# NATURAL GAS ENERGY EFFICIENCY RESOURCE DEVELOPMENT POTENTIAL IN NEW YORK

Final Executive Summary

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## Notice

# EXECUTIVE SUMMARY

## 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)**

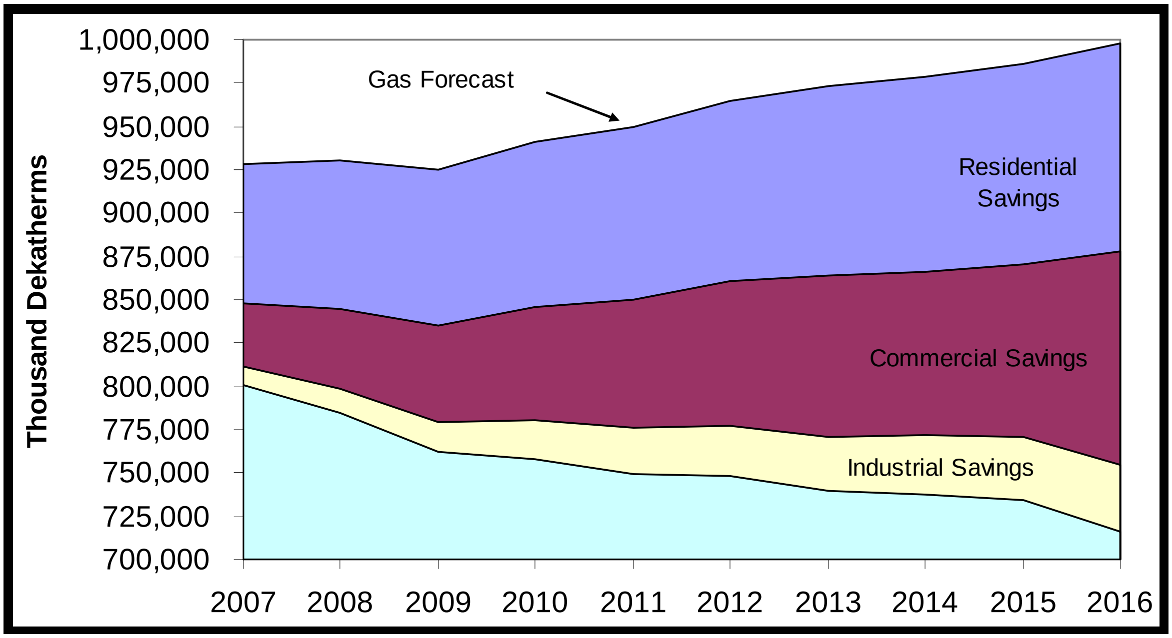
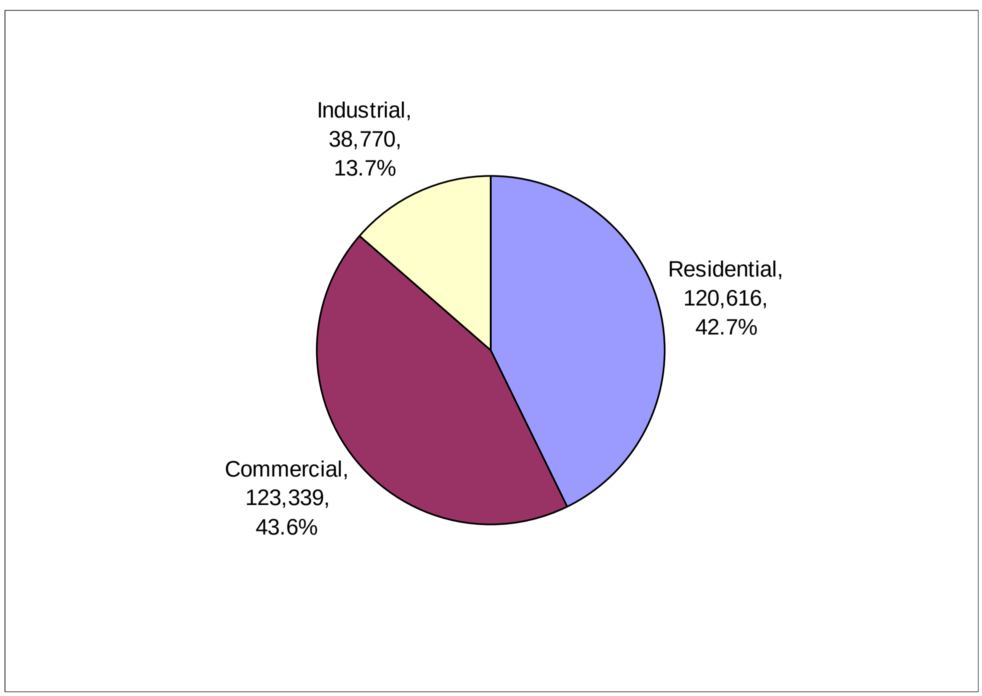



Figure E.2 shows that 2016 energy savings for the commercial sector are slightly more than savings for the residential sector, with 13.7% of savings attributable to the industrial sector. The greatest opportunities for efficiency are in space heating, followed by domestic water heating, service technologies,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

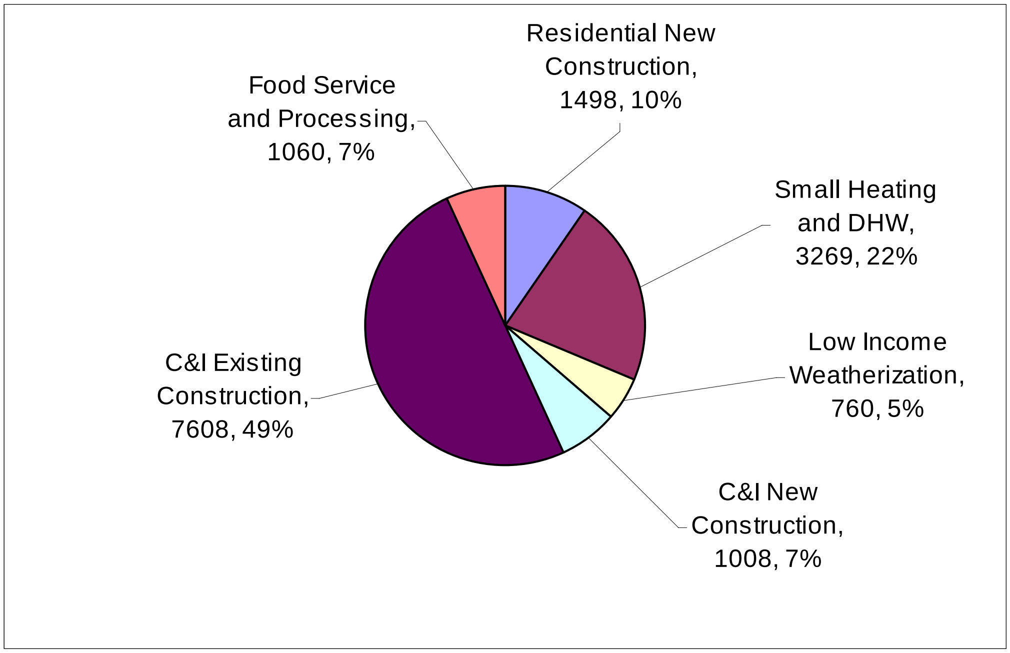


**Table E.2. Program Scenario Total Resource Present Value Net Benefits by 2016, Not Including Price Effects**

| 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

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