to maximize effectiveness and eliminate redundancy. In particular, the program would be integrated with existing programs serving C&I existing facilities and the Small Heating and Water Heating program.

5.1.4.5.6. Program Budget

This program analysis is based on a budget of $173.7 million (2005$) over the five-year program period.

5.1.4.6. Food Service and Processing

5.1.4.6.1. Overview

The Food Service and Processing Program promotes the sale and purchase of efficient cooking equipment and other equipment related to commercial kitchens or small industrial food processing facilities (such as pre-rinse spray valves). Its long-term goal is to transform markets so that currently deployable high efficiency equipment becomes the market standard. The program must overcome several market barriers to achieve this goal. Key among these are: (1) consumers lack of information on the magnitude of the benefits of efficiency, and the product choices available; (2) limited availability, especially without delays, of high efficiency equipment; (3) vendors lack of skill/tools for selling efficiency; (4) perception of risk that efficiency technologies may not perform as expected; (5) split incentives where equipment leased by end users who say the energy costs but have little influence of the efficiency of models offered; and (6) higher costs than standard efficiency equipment related, in part, to lower sales volumes for efficient equipment. The program employs several key strategies to address these barriers:

- Incentives for the sale or purchase of efficient equipment
- Consumer marketing campaign on the benefits of efficiency, and non-energy benefits of promoted products
- Extensive outreach, marketing, engagement and potential building of program services to equipment distributors, retailers and trade associations who sell or lease targeted equipment, and possibly to manufacturers
- Possible point of purchase and cooperative advertising with equipment vendors

5.1.4.6.2. Target Market/Eligibility

The program targets all commercial and industrial customers likely to purchase food service or processing equipment. This includes commercial and institutional kitchens (for example, restaurants, hospitals, schools), as well as small industrial food processors (such as bakeries). Customers participating in the other programs (namely C&I New Construction and Existing Buildings) would take advantage of this program in a seamless, integrated way through their primary program channel. A separate program, however, is proposed because achieving long-term market-transformation and capturing high penetration rates requires separate upstream strategies for these market actors, particularly since many food service equipment are purchased or leased and installed directly by consumers through retail channels.

5.1.4.6.3. Efficiency Measures/Standards

The program promotes all cost-effective food service equipment and other products specifically relevant to this market (such as pre-rinse spray valves).

5.1.4.6.4. Program Strategies

- **Incentives**. The program would offer rebates equal to approximately 50% of the incremental cost of efficient food service equipment. Incentives may be payable to the consumer, or directly to vendors, lessors or tenants through an upstream "buydown" approach, depending on the product and its market supply channel.
- **Consumer Education**. The program would use a variety of vehicles for educating consumers about the benefits of efficient equipment. This would include distribution of educational materials through a website, paper materials, point of purchase materials in retail facilities (such as restaurant supply stores) and other vehicles. Yellow page ads and other advertising venues would also be considered. Finally, the program would explore options for marketing partnerships with manufacturers, distributors, lessors, and retailers that leverage marketing dollars by requiring industry contributions.
- **Distributor, Vendor and Retailer Outreach and Training.** The program would include dedicated staff time for regular meetings with distributors, vendors and retailers. The purpose of the meetings would be to explain the program, encourage industry partners to actively participate in and promote the program to consumers, ensure that efficient equipment is stocked and promoted, and obtain feedback on both how the program is perceived and the effects it is having in the market.

- **Outreach and Marketing to Trade Associations**. The program would provide marketing and other services and coordination with relevant trade associations to educate industry members and leverage the marketing and education aspects of these organizations.

5.1.4.6.5. Joint/Coordinated Delivery

Program services may be integrated with delivery of other programs wherever appropriate to maximize effectiveness and eliminate redundancy. For example, a restaurant participating in the C&I new construction program would be encouraged to purchase high efficiency food service equipment in a seamless, integrated fashion.

5.1.4.6.6. Program Budget.

The program analysis is based on a budget of $20.2 million (2005$) for the 5-year period.

5.1.5. Program Penetration and Budget Development

In addition to per unit savings and baseline market penetration assumptions discussed in the economic potential section above, there are three key components to any estimate of the savings that can be achieved within the context of a fixed budget: (1) program penetration rates – or the number of efficiency measures that would be installed in each year; (2) market effects – both the fraction of program penetration rates that would be influenced by a program but not directly participate in it during the five year program period analyzed (often called spillover) and the lingering market-transformation effects that would persist and produce savings in the five years following the end of the program;[83] and (3) program budgets. Each of these is discussed further below.

5.1.5.1. Penetration Rates

There is no perfect way to accurately forecast program penetration rates. Some firms attempt to develop complex formulas based on customer paybacks and other variables to mathematically predict penetrations. Having reviewed such work on numerous occasions in the past, the project team is very skeptical of the results of such (often "black box") formulations because it is impossible to develop a single equation that adequately addresses the real differences in the types and severity of market barriers to the acquisition of different efficiency measures. The best method for forecasting program penetrations is to understand the market barriers affecting a particular market, identify other programs that have attempted to address similar barriers and extrapolate from those experiences (adjusting for local conditions as appropriate). Thus, this analysis relied heavily on the experience of leading programs from across the country – both gas and electric – that have attempted to address the same or similar efficiency markets with similar levels of budgetary resources.

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[83] Market-transformation effects can often be expected to persist more than five years after the end of a program. However, the analysis was limited to a 10-year period, five years with programs and five years post-program market effects.

For example, the estimate of the market share that could be realized for condensing furnace sales to residential customers is based, in part, on the experience of the Massachusetts gas utilities who have achieved a market share of between 60% and 70% with rebate levels similar to those analyzed for New York. Recognizing that the current market share in New York is approximately 35% and that it often takes a few years for programs to fundamentally change markets, the analysis assumed that level could be reached statewide after 3 to 5-years of program implementation. The analysis estimates base-case penetrations that are expected to occur in the absence of programs, "with program" penetration rates that reflect estimated market penetrations with intervention (including market effects and spillover), and finally "in program" penetration rates that reflect the portion of equipment adoption that is expected to directly participate in programs, thus impacting incentive budgets. The difference between the "with program" and base-case penetrations reflect the net effect of the program interventions. Penetrations for each measure are separately estimated, based both on other program experience, understanding of the particular markets and market barriers, and expectations about future codes and standards. Appendices A, B and C provide the market penetration assumptions assumed for each measure analyzed. Penetration rates are presented as either market shares (values in percentages) or number of homes or businesses receiving treatment.

5.1.5.2. <u>Market Effects</u>

As noted above, there are two important components to market effects. One is the effects of the program after the program has ended. Those are a function of the difference between the post program market penetrations and the assumed baseline market penetrations discussed in the economic potential section of the report. The second is what is commonly called spillover – or market actions that were influenced by a program but did not involve direct program participation. This occurs for a variety of different reasons including trade allies or consumers not bothering with the hassle associated with submitting rebate forms (even if the market presence of the incentives caused contractors or retailers to stock and promote it in ways that influenced the purchase decision) or builders, architects or contractors acquiring skills that they bring to work that doesn't fully qualify for program participation (*e.g.,* an ENERGY STAR® homes builder who learns how to reduce duct leakage is convinced it has benefits beyond the benefits of program participation and incorporates that expertise into all homes built, even those that do not have enough other efficiency upgrades to directly participate – because the customer did not want them for other reasons).

In developing assumptions about such spillover effects, the analysis carefully considered results of evaluations of NYSERDA's programs as well as those of others in other jurisdictions. In cases where there were no directly analogous programs with evaluations of spillover, judgment was used informed by the factors that affect spillover. These include magnitude of incentives (larger incentives generally lead to lower spillover because there is a greater cost to giving into the "hassle factor"), complexity of market barriers (greater complexity can lead to increased spillover because there are times when a market actor can translate some lessons to other jobs in which it cannot sell a complete upgrade to a program standard), non-energy benefits (some measures capture rapid penetration in the market place because of the significant non-energy benefits associated with them, once vendors, contractors and consumers are made aware of them), and perceptions of administrative burden (*e.g.,* HVAC contractors are notorious for hating paperwork associated with energy efficiency program participation). While the analysis does not explicitly estimate spillover separate from freeridership, the difference between the net program penetrations (with-program penetrations – base-case penetrations) and the in-program penetrations that reflect direct participation provide overall net-to-gross ratios which are a function of both freeridership and spillover.

5.1.5.3. Program Budgets

The estimated program budgets are partly a function of assumed in-program penetration rates because significant portions of most program budgets are variable, particularly those attributable to incentives. For example, the more furnaces for which incentives are provided, the larger the program budget. Similarly, the more homes inspected to verify compliance with an ENERGY STAR® Labeled Home program standard, the larger the program budget. The analysis includes estimates of other components of program budgets – including costs associated with program management, marketing, outreach to and training of trade allies, and evaluation – based on the project team’s experience with similar programs in New Jersey, Long Island, Massachusetts, Vermont and several other jurisdictions. Needless to say, there may be differences between labor, advertising and other costs statewide and the service territories of other programs. The analysis does not explicitly adjust for such differences because they would not have a significant affect on the bottom line results (in part because these fixed costs tend to represent a modest fraction – 15% to 30% in most cases – of total program costs). It is important to note that the analysis did assume, in several cases, integration with existing electric energy efficiency programs. For example, in the ENERGY STAR® Labeled New Homes program, the analysis assumes that DSM administrators would be able to add onto existing incentive offers rather than cover the full incentive cost of the program design analyzed.

5.1.5.4. An Iterative Process

Because a significant portion of most program budgets depends on assumed penetration rates, development of savings estimates is necessarily an iterative process. One must first develop initial assumptions about penetration rates and fixed elements of program budgets. Total budgets – including the variable portion that is tied to penetration rates (*e.g.*, the number of incentives paid or the number of homes or businesses assisted) – are then examined to assess whether they are too high or too low relative to the total funding available (an average of $80 million per year for five years).

5.2. PROGRAM SCENARIO POTENTIAL RESULTS

Table 5.2 and Table 5.3 present the incremental annual and cumulative annual gas savings and peak-day gas savings, by program, estimated for the program scenario. The cumulative annual gas savings in 2011, the fifth and final year assumed for program activity, represents approximately 1.6% of total forecast gas sales in that year. The cumulative annual gas savings in 2016 – after another five years of post-program market effects – represents approximately 1.5% of total forecast sales in that year. Figure 5.2 shows 2016 gas savings by program. Program scenario savings are presented for the reference case only because all programs are cost-effective under all avoided cost scenarios. The savings therefore do not change by scenario.

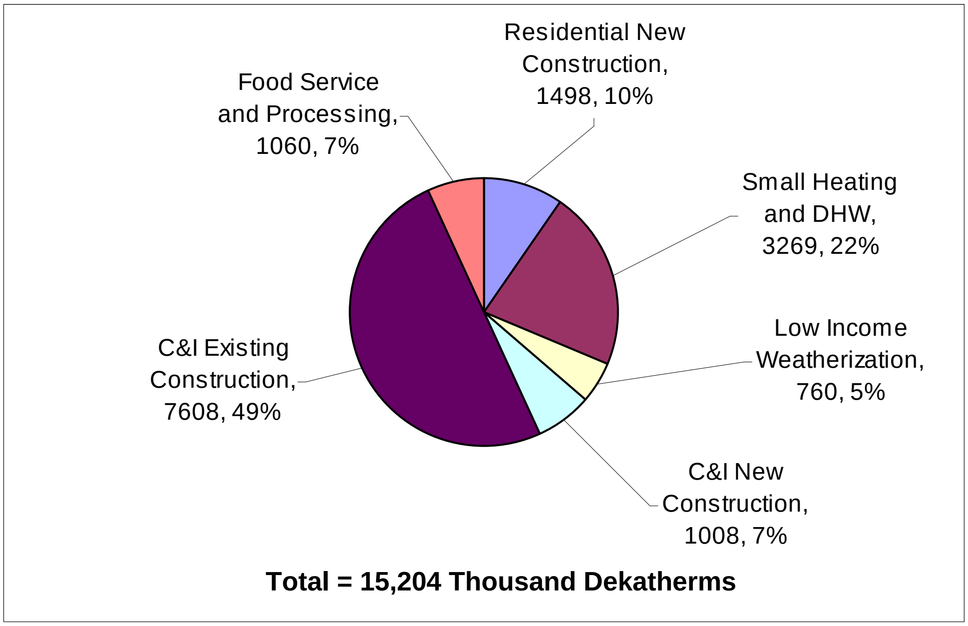
Table 5.2. Program Scenario Annual Gas Savings by Program

	Annual (MDth)										Lifetime Savings (MDth)
	Program Years					Post-program Market Effect Years					
Incremental annual	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
Residential New Construction	80	122	150	178	201	128	141	154	166	178	
Small Heating and DHW	200	333	404	480	557	243	251	259	267	275	
Low Income Weatherization	152	152	152	152	152	-	-	-	-	-	
C&I New Construction	32	65	102	143	185	82	92	102	112	123	
C&I Existing Construction	2,774	2,917	3,077	3,254	3,432	832	877	921	968	1,011	
Food Service and Processing	32	65	104	151	199	102	110	118	127	135	
Total Programs	3,271	3,654	3,989	4,359	4,726	1,387	1,471	1,554	1,641	1,723	
Cumulative annual	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
Residential New Construction	80	202	352	530	731	859	1,000	1,154	1,320	1,498	32,156
Small Heating and DHW	200	533	937	1,417	1,974	2,217	2,467	2,727	2,994	3,269	66,006
Low Income Weatherization	152	304	456	608	760	760	760	760	760	760	14,543
C&I New Construction	32	97	198	339	521	599	685	783	891	1,008	20,192
C&I Existing Construction	2,774	5,691	7,109	8,675	10,386	9,012	7,641	7,607	7,597	7,608	125,985
Food Service and Processing	32	97	201	353	552	654	764	882	981	1,060	10,298
Total Programs	3,271	6,924	9,253	11,922	14,923	14,100	13,317	13,913	14,543	15,204	269,180

Table 5.3. Program Scenario Peak Day Savings by Program

	Peak Day (MDth)									
	Program Years					**Market Effect Years**				
Incremental annual	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New Construction	0.5	0.7	0.8	1.0	1.1	0.7	0.8	0.9	0.9	1.0
Small Heating and DHW	1.2	2.0	2.4	2.9	3.3	1.4	1.5	1.5	1.6	1.6
Low Income Weatherization	0.9	0.9	0.9	0.9	0.9	-	-	-	-	-
C&I New Construction	0.4	0.7	1.2	1.6	2.1	0.9	1.1	1.2	1.3	1.4
C&I Existing Construction	9.1	10.7	12.5	14.4	16.4	5.3	5.8	6.2	6.8	7.2
Food Service and Processing	0.1	0.2	0.4	0.5	0.7	0.4	0.4	0.5	0.5	0.5
Total Programs	**12.2**	**15.4**	**18.2**	**21.4**	**24.5**	**8.7**	**9.5**	**10.3**	**11.0**	**11.8**
Cumulative annual	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New Construction	0.5	1.2	2.0	3.0	4.1	4.8	5.6	6.4	7.3	8.3
Small Heating and DHW	1.2	3.3	5.7	8.6	11.8	13.3	14.8	16.3	17.9	19.5
Low Income Weatherization	0.9	1.9	2.8	3.8	4.7	4.7	4.7	4.7	4.7	4.7
C&I New Construction	0.4	1.1	2.3	3.9	6.0	6.9	7.8	9.0	10.2	11.6
C&I Existing Construction	9.1	19.8	27.4	36.7	47.4	45.3	43.2	45.8	48.7	51.8
Food Service and Processing	0.1	0.4	0.7	1.3	2.0	2.4	2.8	3.3	3.7	4.0
Total Programs	**12.2**	**27.6**	**41.0**	**57.2**	**76.0**	**77.4**	**78.9**	**85.5**	**92.5**	**99.9**

Figure 5.2. Program Scenario Cumulative Annual Gas Savings by Program by 2016



As Table 5.4 shows, over the full analysis period, all of the programs that were analyzed are estimated to be highly cost-effective. Benefit-cost ratios for 2016 range from 1.70 to 3.06, with a total portfolio average of 2.48. That translates to present value net economic benefits of approximately $1.1 billion for the entire portfolio (2005$). Table 5.5 and Table 5.6 show that the average levelized cost per dekatherm saved from 2016 cumulative savings is estimated to be $3.42/Dth downstate and $4.47/Dth upstate.

Table 5.4. Program Scenario Total Resource Net Benefits and Benefit-Cost Ratios, Not Including Price Effects

Resource Avoided Costs	Total Resource Net Benefits ($Million)									
	Program Years					Post-Program Market Effect Years				
Cumulative Net Benefits (benefits minus costs, present worth 2005$)	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New Construction	9	23	39	56	75	87	99	113	127	141
Small Heating and DHW	16	42	72	106	144	161	177	194	210	226
Low Income Weatherization	9	18	27	35	42	42	42	42	42	42
C&I New Construction	2	9	21	37	56	66	77	88	100	112
C&I Existing Construction	59	128	204	288	382	411	443	478	515	553
Food Service and Processing	0	2	6	11	18	23	28	34	39	45
Total Programs	**96**	**223**	**368**	**533**	**718**	**790**	**867**	**948**	**1,032**	**1,119**
Cumulative Benefit/Cost Ratio (2005$)	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New Construction	3.23	3.19	3.14	3.08	3.03	3.03	3.04	3.05	3.05	3.06
Small Heating and DHW	2.24	2.30	2.33	2.34	2.34	2.36	2.37	2.38	2.39	2.40
Low Income Weatherization	1.73	1.71	1.71	1.70	1.70	1.70	1.70	1.70	1.70	1.70
C&I New Construction	1.50	1.78	2.00	2.13	2.21	2.29	2.36	2.42	2.47	2.52
C&I Existing Construction	2.25	2.31	2.34	2.37	2.39	2.42	2.45	2.48	2.51	2.53
Food Service and Processing	1.12	1.40	1.64	1.79	1.90	2.03	2.15	2.25	2.34	2.43
Total Programs	**2.14**	**2.22**	**2.26**	**2.29**	**2.31**	**2.35**	**2.39**	**2.42**	**2.45**	**2.48**

Low Avoided Costs	Total Resource Net Benefits ($Million)									
	Program Years					Post-Program Market Effect Years				
Cumulative Net Benefits (benefits minus costs, present worth 2005$)	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New Construction	6	15	26	37	49	57	65	74	83	93
Small Heating and DHW	4	12	22	33	45	51	57	63	69	75
Low Income Weatherization	4	7	10	13	15	15	15	15	15	15
C&I New Construction	1	5	12	23	36	43	50	58	66	75
C&I Existing Construction	33	74	119	170	228	247	269	292	317	343
Food Service and Processing	0	1	3	6	11	14	18	22	26	30
Total Programs	**48**	**114**	**192**	**282**	**384**	**428**	**474**	**524**	**576**	**630**
Cumulative Benefit/Cost Ratio (2005$)	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New Construction	3.32	3.29	3.25	3.20	3.16	3.16	3.17	3.18	3.19	3.20
Small Heating and DHW	1.36	1.41	1.44	1.46	1.47	1.49	1.50	1.51	1.52	1.52
Low Income Weatherization	1.39	1.37	1.38	1.37	1.36	1.36	1.36	1.36	1.36	1.36
C&I New Construction	1.20	1.42	1.59	1.70	1.77	1.83	1.89	1.94	1.98	2.01
C&I Existing Construction	1.70	1.76	1.78	1.81	1.83	1.85	1.88	1.90	1.93	1.95
Food Service and Processing	0.89	1.12	1.32	1.43	1.52	1.63	1.72	1.81	1.88	1.95
Total Programs	**1.61**	**1.67**	**1.71**	**1.74**	**1.76**	**1.79**	**1.83**	**1.86**	**1.88**	**1.91**

High Avoided Costs	Total Resource Net Benefits ($Million)									
	Program Years					Post-Program Market Effect Years				
Cumulative Net Benefits (benefits minus costs, present worth 2005$)	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New Construction	11	28	47	68	91	105	120	136	153	170
Small Heating and DHW	15	41	72	106	144	161	177	194	210	227
Low Income Weatherization	12	23	34	44	54	54	54	54	54	54
C&I New Construction	4	13	29	50	77	90	103	118	133	150
C&I Existing Construction	84	182	288	406	536	575	618	664	713	764
Food Service and Processing	1	4	9	16	26	32	39	45	52	60
Total Programs	**128**	**292**	**479**	**691**	**927**	**1016**	**1111**	**1212**	**1,316**	**1,424**
Cumulative Benefit/Cost Ratio (2005$)	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New Construction	3.85	3.84	3.78	3.72	3.66	3.66	3.66	3.66	3.67	3.68
Small Heating and DHW	2.21	2.28	2.32	2.32	2.33	2.35	2.37	2.38	2.39	2.40
Low Income Weatherization	1.93	1.91	1.91	1.90	1.90	1.90	1.90	1.90	1.90	1.90
C&I New Construction	1.80	2.14	2.40	2.56	2.66	2.75	2.84	2.91	2.97	3.02
C&I Existing Construction	2.80	2.87	2.90	2.92	2.94	2.98	3.02	3.05	3.09	3.12
Food Service and Processing	1.34	1.68	1.97	2.14	2.27	2.43	2.57	2.70	2.81	2.91
Total Programs	**2.53**	**2.60**	**2.65**	**2.68**	**2.70**	**2.74**	**2.79**	**2.82**	**2.86**	**2.89**

Table 5.5. Program Scenario Total Resource Levelized Cost Per Saved Dth, Not Including Price Effects - Downstate

	Total Resource Levelized Cost Per Saved Dekatherm ($/Dth)									
	Program Years					**Market Effect Years**				
Cumulative	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New Construction	2.73	2.75	2.83	2.92	3.00	3.02	3.03	3.03	3.03	3.02
Small Heating and DHW	5.22	5.02	4.88	4.81	4.74	4.69	4.66	4.62	4.60	4.58
Low Income Weatherization	7.55	7.64	7.60	7.62	7.61	7.61	7.61	7.61	7.61	7.61
C&I New Construction	5.50	4.39	3.67	3.35	3.16	3.00	2.86	2.74	2.64	2.56
C&I Existing Construction	4.17	3.57	3.15	2.90	2.73	2.68	2.62	2.55	2.47	2.40
Food Service and Processing	10.13	7.97	6.65	6.04	5.64	5.26	4.96	4.73	4.53	4.37
Total Programs	**5.27**	**4.73**	**4.33**	**4.10**	**3.92**	**3.81**	**3.70**	**3.61**	**3.51**	**3.42**

Note: Combined statewide figures are not available because each zone must be analyzed with a separate cost-effectiveness screening tool.

Table 5.6. Program Scenario Total Resource Levelized Cost Per Saved Dth, Not Including Price Effects - Upstate

	Total Resource Levelized Cost Per Saved Dekatherm ($/Dth)									
	Program Years					**Market Effect Years**				
Cumulative	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New Construction	2.07	2.15	2.23	2.33	2.42	2.39	2.36	2.33	2.31	2.29
Small Heating and DHW	4.97	4.91	4.90	4.95	5.01	4.98	4.97	4.96	4.96	4.96
Low Income Weatherization	6.22	6.29	6.26	6.28	6.27	6.27	6.27	6.27	6.27	6.27
C&I New Construction	22.82	17.51	14.63	12.85	11.85	11.07	10.45	9.97	9.58	9.26
C&I Existing Construction	4.07	4.10	4.14	4.18	4.23	4.25	4.28	4.30	4.33	4.35
Food Service and Processing	10.87	8.28	6.74	6.02	5.56	5.12	4.78	4.51	4.30	4.11
Total Programs	**4.35**	**4.38**	**4.40**	**4.45**	**4.50**	**4.49**	**4.48**	**4.48**	**4.47**	**4.47**

Note: Combined statewide figures are not available because each zone must be analyzed with a separate cost-effectiveness screening tool.

The study included an analysis of the retail price effects of reduced demand on the gas system from the program scenario. Currently gas supplies are constrained, so as demand increases prices tend to rise. As a result, significant reductions in demand can result in downward pressure on market clearing prices. Section 6 describes the price effects analysis. Table 5.7 provides the total resource economic results with price effects. Price effects included are the present value of consumer commodity price effects from 2007 through 2025.[84] Including price reductions that would be enjoyed by all New York gas consumers, present value net benefits increase to $1.6 billion (2005$), with a benefit-cost ratio of 3.14.

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[84] While the analysis period is only to 2016, efficiency savings from the program scenario continue for the life of the measures installed, sometimes as long as 30 years, or until 2046. As a result, only counting present value price effects through 2025 underestimates the total benefits. The EEA gas model of price effects only analyzed price effects to 2025.

Table 5.7. Program Scenario Total Resource Economics by 2025, Including Price Effects (Present Value 2005$Million)

Gross Benefits without Price Effects*	Price Effect Benefits	Costs	Net Benefits	B/C Ratio
$1,876.2	$500.7	$757.0	$1,619.9	3.14

*For the Program Scenario, benefits and costs are not available at the sector level. See discussion of the appropriateness of considering price effects in cost-effectiveness analyses and under Section 2.3.4.

The savings would, in turn, produce significant reductions in emissions of various pollutants. As Table 5.8 shows, lifetime reductions of 16.1 million metric tons of CO_2, 2,005 metric tons of SO_2 and 1,841 metric tons of NO_x would result from implementing the portfolio. The CO_2 ten-year reductions represent 0.1% of forecast total New York ten-year CO_2 emissions[85].

From a gas systems perspective, total present value net benefits would be $1.4 billion, or approximately 123% of the TRC net benefits. The benefit-cost ratio under the gas systems test would be 5.11 without including price effects. Table 5.9 shows the gas system test net benefits and benefit-cost ratio without including price effects, while Table 5.10 shows the net benefits and benefit-cost ratio with price effects included. When adding price effects, present value net benefits increase roughly 36% to $1.9 billion with a BCR of 6.60.

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[85] Center for Clean Air Policy, *Recommendations to Governor Pataki for Reducing New York State Greenhouse Gas Emissions,* April 2003, New York forecast CO_2 emissions interpolated from Table ES-1, p. ES-4.

Table 5.8. Program Scenario Emissions Reductions Associated with Projected Gas Programs

Emissions Reductions (metric tons)												
	Program Years					Post-program Market Effect Years					10-year Total	Lifetime Reductions
Cumulative Annual CO_2	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**		
Residential New Construction	2,361	6,562	11,662	17,940	25,068	28,886	33,121	37,771	42,831	48,295	254,496	2,054,461
Small Heating and DHW	4,750	12,567	21,921	32,811	45,239	50,755	56,424	62,246	68,221	74,350	429,284	3,562,860
Low-income Weatherization	4,610	9,220	13,830	18,440	23,050	23,050	23,050	23,050	23,050	23,050	184,402	870,380
C&I New Construction	2,096	6,329	12,876	21,963	33,629	38,431	43,834	49,865	56,411	63,481	328,915	1,561,953
C&I Existing Construction	21,159	51,047	79,568	117,585	164,935	169,215	175,378	191,502	206,748	220,948	1,398,084	7,415,790
Food Service and Processing	1,471	4,437	9,220	16,153	25,270	29,981	35,067	40,531	45,129	48,845	256,104	589,890
Total Programs	**36,447**	**90,162**	**149,077**	**224,892**	**317,191**	**340,318**	**366,874**	**404,965**	**442,390**	**478,969**	**2,851,284**	**16,055,334**
Cumulative Annual SO_2	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**10-year Total**	**Lifetime Reductions**
Residential New Construction	1	3	5	7	9	11	13	15	17	19	100	412
Small Heating and DHW	0	0	0	0	0	0	0	0	0	0	2	18
Low-income Weatherization	1	2	3	4	5	5	5	5	5	5	44	112
C&I New Construction	1	3	5	9	14	16	18	21	23	26	137	603
C&I Existing Construction	4	12	25	42	64	69	76	81	84	84	542	813
Food Service and Processing	0	0	0	1	1	1	1	2	2	2	11	46
Total Programs	**7**	**20**	**39**	**63**	**94**	**103**	**115**	**124**	**132**	**138**	**836**	**2,005**
Cumulative Annual NOx	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**10-year Total**	**Lifetime Reductions**
Residential New Construction	0	1	2	3	4	4	5	6	6	7	38	256
Small Heating and DHW	0	1	2	3	4	5	6	6	7	7	43	353
Low-income Weatherization	1	1	2	2	3	3	3	3	3	3	24	100
C&I New Construction	0	1	2	3	5	6	7	8	9	10	50	232
C&I Existing Construction	3	7	11	17	25	26	27	29	31	33	208	836
Food Service and Processing	0	0	1	2	3	3	4	4	5	5	27	64
Total Programs	**5**	**11**	**20**	**30**	**43**	**47**	**51**	**56**	**61**	**65**	**389**	**1,841**

Table 5.9. Program Scenario Gas System Net Benefits and Benefit-Cost Ratios by 2016, Not Including Price Effects

Proposed Programs	Cumulative Net Benefits (PV 2005$Million)	Cumulative Benefit/Cost Ratio
Residential New Construction	$170.6	31.68
Small Heating and DHW	$326.6	6.30
Low Income Weatherization	$26.9	1.40
C&I New Construction	$113.7	4.16
C&I Existing Construction	$694.6	5.72
Food Service and Processing	$43.2	3.53
All Programs	**$1,375.5**	**5.11**

Table 5.10. Program Scenario Gas Energy System Economics by 2016, Including Price Effects (Present Value 2005$Million)

Gross Benefits without Price Effects*	Price Effect Benefits	Costs	Net Benefits	B/C Ratio
$1,710.5	$500.7	$335.0	$1,876.2	6.60

*For the Program Scenario, benefits and costs are not available at the sector level. See discussion of the appropriateness of considering price effects in cost-effectiveness analyses and under Section 2.3.4.

5.3. ADMINISTRATION RECOMMENDATIONS

A variety of different models could be considered for administration of gas energy efficiency programs in New York. The question of administration has three key elements:

- **Integration with existing electric programs**. Would gas programs be integrated with existing electric programs? Put another way, would there be essentially a single set of fuel neutral program designs that are broadly applicable throughout New York,[86] or would gas and electric programs have significantly different features and/or different administrators?
- **Individual local or common statewide gas program designs**. Would gas programs be unique to their own service areas and therefore different from those of other gas utility service territories or would they be identical to other gas programs in the State?

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[86] For example, several years ago Efficiency Vermont and Vermont Gas reached agreement on a common statewide program design; the only difference being that incentive levels are higher in the Vermont Gas service area. Extensive collaboration existed between the two entities, including some joint delivery (*i.e.*, all technical support to builders and all energy ratings are performed by Efficiency Vermont).

- **Local or statewide administration**. Would programs – whether or not they are identical to others in the State – be delivered and managed by individual utilities or delivered and managed by a statewide entity.[87]

Needless to say, there are advantages and disadvantages to different approaches to each of these questions. These are explored below. For analytical purposes, this study assumed gas programs would be integrated with existing electric programs.

Integration with Existing Electric Programs. Significant advantages exist for integrating program delivery with delivery of existing electric programs. Integration reduces confusion in the markets, makes program offerings more attractive to trade allies and consumers, reduces the incremental cost of promoting gas efficiency, and allows for quicker program ramp-up. These benefits are captured in the analysis. In addition, integration provides better customer service by providing customers and other market actors with one-stop-shopping for comprehensive services.

An issue that arises when electric and gas programs are integrated is the allocation of program costs – for financial incentives, marketing, training, administration, and other functions – to two different sources of revenue. One approach that has been taken in other jurisdictions is to simply allocate program costs to the electric ratepayers and gas ratepayers in direct proportion to the economic value of the benefits those ratepayers receive.

The New Jersey electric and gas utilities faced this dilemma several years ago when they were instructed to begin jointly delivering a consistent set of statewide programs. In the case of their Residential New Construction program, they began by identifying any program costs that were directly attributable to one fuel. For example, financial incentives for efficient lighting were allocated 100% to electric ratepayers. For costs that were associated with generating gas and electric savings, they used a cost-effectiveness screening tool loaded with gas and electric avoided costs to estimate the magnitude of the economic benefits associated with each type of savings (including energy and peak demand savings). For homes that had central air conditioning and gas heating, they found that 62% of the economic benefits were electric and 38% were gas. Thus, for all program costs that were not directly attributable to one fuel, electric ratepayers paid 62% of the cost and gas ratepayers paid 38%.

A similar approach could be developed for programs in New York once there is agreement on the magnitude of avoided costs and the gas and electric savings the programs would generate.

The project team believes it would be ideal for program designs to be consistent statewide – especially for programs addressing market-driven opportunities such as new construction and

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[87] Administration of statewide programs has been tried in different ways in different jurisdictions. In Massachusetts, for example, Gas Networks – a coalition of the State's gas utilities – has developed a set of programs that are identical across service territories. However, each utility still has an important role in the management of the programs. A similar approach has been taken in California and New Jersey (although that appears about to change in New Jersey with statewide program management being put out to bid). NYSERDA, Efficiency Vermont, and the Oregon Energy Trust are alternative models in which management is by an independent third-party rather than by a coalition of utilities.

equipment purchases. For such programs, statewide implementation allows greater efficiency in service delivery, and greater impact on markets due to consistent messages and requirements imposed on builders, developers, architects, HVAC contractors who often work across service area boundaries. Consistency is not as important when providing discretionary retrofit services, such as through a Low-income Retrofit program, although also desirable.

Local or Centralized Administration. If a program is well designed and implemented– and this is an important caveat – the project team also believes that some form of centralized statewide or regional (*e.g.*, Long Island and rest of state as is now the case for the electric programs) administration is preferable to utility-by-utility administration. Centralized administration offers the potential for reductions in administrative costs (one set of administrative staff rather than one set for each utility trying to coordinate with each other), quicker decision making, easier interface with key trade allies (one program manager to call rather than a different program manager in each utility service area), and more effective branding of efficiency efforts. While utilities currently have relationships with their customers that can be leveraged to deliver efficiency services, the team does not believe that these potential benefits outweigh the benefits of centralized administration. In addition, these relationships tend to be focused on providing customer service related to their bills, reliability and power quality issues. Building long term relationships with customers and fully understanding their businesses and investment plans can be done by a new entity successfully.[88] The project team also recommends that under any type of administration, the Public Service Commission considers performance-based arrangements, including financial incentives, to the administrator for exemplary performance.

A hybrid approach, where utilities provide energy efficiency services to large C&I customers while a central statewide administrator provides services to residential and small and medium C&I customers, has been suggested by some stakeholders. This would preserve many of the benefits of centralized administration for those customers were it may be most important, while building on current utility relationships with large C&I customers for those markets. The project team believes this hybrid approach would be a mistake causing customers to lose many of the benefits of centralized administration, while creating numerous additional barriers and increased costs. As mentioned above, development of relationships with large customers can be cultivated by any well designed and organized entity, so the need for such a hybrid approach is not clear. Specifically, drawbacks to this approach include:

- **Balkanization of services, branding, outreach, and upstream market actor relationship development.** The hybrid approach would create artificial barriers where different entities were offering similar services and conducting similar outreach to many of the same players. Because equipment and service markets cross over these small/large customer boundaries, this would create significant confusion in the market, result in poor coordination, and require redundant services. For example, a large customer purchasing food service equipment would not participate in a broad-based, widely promoted food

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[88] The project team, which has extensive experience running Efficiency Vermont, finds that the ability to ramp-up and build these relationships with larger customers is not typically a major barrier for independent administrators.

service product program, but rather work with a separate entity to obtain this efficiency thru different channels.

- **Detract from integrated branding and outreach efforts.** It is important for any entity delivering efficiency to build awareness of its role and services throughout the State. This awareness will over time assist in transforming markets and driving program participation. By separating services and target markets among numerous entities, this branding ability is severely hampered and would result in customer and market actor confusion.
- **Prevent full integration of electric and gas services.** Because the gas LDCs do not deliver the electric efficiency programs,[89] having LDCs deliver gas efficiency to large C&I customers by definition means that electric and gas programs must be separately delivered. This would eliminate all the benefits of integrated programs described above. Many of these integration benefits are most important for large C&I customers that desire to address their overall energy needs comprehensively.
- **Requirement for redundant systems.** The hybrid approach would potentially result in numerous LDCs throughout the State having to separately develop systems and build delivery capability. This includes redundancy in everything from staffing to database tracking to marketing materials to regulatory filings and approvals.

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[89] The one exception to this is on Long Island, where Keyspan delivers electric efficiency programs under contract to LIPA. Under this scenario, separate administration on Long Island from the rest of the state could be supported while still preserving the integration of gas and electric services.

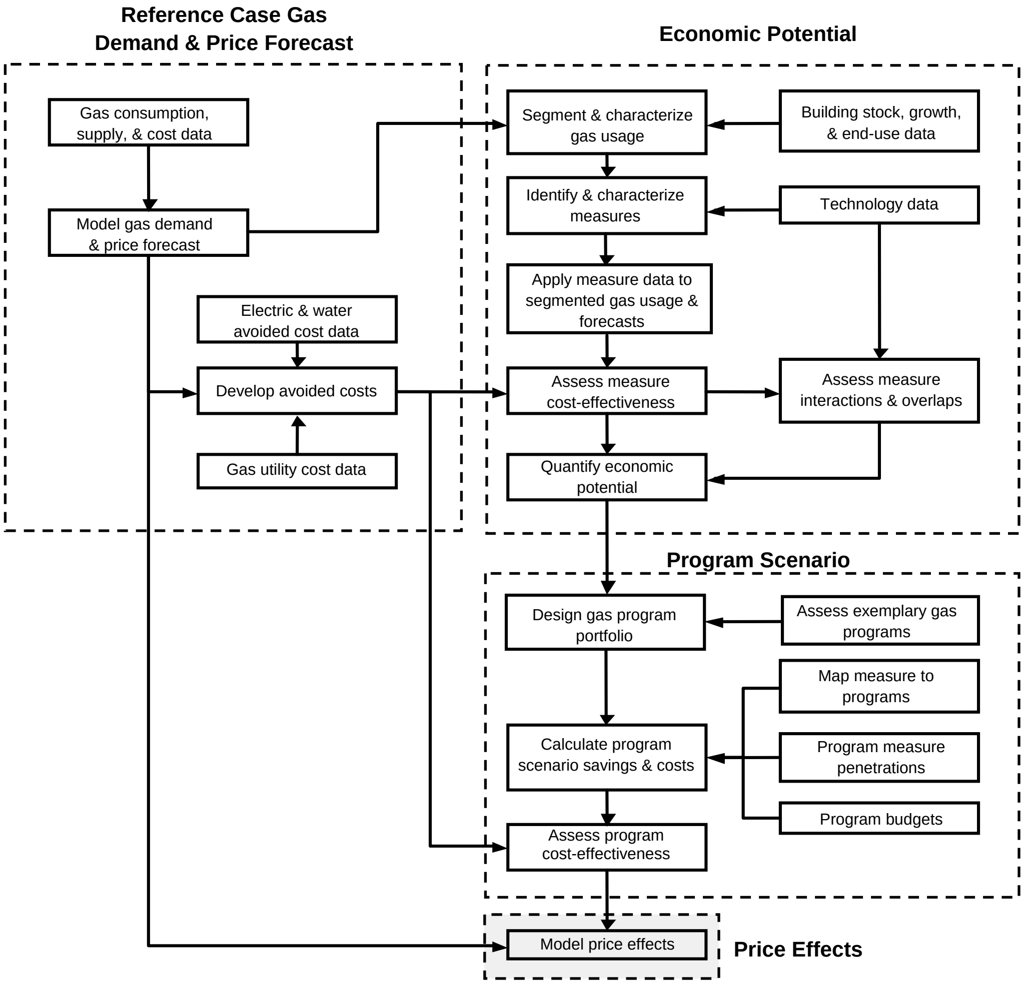
6. CONSUMER GAS PRICE EFFECTS OF ENERGY EFFICIENCY

6.1. INTRODUCTION

The analysis included an estimate of the downward pressure on commodity prices from reduced demand by the program scenario savings. Because gas supply is somewhat constrained and expected to remain so, small reductions in demand can result in small reductions in the market clearing commodity price, resulting in significant overall benefits to all gas consumers beyond those captured from program participants directly through reduced energy use. The *total* consumer commodity cost savings from the program scenario have two components: 1) the savings resulting from lower commodity prices (price effect); and 2) result of lower commodity *usage* because of energy savings (energy savings).

Total consumer commodity savings (price effects plus energy savings) are shown to quickly exceed programmatic expenditures. The price effects analysis identifies commodity consumer price savings that might result from implementation of the program scenario. Figure 6.1 shows how the price effects analysis relates to the other parts of the study.

Figure 6.1. Project Flow Diagram: Price Effects



6.2. THE PRICE EFFECTS MODEL

The reference case natural gas sales and price forecasts were developed using Energy and Environmental Analysis, Inc.'s (EEA) *Gas Market Data and Forecasting System.* This system is a full supply/demand equilibrium model of the North American gas market. The model solves for monthly natural gas prices throughout North America, given different supply/demand conditions, the assumptions for which are specified by the user. Overall, the model solves for monthly market clearing prices by considering the interaction between supply and demand curves at each of the model's nodes. On the supply-side of the equation, prices are determined by production and storage price curves that reflect prices as a function of production and storage utilization. Prices are also influenced by "pipeline discount" curves, which reflect the change in the basis or the marginal value of gas transmission as a function of load factor. On the demand-side of the equation, prices are represented by a curve that captures the fuel-switching behavior of end-users at different price levels. The model balances supply and demand at all nodes in the model at the market-clearing prices determined by the shape of the supply curves. Unlike other commercially available models for the gas industry, EEA does significant calibration of the model's curves and relationships on a monthly basis to make sure that the model reliably reflects historical gas market behavior, instilling confidence in the projected results.

6.3. PRICE EFFECTS RESULTS

Upon initial examination, the commodity price effects of the program scenario seem quite small. Figure 6.2, Figure 6.3, and Figure 6.4 show the price effects by sector of the program scenario.[90]

Figure 6.2 illustrates commodity price forecast by sector for the base case demand and the lower demand due to energy efficiency and those savings are clearly negligible. Figure 6.3 illustrates the difference between the base case natural gas price forecast and the forecast based on the lower demand. The consumer commodity price reductions peak in 2016 for all three end-use sectors with a commodity price reduction of approximately $0.03/Mcf. As shown in Figure 6.4, the 2016 price reduction is approximately 0.35% of base case price. The average estimated commodity price decrease from 2007-2016 from the program scenario would be approximately 0.2% of base case commodity costs.

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[90] Note, these figures do not include power generation sector savings. However, customer electric savings are included in benefit-cost calculations shown in Section 2.

Figure 6.2. Forecasted Natural Gas Commodity/Wholesale Prices by Sector for Base Case and Efficiency Case

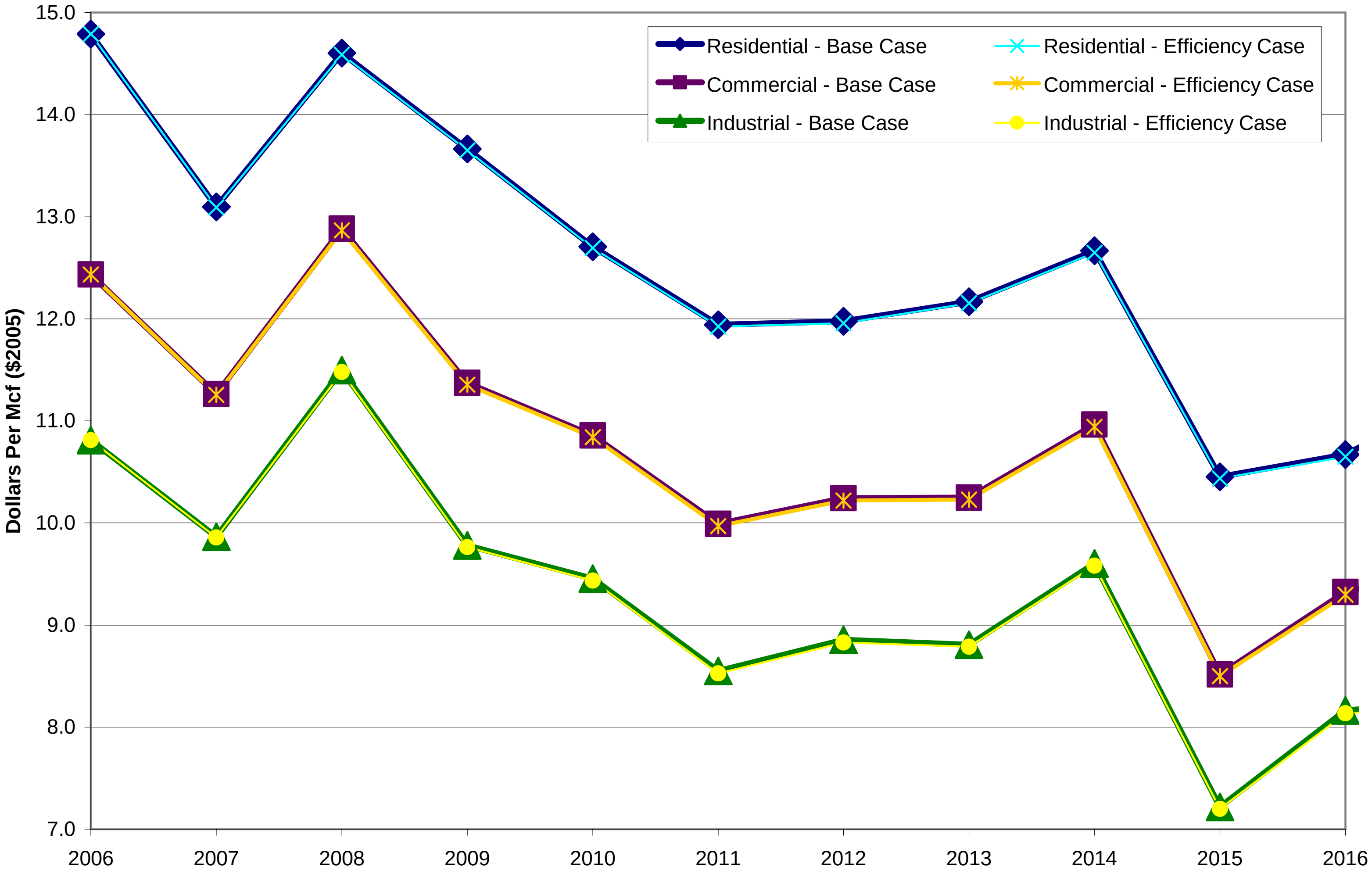


Figure 6.3. Natural Gas Consumer Savings from Price Effects due to Demand Reduction

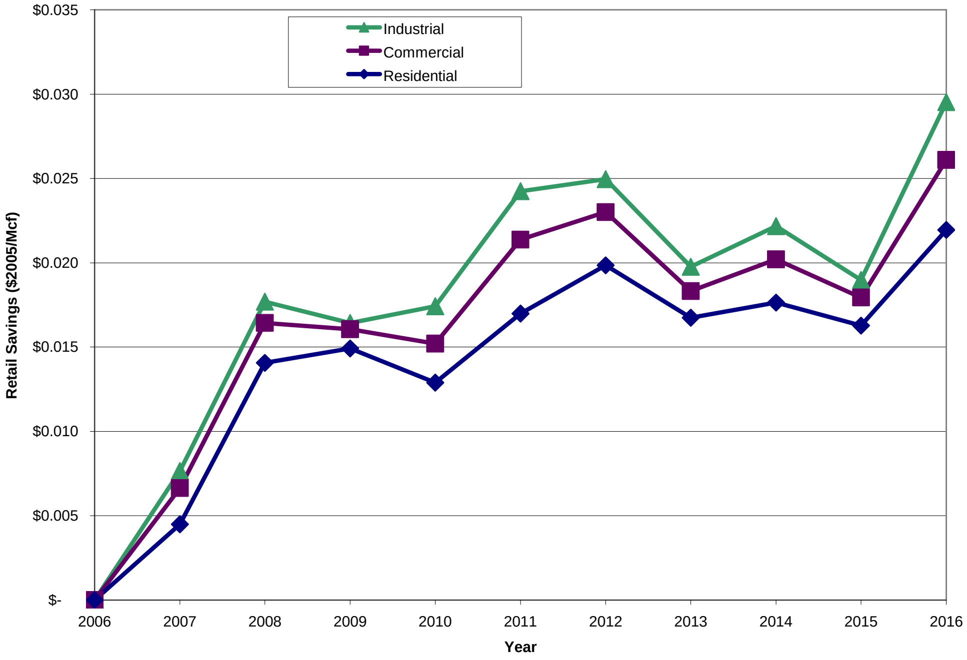
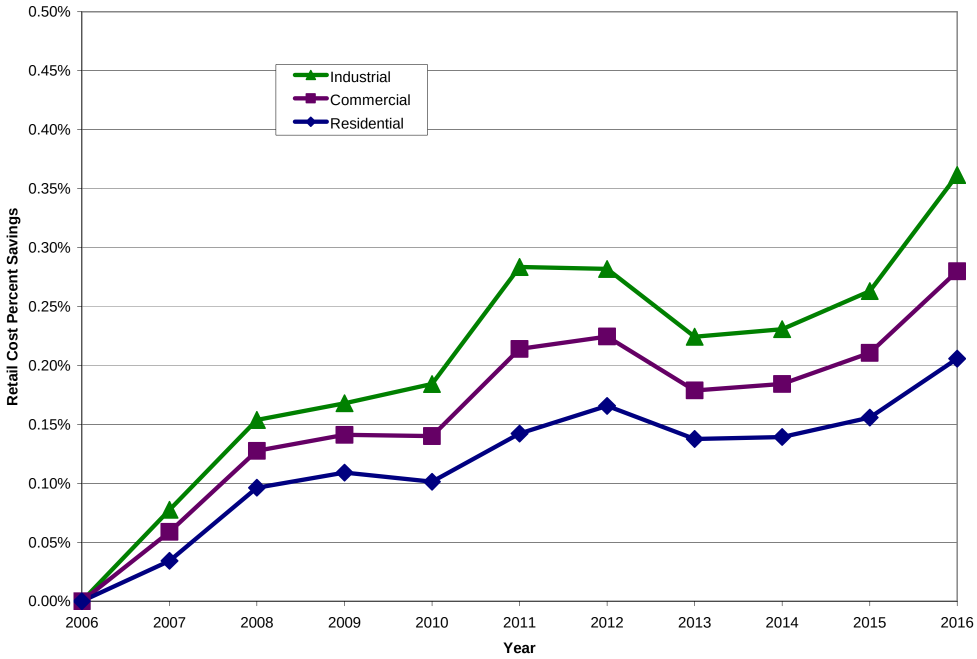
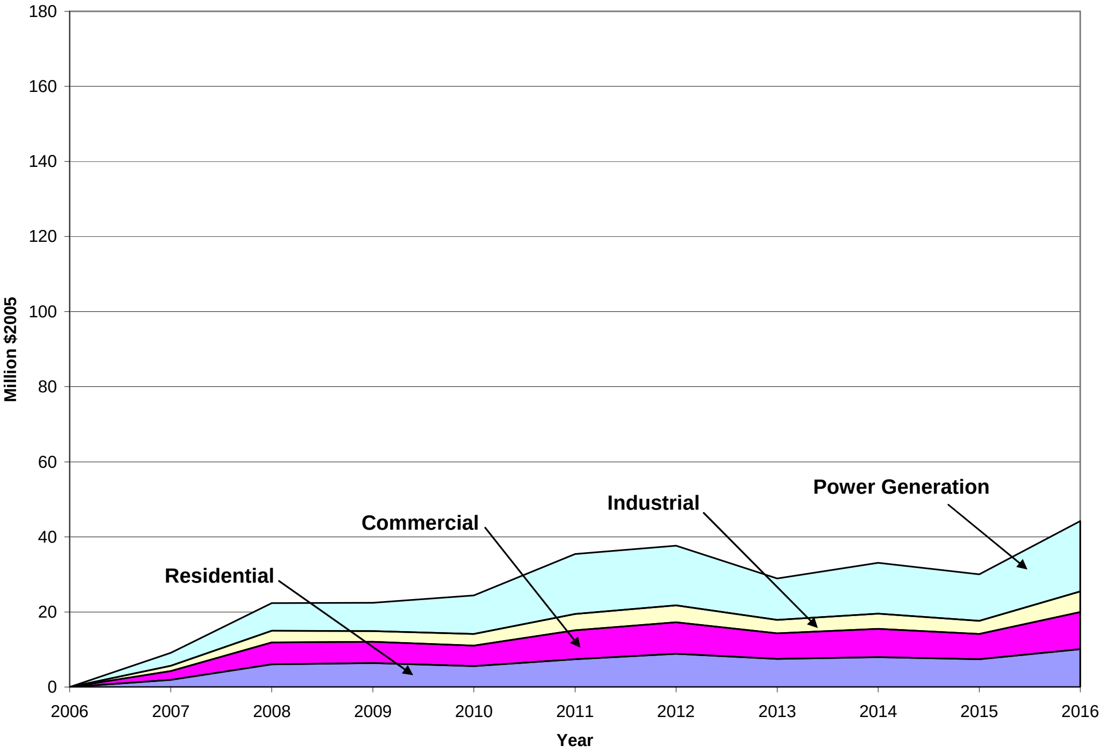


Figure 6.4. Natural Gas Consumer Savings (Percent) from Price Effects due to Demand Reduction



While these price reductions seem small, when applied over the total State gas consumption, total benefits from these small price reductions become significant. Figure 6.5 shows the annual consumer commodity price effects due to demand reduction, while Figure 6.6 shows the cumulative price effects through the same period.[91] Total annual price effects peak in 2016 at $44 million (2005$). Average annual commodity price savings from price effects alone (in 2005$) during the planning horizon (2007-2016) would be $29 million/yr.[92] Total 2016 cumulative consumer commodity price savings from price effects alone (in 2005$) would be approximately $288 million from the program scenario.

Figure 6.5. Annual Natural Gas Consumer Cost Savings from Price Effects due to Demand Reduction, by Sector (2005$)



*Note - Y-axis scale consistent with Figure 6.7 for comparison.

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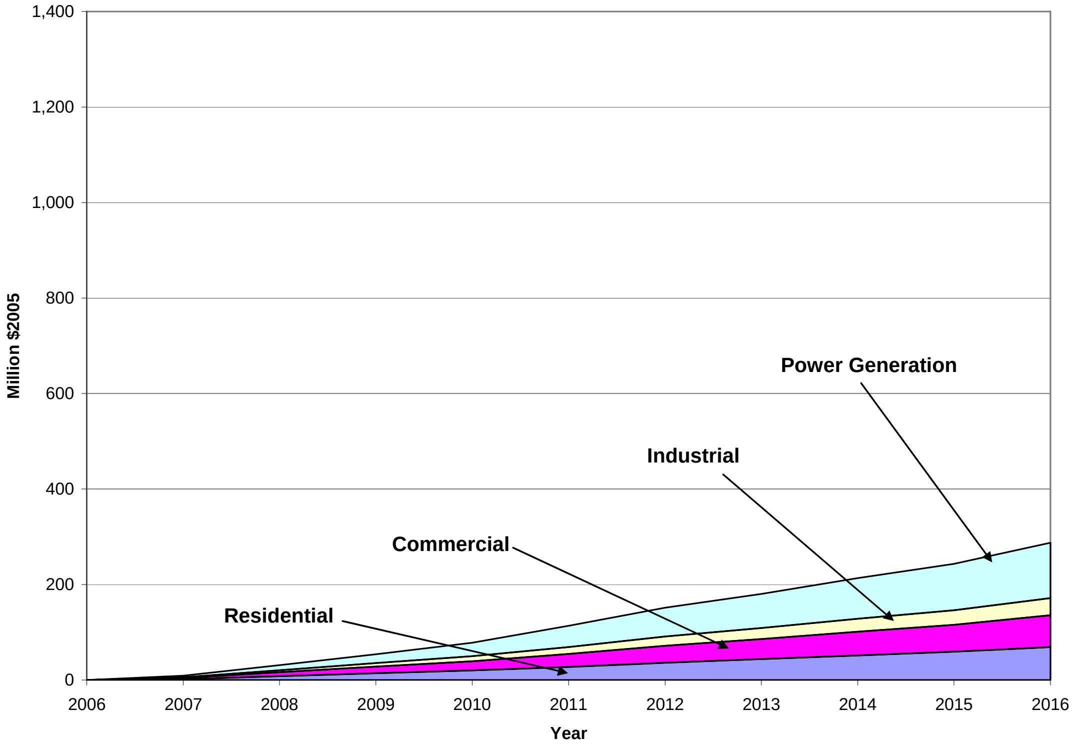
[91] These are the *price effects* savings only, and do not include the additional commodity cost savings resulting from the fact that total commodity consumed is lower because of program impacts for participants.

[92] While the program scenario only analyzes impacts through 2016, these savings will continue for the life of the efficiency measures and result in continued price effects beyond 2016.

Figure 6.6. Cumulative Natural Gas Consumer Cost Savings from Price Effects due to Demand Reduction, by Sector



*Note - Y-axis scale consistent with Figure 6.8 for comparison.

When considering the *total* consumer commodity cost savings resulting from both lower commodity prices and the fact that total gas consumed would be lower, total savings over the planning horizon (2007-2016) would be $1.3 billion (2005$), as shown in Figure 6.6. Note that this is not the same as total bill reductions, which would be based on retail rates that include contributions to transmission and distribution costs as well as commodity costs. Total bill reductions are estimated separately above based on 2004 retail rates. Figure 6.7 shows annual total consumer commodity cost savings. By 2011, the year programs are assumed to end, annual consumer savings would be approximately $160 million, or $80 million per year more than the average annual program spending, providing significant benefits to New York consumers. Consumer savings continue well after the program has ended, with savings remaining roughly level at close to $150 million per year through 2016.[93]

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[93] Note these consumer commodity cost savings will continue beyond 2016 for as long as the impacts occur,

Figure 6.7. Annual Natural Gas Consumer Commodity Cost Savings from Price Effects and Reduced Energy Usage, by Sector (2005$)

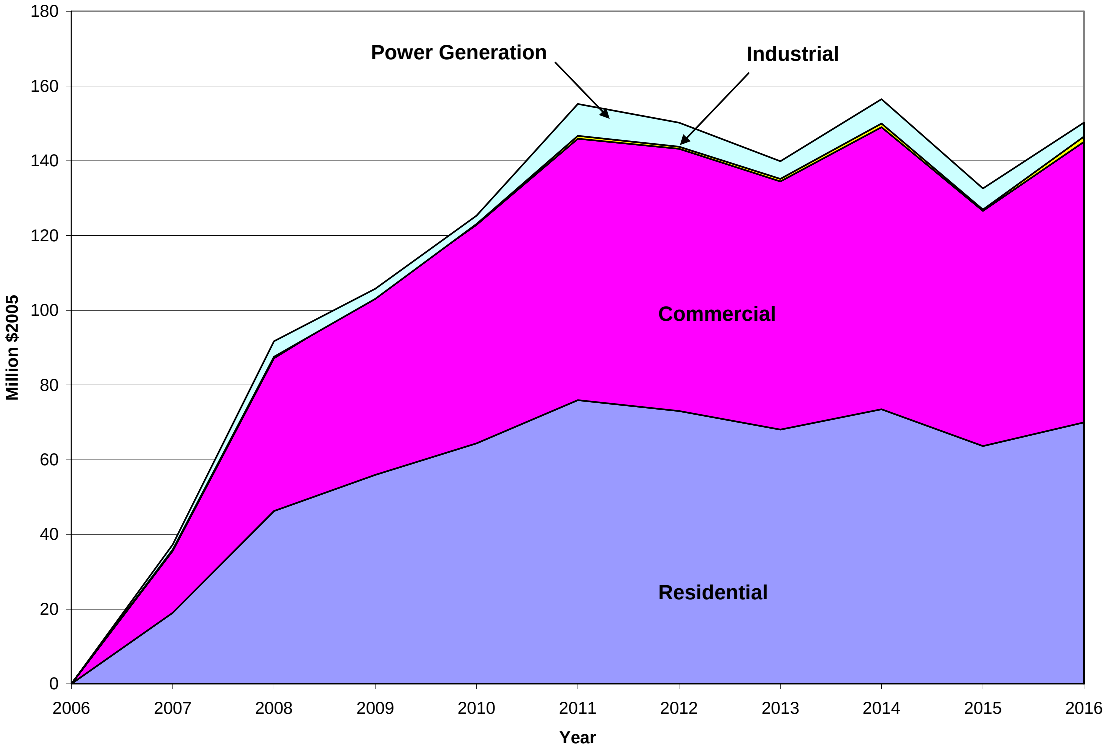
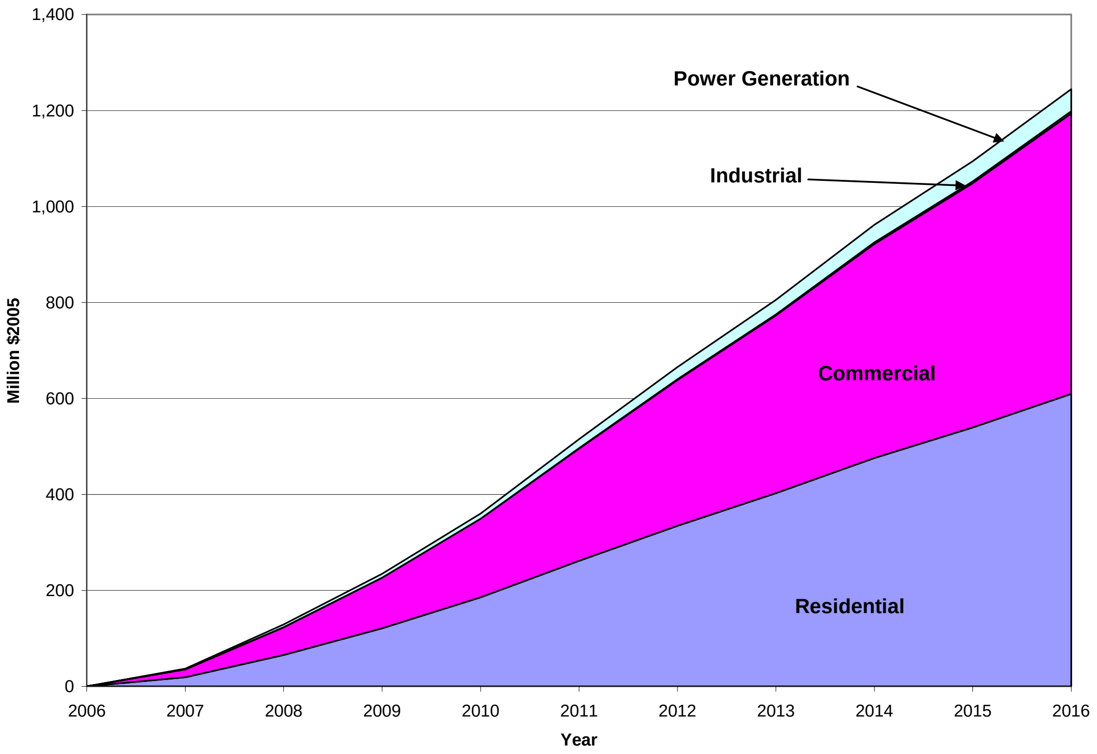


Figure 6.8 shows cumulative consumer savings totaling over $1.3 billion by 2016. By 2011, the year the programs end, cumulative consumer savings are approximately $500 million. These savings are 20% greater than the funding spent on the programs.

The residential and commercial sectors account for the vast majority of the total consumer commodity cost savings. While industrial and power generation sectors enjoy the benefits of price effects, the bulk of the reductions in total commodity consumed are in the residential and commercial sectors.

Figure 6.8. Cumulative Natural Gas Consumer Cost Savings by Sector



APPENDICES

A. RESIDENTIAL ANALYSIS DATA INPUTS AND RESULTS

B. DOWNSTATE COMMERCIAL ANALYSIS DATA INPUTS AND RESULTS

C. UPSTATE COMMERCIAL ANALYSIS DATA INPUTS AND RESULTS

D. LIST OF INDUSTRIAL MEASURES

- Steam trap maintenance/ management
- Boiler Replacement
- Boiler tune-up
- Improved sensors and controls
- Economizers and feedwater preheaters
- Upgraded heat exchangers
- Improved heat exchanger maintenance
- Improved insulation
- Condensing hot water heaters
- Hot water conservation
- Improved unit space heaters
- Improved insulation
- Improved sensors and process controls
- Improved dryer and furnace designs
- Heat recovery from dryer and furnace exhausts and thermal oxidizers
- Improved insulation

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F. GLOSSARY

ACEEE: American Council for an Energy-Efficient Economy.

Avoided Costs: The monetized societal value of electric, fossil fuel or water supply costs associated with marginal reductions in consumption.

Balance Point: For heating, the temperature below which a building needs to use mechanical heating. For cooling, the temperature above which a building needs to use mechanical cooling.

Base Temperature: The *balance point* from which heating or cooling degree days are calculated.

Baseline: The efficiency level of equipment, buildings or systems reflecting standard practice that exists at a given time. Efficient measure savings are based on the difference between the baseline efficiency and the high efficiency.

Baseline Shift: For retrofit efficiency measures, the change in the baseline energy usage that would occur at the time when the existing equipment would have been replaced (in the absence of the retrofit) with new standard efficiency equipment.

Baseline Study: A study of current energy usage and trends in the absence of an efficiency initiative, providing a baseline against which an efficiency measure or energy initiative can be compared.

Baseload: Energy load that is generally constant over time and weather conditions.

Bcf: Billion cubic feet. A natural gas measurement approximately equal to one trillion (10^{12}) BTUs.

BCR: Benefit-Cost Ratio, equal to gross benefits divided by costs.

Benefits: The monetized value of energy savings and any related resource savings associated with an efficiency measure. potential or initiative.

Btu: British thermal unit, the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit at 60 degrees Fahrenheit.

Btuh: British thermal units per hour. A measure of thermal equipment capacity.

CBECS: Commercial Building Energy Consumption Survey, produced by the U.S. Energy Information Administration.

Citygate: A utility's delivery point from the natural-gas transmission system.

Coincidence Factor: For an efficiency measure, the percentage of the electric demand reduction that will occur during the electric system peak demand period.

Commodity Cost: Variable cost of gas supply to the citygate. This is a component of the total gas supply cost, which also include transmission, distribution and storage capacity costs.

C&I: Commercial and Industrial.

Cost of Saved Energy: The net cost of an efficiency investment amortized (or levelized) over the efficiency savings life per unit of savings (either Dth for gas or kWh for electricity).

CSE: Cost of Saved Energy.

Cumulative Annual Savings: Energy and/or demand savings occurring in a given year resulting from all program or potential analysis activity since program or potential analysis inception. For example, for a program started in 2007, cumulative annual savings for 2011 would be the total savings realized in 2011 due to all program activities (*i.e.*, all installed efficiency measures) from 2007 through 2011.

Cumulative Cumulative Savings: The sum of all *Cumulative Annual Savings* from program or potential analysis inception through a given year.

Deferral Credit: In the case of retrofit efficiency measures, the present economic value of deferral of future capital costs resulting from permanently shifting the equipment replacement cycle by early retirement of equipment.

Dekatherm (Dth): A quantity of natural gas with a heat energy equivalent to one million (1,000,000) Btu.

DHW: Domestic Hot Water.

Discount Rate: The rate at which future costs and benefits are discounted to current-year (or some other base-year) dollars. The discount rate reflects the concept that money today is worth more than money in the future.

DSM: Demand side Management.

Economic Potential Analysis: An analysis of the gas efficiency potential from all measures that are cost-effective based on estimated avoided supply costs; as compared to the reference case forecast.

EEA: Energy and Environmental Analysis, Inc.

EIA: The Energy Information Administration of the U.S. Department of Energy.

Electric Systems Test: A test of the cost-effectiveness of an efficiency measure or program from the perspective of the electric utility or system. Similar to the "utility cost test." Costs are all costs incurred by electric ratepayers. Benefits are all benefits accruing to ratepayers.

EPAct: Energy Policy Act.

Externalities: Monetized values for emissions or other impacts external to the total resource cost/benefit analysis.

Heating Degree Day (HDD): The summation of the differences between the average hourly temperature and a base temperature (or balance point) for each hour of the day.

HVAC: Heating, Ventilating and Air Conditioning.

Incremental Annual: Energy and/or demand savings in a given year due to program or potential analysis activity in a single year.

Individually metered: In a multifamily dwelling, the case where each dwelling has its own energy usage meter. See *Master metered*.

Gas Systems Test: A test of the cost-effectiveness of an efficiency measure or program from the perspective of the gas utility or system. Similar to the "utility cost test." Costs are all costs incurred by gas ratepayers. Benefits are all benefits accruing to ratepayers.

LBL: Lawrence Berkeley Laboratory.

LDC: Local Distribution Company. Gas distribution utilities that deliver gas to end users.

Levelized Costs: Cost of Saved Energy.

LIPA: Long Island Power Authority.

LNG: Liquefied Natural Gas.

Local Transmission and Distribution Cost: A utility's cost of building, operating, and maintaining the high-pressure transmission and lower-pressure distribution systems in its service area.

Lost Opportunity: A type of efficiency measure characterized as one that takes place when investment is being made for some non-energy reason, *e.g.*, at the equipment's end of life. Hence, if the efficiency improvement is not captured at that time the opportunity for efficiency is "lost." Contrast with *Retrofit*.

Master metered: In a multifamily dwelling, the case where the entire building has a single energy usage meter. See *Individually metered*.

Market: For purposes of this study, *market* reflects the type of transaction situation (*e.g.,* new construction, renovation, remodeling, replacement or retrofit). *Market* is also used to refer to distinct transactions in the economy specific to customers, actors, or technologies (*e.g.,* the boiler market).

Market-Driven: See *Lost Opportunity*.

Market Effects: The energy savings impacts resulting from an efficiency program after the program ends or from customers not directly participating in the program.

Market Segmentation: Division of various markets into discrete components.

MDth: A thousand dekatherm.

Measure Characterization: The properties of a specific efficiency measure, (*e.g.,* measure life, energy savings, demand savings, cost).

Multifamily: A single residential building with multiple dwelling units, generally each with its own independent living facilities.

NAICS: North American Industrial Classification System. Numeric codes defining different industrial sub-sectors.

Net Benefits: Gross benefits minus costs.

New Construction: Construction of new buildings or facilities.

NFG: National Fuel Gas.

NiMo: Niagara Mohawk.

NOAA: National Oceanic and Atmospheric Administration.

Non-Resource Cost / Benefit: Benefits or costs resulting from efficiency measures that accrue from impacts other than to energy or water use (*e.g.,* operation and maintenance).

NYSEG: New York State Gas and Electric Corporation.

NYSERDA: New York State Energy Research and Development Authority.

OEI: Optimal Energy, Inc.

O&M: Operation and Maintenance.

O&R: Orange and Rockland Corporation.

Peaking-capacity cost: The costs of local capacity to cover the difference between normal and design-peak conditions.

Peak Day: The day when single highest gas usage occurs. *Peak Day* savings are expressed in MDth/day.

Penetration Rates: The rate at which an efficiency measure is adopted, expressed as a fraction of the maximum feasible level of adoption.

Price Effects: The impact on market clearing prices for gas commodity resulting from reduced gas demand due to efficiency efforts.

Program Scenario Potential Analysis: An efficiency analysis of programs selected and designed to optimize results given the selected funding level as well as other constraints.

PUMS: Public Use Microdata Set of U.S. Census data.

PV: Present value.

RECS data: Residential Energy Consumption Survey data developed by the U.S. Energy Information Administration.

RER: Regional Economic Research.

Retrofit: A type of efficiency measure characterized as either: one that replaces equipment before the end of its life, for the sake of the efficiency measure; or the addition of new discretionary equipment that does not currently exist for energy efficiency purposes. Contrast with *Market-driven*.

Sector: Residential, Commercial, and Industrial customer classes.

Societal Cost / Benefit: Costs and benefits of the gas efficiency to society as a whole.

Sub-sector: Major industrial sectors, by NAICS code.

TCF: Trillion cubic feet of gas.

T&D: Transmission and distribution.

Total Resource Cost (TRC) Test: A test of cost effectiveness that compares the present value total of all monetized benefits and costs for an efficiency measure, program, potential, or portfolio, from a societal perspective. The TRC test does not include monetized values for externalities.

Transportation Gas: Gas supply purchased by customers from independent third party vendors, but delivered via local gas distribution company lines.

VEIC: Vermont Energy Investment Corporation.