NATURAL GAS ENERGY EFFICIENCY RESOURCE DEVELOPMENT POTENTIAL IN CON EDISON SERVICE AREA

Final Report

Prepared for

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

Prepared by

OPTIMAL ENERGY, INC. • BRISTOL, VT

Philip Mosenthal, Project Leader
Jonathan Kleinman, 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 and Lost Revenue Recovery Mechanisms Leader

ENERGY AND ENVIRONMENTAL ANALYSIS, INC. • ARLINGTON, VA

Kevin Petak, Forecast and Price Effects Leader

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Notice

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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 in the Consolidated Edison of New York, Inc. (Con Edison) service area, in response to the Public Service Commision Order issued for the Con Edison's gas and steam business.[1] The study examines the potential to reduce gas consumption available from existing and emerging efficiency technologies and practices to lower end-use natural gas requirements in residential, commercial, and industrial facilities. The study assessed Con Edison's gas efficiency potential over 10-years from 2007 through 2016.

The study had five main objectives:

- Evaluate the potential cost-effective natural gas efficiency savings (economic potential) in the Con Edison service area over a 10-year horizon (2007-2016)
- Examine natural gas efficiency program designs and recommend programs for implementation
- Estimate the potential achievable cost-effective natural gas efficiency savings in the Con Edison service area over a 10-year horizon (2007-2016) from delivery of a portfolio of recommended efficiency programs and a target funding level (program scenario), based on program delivery for 5-years with 5-years post-program market effects
- Examine and recommend utility lost revenue recovery mechanisms
- Develop a reference case natural gas price forecast and consider the potential impact of efficiency programs on natural gas prices, if applicable

Our analysis identifies a large amount of efficiency would be economical compared to forecasted gas supply costs. Opportunities vary widely among individual efficiency technologies. However, aggregate opportunities in each sector reflect similar portions of forecasted gas usage. The study authors caution how to interpret and use this analysis. The economic potential estimates ***do not*** account for the market barriers to adoption of efficiency technologies ***nor*** the costs of market intervention strategies to overcome these barriers. The economic potential analysis serves as a starting point from which the program scenario evaluation was built upon.

We also estimate substantial opportunities for delivery of cost-effective efficiency programs. Again, caution should be used in interpretting the program scenario results. We recommend a set of efficiency programs that would optimize efficiency efforts given specific funding constraints

[1] Cases 03-G-1671 and 03-5-1672, Con Edison Company of New York. Inc. – Gas and Steam Rates, Order adopting the terms of a Joint Proposal (issued September 27, 2004).

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, we believe, given a full understanding, both the economic potential and program scenario analyses are useful to inform ultimate 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. We define these terms 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 only to the avoided gas consumption valued at the forecasted natural gas supply costs. It does not take into account market barriers or cost of market intervention. Potential is defined as additional savings over and above what is currently expected to occur without a gas program intervention.[2]
- **Program Scenario Potential:** Program Scenario potential refers to the estimated maximum natural gas efficiency impacts over the planning period, given specific program designs and funding levels assumed. It considers economic and other barriers to efficiency adoption, as well as the specific funding and program strategies.

The analysis covers all of Con Edison's gas service area. It addresses all gas ratepayers, and assumes for the program scenario that all ratepayers would contribute to program funding and be eligible to participate.[3] The study scope included all applicable natural gas efficiency technologies, with the exception of fuel switching and electricity generation measures, including combined heat and power technologies.

We conclude, if captured, the economic efficiency potential would reduce Con Edison's annual natural gas requirements by over 32,000 thousand Dth (MDth) by 2016. This represents 26.5% of expected Con Edison 2016 requirements. The study also shows peak day economic potential of more than 300 MDth in 2016. Figure 1.1 shows 2016 energy savings for the residential sector are slightly more than that of the commercial sector, with only 1% of savings attributable to the industrial sector. Figure 1.2 shows the breakout of the savings as a portion of the 2016 forecast sales.

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2 The basecase 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.

3 Note that this is different from the current gas pilot program which is only available to firm gas customers.

Figure 1.1. 2016 Economic Potential by Sector and as % of Total Savings

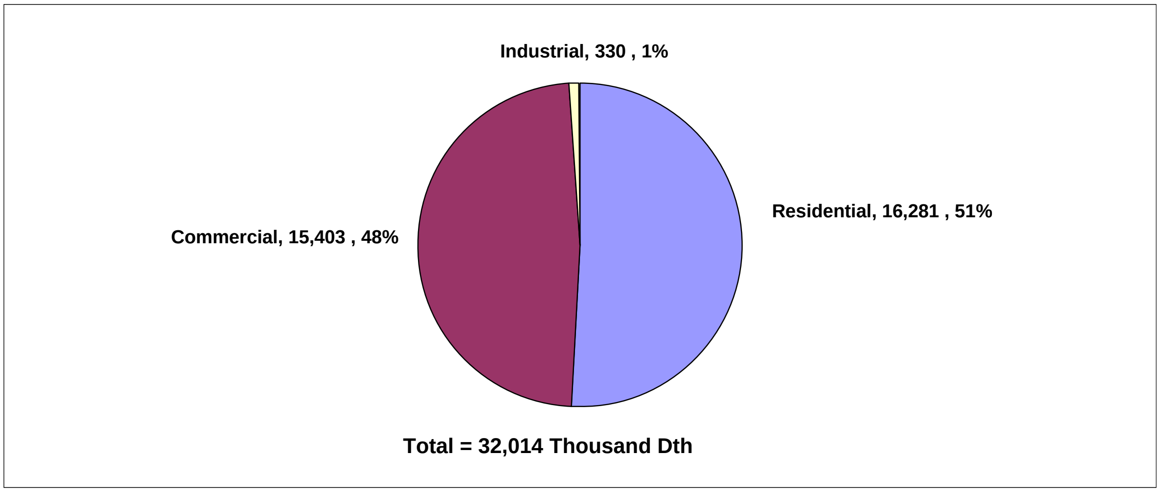
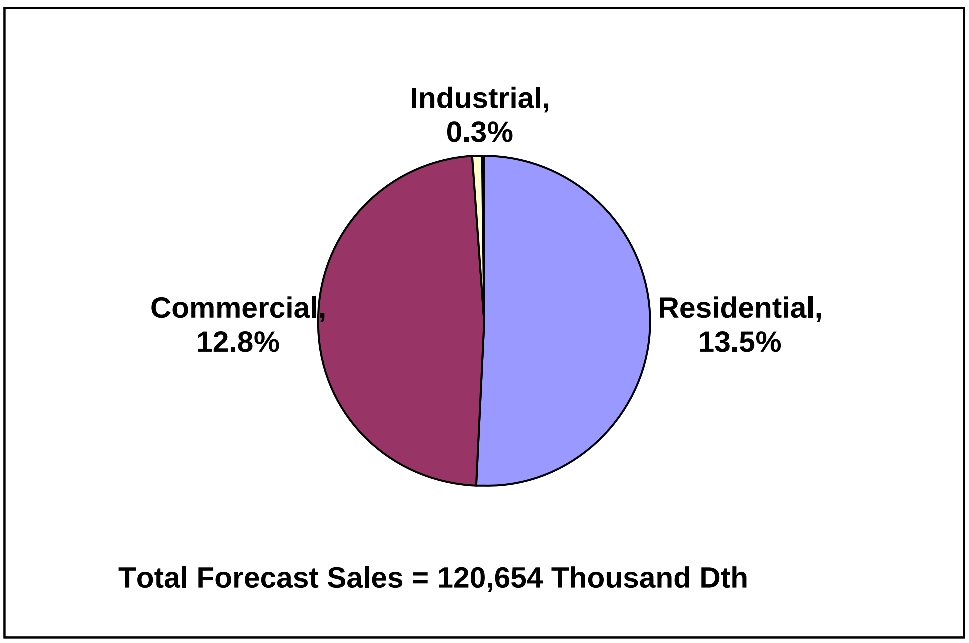


Figure 1.2. 2016 Economic Potential by Sector as % of Total Forecast Gas Usage



The program scenario was optimized based on an average program funding level of $15 million per year over 5-years. We assumed that all Con Edison service area ratepayers pay into the program funding and are all eligible to participate in programs. Spending was allocated to each sector proportional to the sector level revenues generated to Con Edison.[4,5] Low-income was

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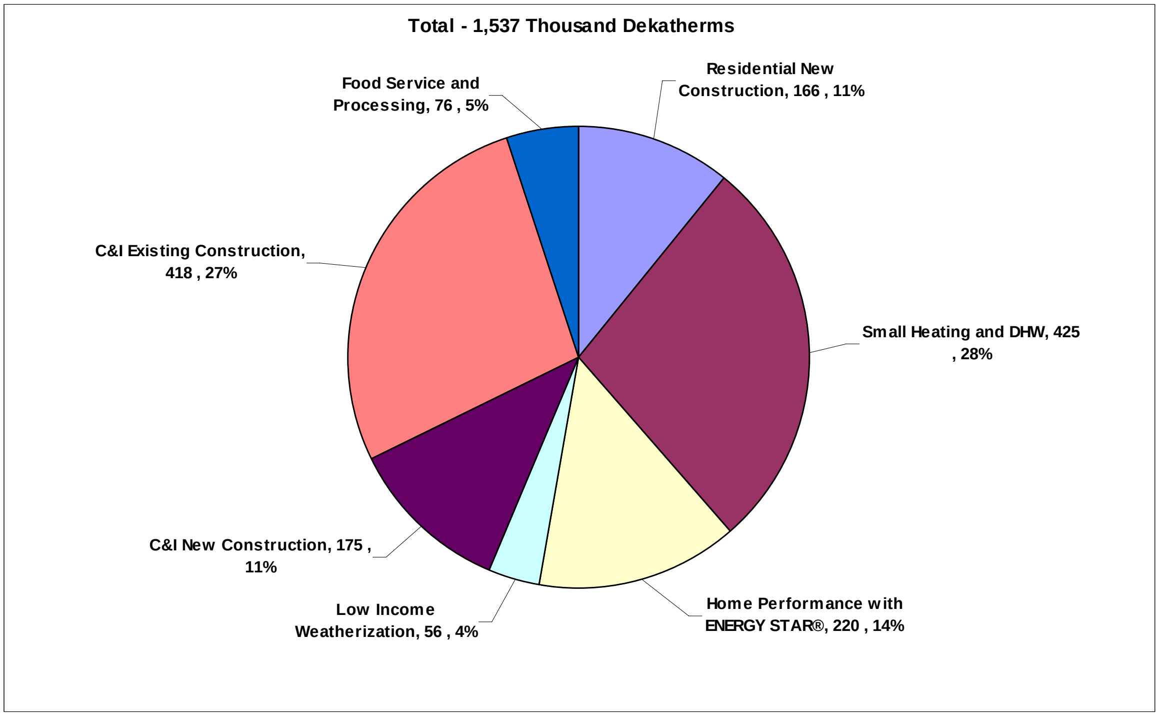
4 Revenue data from 2003 Con Edison Annual Report.

further allocated 20% of residential funding. Based on these constraints, we estimate program scenario savings by 2016 of 1,537 MDth annual savings, and a peak day load reductions of 11.8 MDth. This represents 1.3% of forecast gas requirements. Figure 1.3 shows program scenario potential by program. Neither the authors nor NYSERDA make any representations as to whether this funding level is an appropriate one, but provide this scenario to inform decision-makers as to the types of programs recommended and the overall cost-effectiveness at a sample level of spending. Section 2.4.5 below discusses options and likely impacts for both ramping up or down funding levels from $15 Million per year.

Figure 1.3. 2016 Program Scenario Potential by Program and as % of Total



1.3. STUDY TEAM

The NYSERDA study team consisted of many individuals and organizations, selected for their specialized expertise in efficiency technologies and markets. The multidisciplinary effort was led by Optimal Energy Inc., the prime contractor for the study. Table 1.1 lists the affiliation and responsibility of each of the five members of the study team.

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5 If spending were allocated to each sector proportional to use, then the distribution of program funding would change.

Table 1.1. NYSERDA Gas Efficiency Study Team

Organization	Team Member and Area of Responsibility
Optimal Energy, Inc. (Bristol, VT)	Philip Mosenthal, Project Leader Jonathan Kleinman, Commercial Efficiency Leader
American Council for an Energy-Efficient Economy (Washington, DC)	R. Neal Elliott, Industrial Efficiency Leader Dan York, Exemplary Programs Leader
Vermont Energy Investment Corporation (Burlington, VT)	Chris Neme, Residential Efficiency Leader and Program Design Leader
Resource Insight, Inc. (Arlingtron, MA)	Paul Chernick, Avoided Cost and Lost Revenue Leader
Energy and Environmental Analysis, Inc. (Arlingtron, VA)	Kevin Petak, Forecast and Price Effects Leader

The study team would like to recognize the positive input provided by NYSERDA, the New York Department of Public Service, Consolidiated Edison, New York City Economic Development Department, Pace Energy Project and the Natural Resources Defence Council. Of course, responsibility for all analysis and conclusions remain with the authors.

1.4. REPORT ORGANIZATION

This report is organized in six sections as follows:

- *Section 2**:** Summary of Approach and Results* describes the study's analytical approach, and major assumptions, and provides an overview of analysis results
- *Section 3: Gas Sales and Price Forecast* details the reference case model and results for forecasting gas sales and prices
- *Section 4: Economic Potential* describes the analytical approach and major assumptions used for estimating the economic potential and provides more detailed results
- *Section 5: Program Scenario Potential* provides a discussion of exemplary 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: Lost Revenue Recovery Mechanisms* describes different lost revenue mechanisms considered and recommendations for the Con Edison pilot program and the program scenario

In addition, the following appendices are provided:

A. Residential Analysis Data Inputs and Results

B. Commercial Analysis Data Inputs and Results

C. List of Industrial Measures

D. Lost Revenue Recovery Mechanisms

E. References

2. SUMMARY OF APPROACH AND RESULTS

2.1. SCOPE OF ANALYSIS

As described above, we analyzed both economic potential and a program scenario potential for the Con Edison service area. The analysis covers gas efficiency measures in all sectors, markets and end uses, with the exception of fuel switching and electricity generation measures, including combined heat and power technologies. The study considered technologies and practices that are currently available commercially, and those emerging technologies far enough advanced that widespread availability at cost-effective levels would be expected over the next five years. Our analysis covers a 10-year period, from 2007 to 2016. Economic potential results are presented in annual and peak-day Dth impacts for 2016 only. This is 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 5-years of program delivery and 5-years of post-program market-effects.

For the residential and commercial sectors, we analyzed technologies based on different markets. We define markets to refer to the market events that might precipitate an investment in efficiency measures, or to distinct market channels that would dictate different programmatic approaches. The broadest market distinctions we make are between early retirement of existing equipment purely for energy efficiency reasons (*i.e.*, discretionary retrofit investments) and incremental efficiency improvements in already planned investments (*i.e.*, market-driven, or lost opportunity investments). Separately analyzing efficiency technologies for these two broad categories is essential. Pursuit of retrofit investments requires paying the full cost of new measures, including both labor and equipment costs. In addition, 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.[6] Conversely, pursuit of market-driven investments requires paying only the additional incremental cost of the efficient equipment as compared to purchasing standard (baseline) efficiency new equipment. This incremental cost typically is a small fraction of the total installation cost, and often there is no incremental labor cost at all. Similarly, market-driven measure savings are based only on the incremental efficiency improvement over what a building owner would have installed in the absence of an efficiency program.[7]

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[6] Note, for retrofit measures, we quantify both the short-term savings based on improvements over existing equipment efficiencies as well as longer-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. On average, we assume that existing equipment that is retired early is halfway through its estimated measure life.

[7] We recognize that in actuality there is a continuum from pure discretionary retrofit measures to pure market-driven measures, and that in delivering programs it is often difficult to classify opportunities as one or the other. However, for analysis purposes, these distinctions are critical.

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 to different buildings, industries, and markets. Table 2.1 indicates the number of distinct 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.

The multifamily segment was disaggregated into two groups: larger multifamily buildings with central heating and domestic hot water systems; and multifamily buildings with decentralized systems. The larger multifamily buildings with central systems were characterized in the commercial sector 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, we report all multifamily within the residential sector.

The Project Team offers several caveats about the use of this study, 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 cannot be applied directly to represent the efficiency resources that Con Edison could realize 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. The study's economic potential analysis can inform other analyses of policy, program, and resource options. Below we provide an estimate of the likely maximum achievable potential that could be captured through aggressive, well designed initiatives, based on past analyses and expert judgement.

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

	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	Envelopee	Space heating	HVAC
	HVAC	Water heating	HVAC controls
	DHW	Cooling	Envelopee
	Laundry	Cooking	Industry-specific processes
	Miscellaneous	Whole building	
		Miscellaneous	
Market segments	**2 building types:**	**9 building types:**	
	Single family	Education	
	Multifamily	Grocery	
		Health	
		Lodging	
		Multifamily (with central systems)	
		Office	
		Restaurant	
		Retail	
		Warehouse	
		Other	

- The study is not a 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 reflects a portfolio of programs designed to optimize various constraints based on a set funding level averaging $15 million per year over 5-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. We make no representation that this funding level is the appropriate level given various issues that policy-makers should consider. The funding level analyzed represents approximately 1.1% of 2004 gas revenues. We present this scenario to give a more robust analysis of program impacts, and a starting point for consideration of ultimate funding levels and programs that might be pursued. Below we provide some guidance on modifications if funding levels significantly higher or lower than $15 million per year were selected.

- Economic potential is dependent on the level of avoided costs used. This study's conclusions on the economic potential for efficiency resources are somewhat dependent on the level of avoided costs. 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 we present estimated physical reductions in CO_2, SO_2 and NOx, we do not monetize these impacts. In other words, we do not consider the societal economic value from reductions in environmental externalities.
  - ♦ *Economic development impacts.* Net benefits from efficiency stimulate economic activity, increasing the gross state product in the Con Edison service area.
  - ♦ *Hard to quantify non-energy benefits*. While our analysis does quantify additional resource impacts (electricity and water), as well as changes in operations and maintenance costs, it does 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 the state, see Figure 2.1 These prices reflect the forecasted North American wholesale price as referenced at the Henry Hub in Lousianna with transportation and congestion charges applied. The analysis in this report have been based on the downstate reference price. 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.

EEA also developed a reference projection of natural gas usage by sector for the State. In the reference case, New York State annual gas consumption is forecast to grow by over 500 Bcf by 2025 to 1.7 Tcf, see

Figure 2.2. This is an average annual growth rate from 2005 to 2025 of 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 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 State 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 generaion gas consumption occurs before 2015.

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

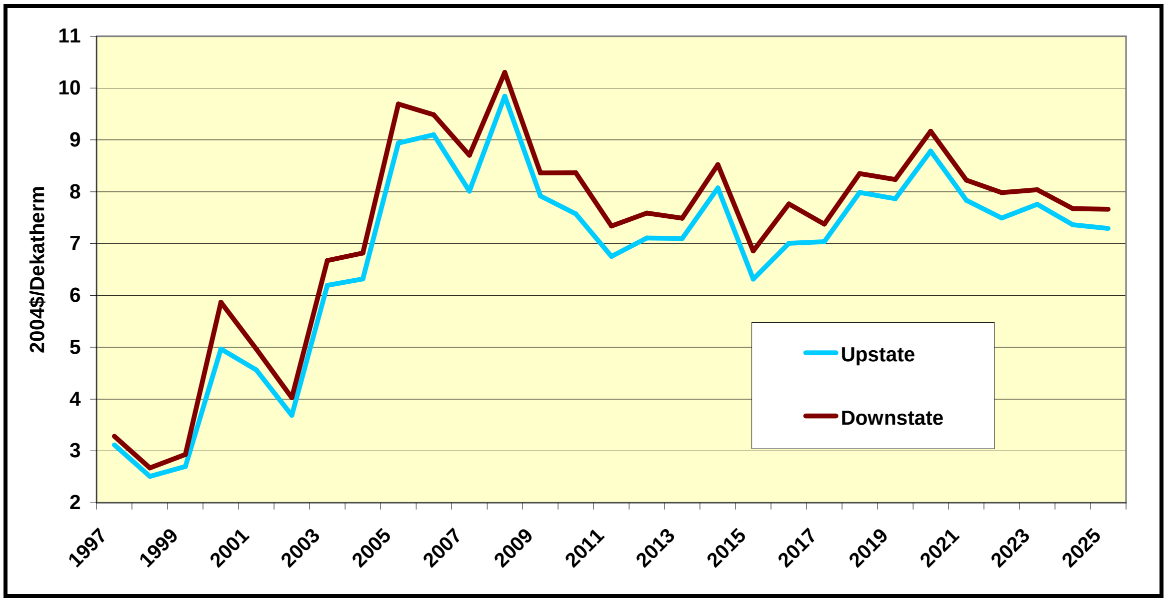
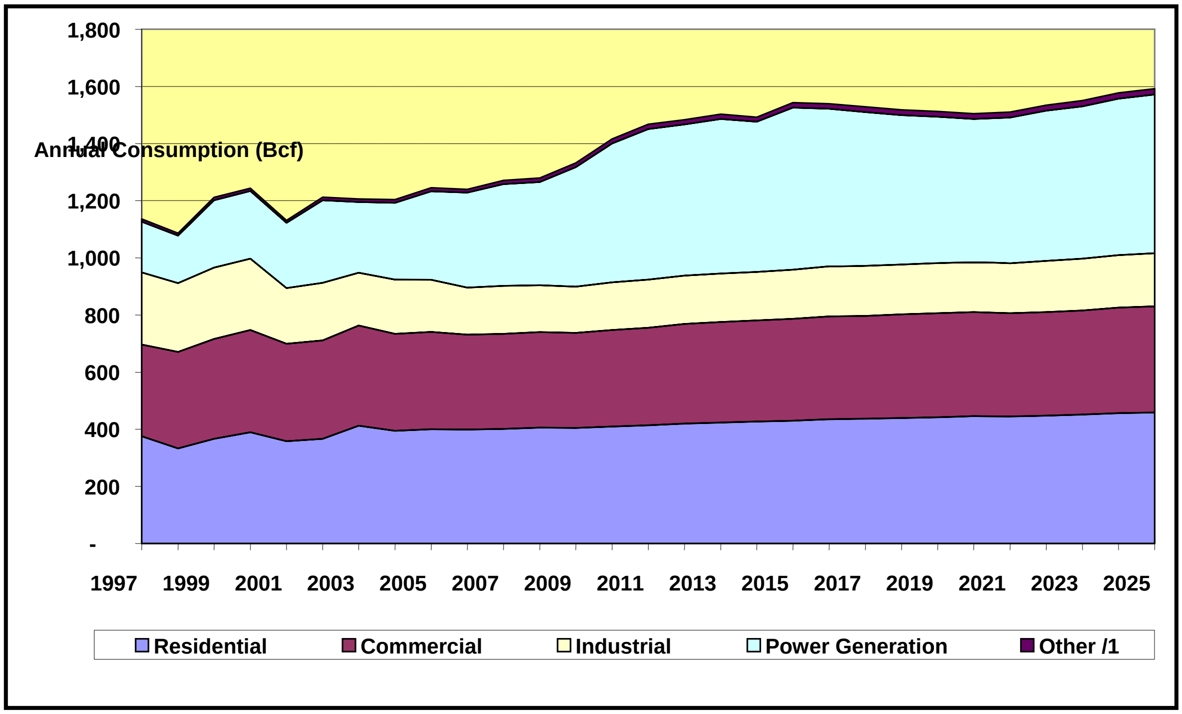


Figure 2.2. Projected Growth in N.Y. State Natural Gas Consumption by Market Segment.



[1]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. Savings Estimation Approach

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. Priority is given to market-driven opportunities. In other words, for measures that we analyze from both a retrofit and market-driven perspective, first we assume that all market-driven opportunities are installed in each year, at the time of planned investment. The remaining opportunities are captured as retrofit measures in 2016.[8]

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8 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. To a certain extent it is arbitrary whether priority is given to retrofit or market-driven measures. 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, we chose this method. Had we given priority to retrofit measures, many market-driven measures would have no impacts associated with them because 100% of the measures would already have been captured in 2007. This approach would provide more limited data to support future program design decisions.

The basic conceptual framework for the economic analysis involved 8 steps:

- Developing a comprehensive list of efficiency technologies and practices
- Selecting final efficiency technologies and practices for analysis based on an initial qualitative screening
- Characterization of the 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 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

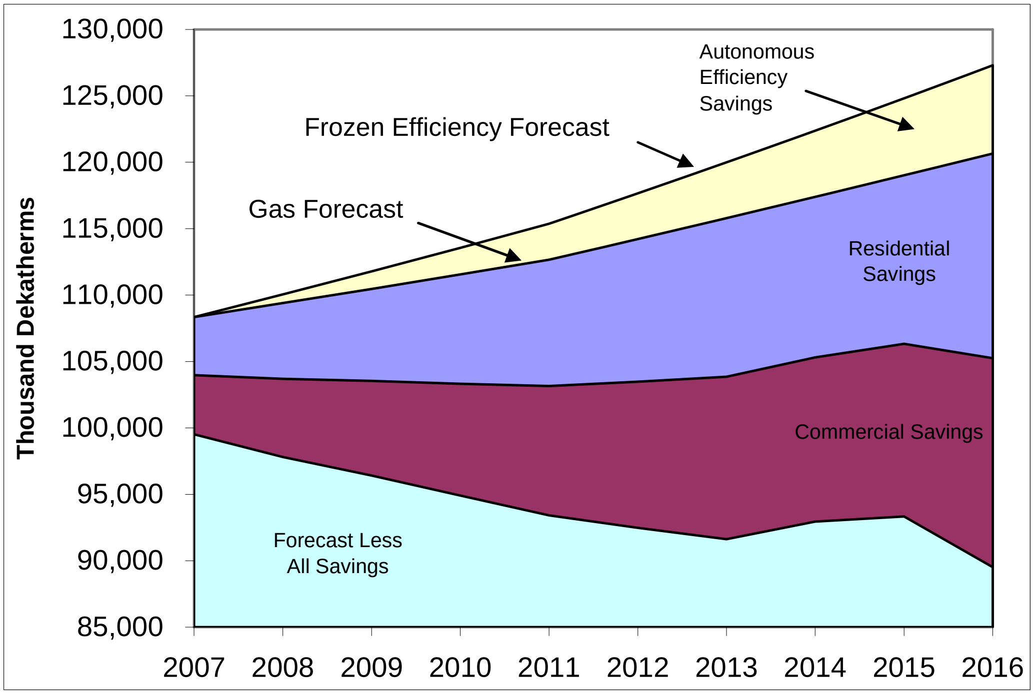
We relied on a large variety of data to support the above approach, including: prior potential analyses; published research studies; equipment and market assessments; baseline studies; NYSERDA; Con Edison and New York Public Service Commission data; engineering analysis; building simulation modeling;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

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. <u>Savings Results</u>

The economic potential for gas efficiency is large. However, we remind the reader that the economical potential does not account for many barriers to capture this potential and presented only to document the process by which the program scenario was developed and to serve as an upper bound estimate of available efficiency. We estimate total potential by 2016 of 32,014 thousand Dth, potentially offsetting 26.5% of the forecasted gas load in that year. This potential is roughly equal between the residential and commercial sectors, with only about 1% of the potential coming from industrial facilities.[9] Figure 2.3 shows how the captured economic potential would reduce forecasted loads. Theoretical capture of the full economic potential would eliminate all future load growth during the planning horizon.

Figure 2.3. Gas Sales Forecast Less Sector Energy Savings



Notes: Industrial sales are too small to depict separately, but are included in "Forecast Less All Savings".

"Autonomous efficiency" is the efficiency that is expected to occur from naturally occurring improvement, changes to codes and standards, and current and future electric efficiency programs.

Figure 2.4 shows economic potential by sector as a portion of forecasted total load and Table 2.2 shows the total economic potential by sector, and the percent of each sector's forecasted sales this represents.

9 The Con Edison service area does not have a large industrial sector, and many of the most significant industrial gas efficiency opportunities are in those sectors outside of Con Edison's service area.

Figure 2.4. 2016 Savings by Sector and as % of Total Forecasted Sales

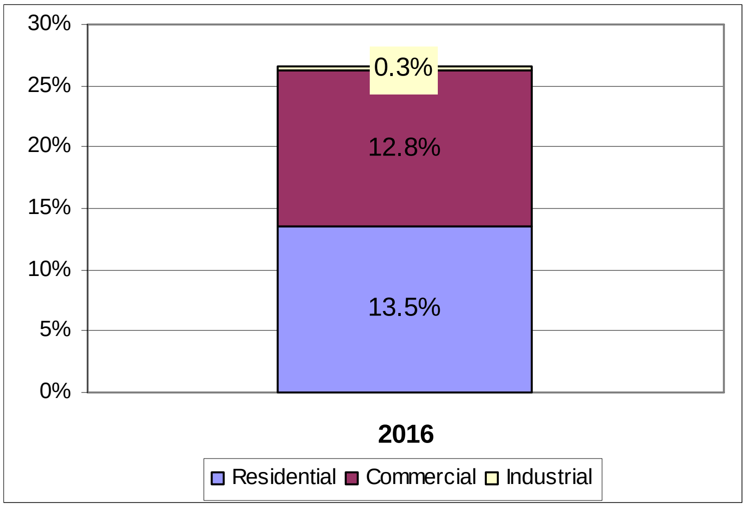
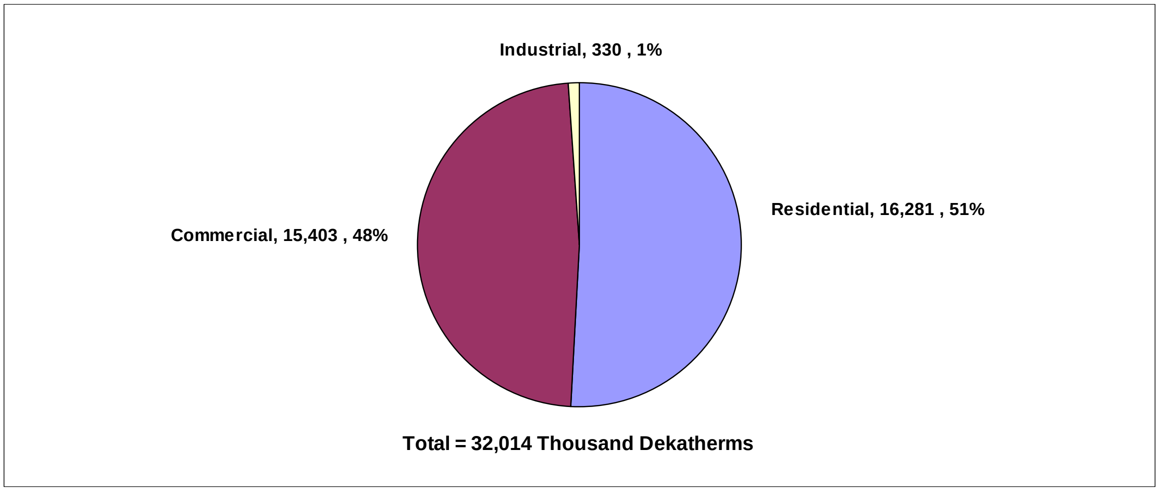


Table 2.2. 2016 Savings by Sector and as % of Forecast Sector Sales

2016	Savings (Thousand Dekatherms)	Gas Sales (Thousand Dekatherms)	% Savings of Sector Sales
Residential	16,281	70,413	23.1%
Commercial	15,403	48,988	31.4%
Industrial	330	1,254	26.3%
Total	**32,014**	**120,654**	**26.5%**

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

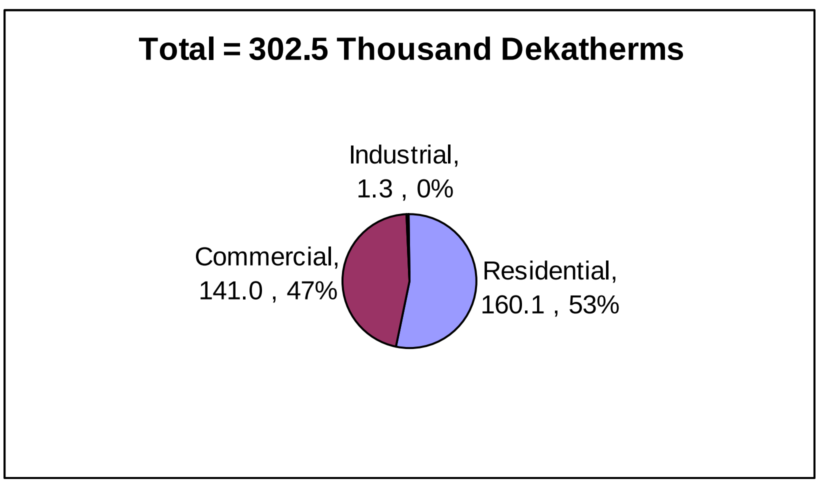
Figure 2.5. 2016 Savings by Sector and as % of Total Savings.



2.3.2.1. Peak-Day Impacts

Peak-day impacts are also large, totaling 302.3 MDth in 2016. A greater share of peak-day impacts comes from the residential sector (160 MDth), although a still significant contribution comes from the commercial sector (141 MDth). Figure 2.6 shows peak-day economic potential by sector.

Figure 2.6. 2016 Peak Day Savings by Sector and as % of Total



2.3.2.2. Emissions Impacts

Capture of the economic potential would result in large emissions reductions over the 10-year planning horizon and into the future for the life of the measures installed. CO_2, SO_2 and NOx emission impacts are provided in Table 2.3. Table 2.3 shows 2016 emissions reductions as well as the lifetime total emission reductions. These emissions reductions are determined from both gas and electricity impacts. We have not monetized the value of emissions reductions in any of the economic analysis of costs and benefits.

Table 2.3. Cumulative Annual CO_2, SO_2 and NO_x Emission Reductions.

Emissions Reductions		**Lifetime**
Cumulative Annual CO_2 (metric tons)	**10-year Total**	**Reductions**
Residential Econ Potential	10,252,489	24,421,227
Commercial Econ Potential	10,390,436	22,456,539
Industrial Econ Potential	124,493	251,828
Total Programs	**20,767,419**	**47,129,594**
		Lifetime
Cumulative Annual SO_2 (metric tons)	**10-year Total**	**Reductions**
Residential Econ Potential	4,478	9,867
Commercial Econ Potential	6,512	11,024
Industrial Econ Potential	1	1
Total Programs	**10,991**	**20,892**
		Lifetime
Cumulative Annual NOx (metric tons)	**10-year Total**	**Reductions**
Residential Econ Potential	1,589	3,683
Commercial Econ Potential	1,866	3,639
Industrial Econ Potential	12	25
Total Programs	**3,468**	**7,346**

2.3.3. <u>Avoided Cost Estimates</u>

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

Commodity: The market prices of gas delivered to the city-gate in a normal year.

Peaking capacity: The costs of local capacity to cover the difference between normal and design 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 city-gate 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 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. Table 2.4 shows the resulting estimates of avoided costs. Section 3 provides a detailed discussion of the avoided cost development.

Table 2.4. Total Avoided Gas Costs (2005 $/ Dth).

Year	Heating 65F base	Heating 50F base	Baseload	Water Heating	Cooling
2006	$14.23	$18.95	$10.14	$11.16	$9.88
2007	$12.52	$16.27	$9.36	$10.15	$8.69
2008	$13.75	$17.02	$11.01	$11.70	$9.55
2009	$13.19	$17.25	$8.99	$10.04	$6.86
2010	$12.66	$16.58	$9.01	$9.92	$7.45
2011	$11.53	$15.56	$7.94	$8.84	$7.33
2012	$11.18	$14.58	$8.20	$8.95	$7.08
2013	$11.41	$15.00	$8.09	$8.92	$6.76
2014	$12.29	$15.77	$9.17	$9.95	$7.92
2015	$11.70	$16.14	$7.43	$8.50	$6.48
2016	$11.85	$15.84	$8.38	$9.25	$7.38
2017	$11.46	$14.92	$7.97	$8.84	$5.92
2018	$11.97	$15.46	$8.98	$9.73	$7.98
2019	$12.33	$16.16	$8.86	$9.73	$7.80
2020	$12.92	$16.55	$9.83	$10.60	$8.74
2021	$12.52	$16.46	$8.85	$9.77	$7.55
2022	$12.00	$15.82	$8.61	$9.46	$7.37
2023	$11.66	$15.08	$8.66	$9.41	$7.50
2024	$11.55	$15.27	$8.29	$9.10	$7.39
2025	$11.58	$15.22	$8.27	$9.10	$6.86
2026	$11.98	$15.68	$8.67	$9.50	$7.45

2.3.4. Economic Perspectives

We present economic results of our analysis using a number of different "tests" or parameters. The primary economic screening criteria for cost-effectiveness is a total resource economic analysis of costs and benefits to the Con Edison service area. However, we also provide costs and benefits based on both natural gas and electric systems tests, as well as the overall levelized cost of saved energy. The total resource cost-effectiveness is generally the overarching consideration because this provides an assessment (from a societal perspective) on the increase in net benefits to the economy, or contribution to the overall economic welfare in Con Edison's service area. However, these other parameters are useful to consider as they provide a sense of how efficiency efforts might impact the gas and electric system economics and ratepayers. The cost of saved energy is a useful parameter to consider individual measures in comparison to typical gas supply costs. This section presents these perspectives.

2.3.4.1. Total Resource Cost Test

Our 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 in the Con Edison service area. For this approach we use the total resource cost test (TRC).[10] 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.**[11]** From the total-resource cost perspective, an efficiency technology 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.

We value the gas benefits from efficiency resources 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 Con Edison's gas needs.[12] Realizing more efficiency potential would allow Con Edison 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 the Con Edison service area, 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 economy in the Con Edison service area.[13] We do, 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 calculation for each customer, as well as their respective monthly usage to determine their rate block. Because data does not support such calculations, we show an estimate based on average revenue per Dth by sector.

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10 Note that the TRC test differs from the "Societal Test" in that the latter includes monetized benefits from environmental externalities, which we have not included. 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.

11 The utility test considers only avoided energy costs as benefits and counts only expenditures supported by ratepayers. Note that we use the terms "energy system test" here because programs are not necessarily administered by utilities. 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.

12 Note that in the Con Edison Collaborative there is some disagreement among parties as to whether benefits from T&D avoided cost reductions should be included in the TRC test. We include them here, both because we believe they are legitimate societal benefits from efficiency, and because they are generally included in other jurisdictions and widely considered standard practice to be included by such references as the "California Standard Practice Manual."

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

Just because technologies or practices are found to be cost-effective to the economy in the Con Edison service area as a whole, however, does not mean that individual consumers find them economically attractive. Economic potential remains untapped precisely because numerous market barriers interact to prevent widespread market adoption of efficiency 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 returns in excess of 60%. Such a high "hurdle rate" for efficiency investments on the part of individual decision-makers is the manifestation of multiple market barriers.

At the same time, energy planners for the Con Edison service area compare resource alternatives by weighing costs and benefits using a far lower cost of capital (4% after inflation in this study). Viewed from the standpoint of the economic well-being of the Con Edison service area, efficiency investment opportunities passed over by individual consumers offer potentially economical resources if Con Edison 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.

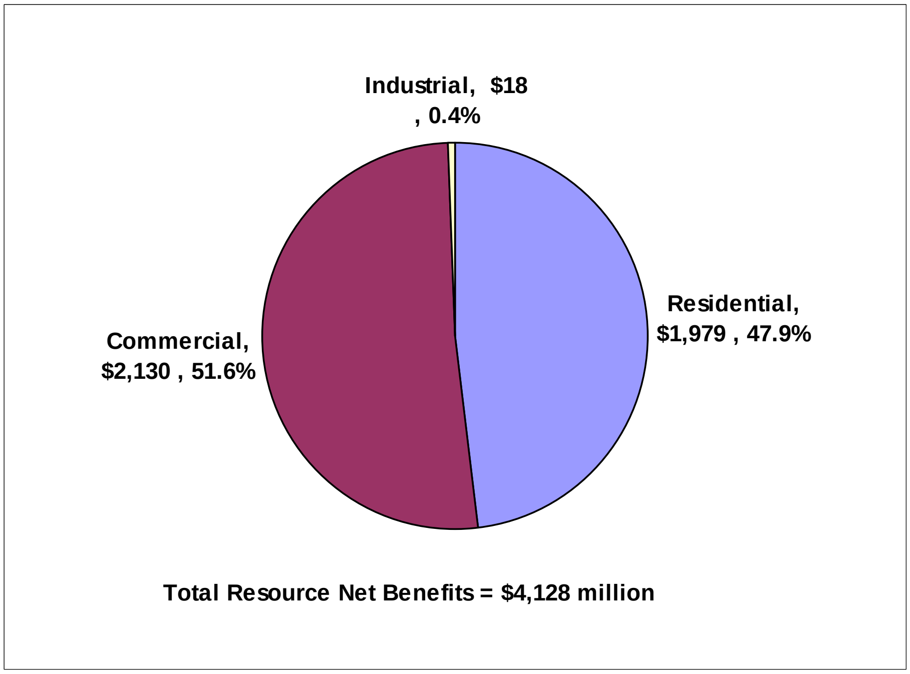
The economic potential, if captured in its entirety, would provide a net present value benefit (in 2005 $) over $4 billion. The overall benefit-cost ratio (BCR) is 3.23. The commercial sector would provide about 52% of the total net benefits, and has the highest benefit-cost ratio, at 3.87. This result is largely a result of significant electric benefits in the commercial sector from HVAC and building shell measures. This occurs because improvements to these systems often have large benefits on the cooling system (usually electric), and proportionally lower heating loads than residential buildings. Table 2.5 and Figure 2.7 show the TRC economic results, by sector.

Table 2.5. 2016 Total Resource Net Benefits, Costs, and Benefit/Cost Ratio

Sector	**Gross Benefits ($Million)**	**Net Benefits ($Million)***	**Costs ($Million)**	**Benefit/Cost Ratio****
Residential	$3,079	$1,979	$1,100	2.80
Commercial	$2,872	$2,130	$742	3.87
Industrial	$27	$18	$9.3	2.94
All Sectors	**$5,979**	**$4,128**	**$1,851.3**	**3.23**

*Net Benefits = Benefits minus costs, present worth 2005
** B/C Ratio = Gross Benefits/Costs

Figure 2.7. 2016 Total Resource Net Benefits and as % of Total



2.3.4.2. Gas and Electric System Tests

In addition to the TRC test, we provide costs and benefits based on a natural gas system test. This test is similar to the "utility test" in that it measures costs and benefits only related to the gas energy system, such as those costs and benefits paid by or accruing directly to ratepayers.[14]

When considering the natural gas system test the potential is still high. Total net benefits are $2,500 million, with a BCR of 2.24. This represents 61% of the TRC benefits, with the remainder coming from electric, water and non-resource benefits. In this case, while the commercial sector still has a BCR slightly higher than average (2.45), the sector level differences are smaller. This is because the gas system test ignores electric benefits and other non-resource benefits such as O&M, which are most significant in the commercial sector. No BCR is shown for the electric system test because costs are applied to the gas side since that is the primary focus of these efficiency measures. Table 2.6 shows gas system economic impacts.

14 We use the term gas system and electric system tests 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.

Table 2.6. Gas Energy System Net Benefits and Cumulative Benefit/cost Ratio).

Gas Energy System Net Benefits		
Net Benefits (benefits minus costs, present worth 2005$ Million)		
Residential	$	1,273
Commercial	$	1,209
Industrial	$	18
Total - Net Economic Potential Savings	**$**	**2,500**
Cumulative benefit/cost ratio 2005	**2016**	
Residential	2.09	
Commercial	2.45	
Industrial	2.97	
All Sectors - Net Economic Potential Savings	**2.24**	

The costs above under the gas system test for economic potential include all measure costs, similar to the TRC test.[15] Table 2.7 and Table 2.8 below show the additional component benefits that make up total TRC benefits.

Table 2.7. Electric Energy System Net Benefits.

Net Benefits (benefits minus costs, present worth 2005$ Million)		
Residential	$	576
Commercial	$	724
Industrial	$	-
Total - Net Economic Potential Savings	**$**	**1,300**

Table 2.8. Non-Gas and Non-Electric Energy Systems Net Benefits.

Net Benefits (benefits minus costs, present worth 2005$ Million)		
Residential	$	130
Commercial	$	197
Industrial	$	-
Total - Net Economic Potential Savings	**$**	**327**

2.3.4.3. Levelized Cost of Saved Energy

We also present societal economics by calculating the levelized cost of saved energy (CSE) in Table 2.9 for the economic potential. This calculation is useful to get a sense of how efficiency resources compare over their lifetime with supply costs, and also allows us to show a measure supply curve in Figure 2.8. The supply curve can give one a sense of the total efficiency potential available for less than a given cost per Dth (Dth). CSE shows net costs per Dth of gas potential. To do this, we subtract the value of all non-gas benefits to arrive at a net measure cost per Dth of gas savings.

Overall CSE for the economic potential is $1.92/Dth. 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. By sector, CSE is $3.23/Dth, $0.15/Dth and $3.23/Dth for residential, commercial and industrial sectors, respectively. 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. Table 2.9 shows CSE by sector.

Table 2.9. 2016 Total Resource Levelized Per Saved Dth.

Sector	$/DTh
Residential	$ 3.23
Commercial	$ 0.15
Industrial	$ 3.23
All Sectors - Economic Potential	**$ 1.92**

Figure 2.8 shows a supply curve 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 levelized cost per MDth (over the life span of the resource, using 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 obtaining 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 $38/Dth for a high efficiency heating system unit in warehouses. The study obtained negative values for some efficiency resource costs because it subtracted the value of non-gas resource savings, such as electricity. Appendices A and B provide tabular measure economics and savings, for residential and commercial sectors, respectively.

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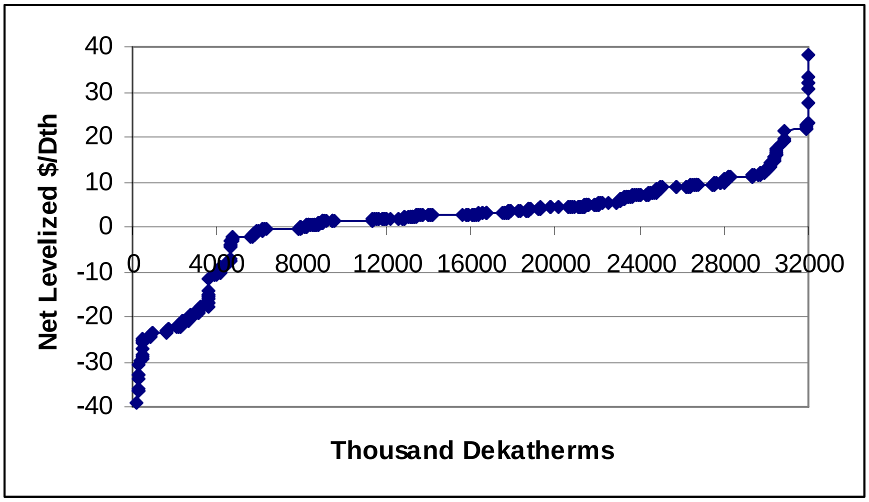
15 For the program scenario, only ratepayer funded costs are included (*e.g.*, administration and measure incentives), while direct customer contributions are not included.

Figure 2.8. 2016 All Sectors Economic Potential Supply Curve



2.3.4.4. <u>Bill Reductions</u>

New York Public Service Commission Order dated September 27, 2004, case 03-G-1671 called for estimating bill reductions from the economic potential. Actual bill reductions depend on the individual rates each customer is on, and further on each customer's monthly usage, which determines the rate block marginal impacts would be offsetting. This calculation is further complicated by the fact that many customers, particularly large commercial and industrial customers, are on interruptible rates and have dual-fuel capability. 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 receive certain summer blocks of usage at lower rates). The data to support such calculations is not available. As a result, we have calculated an estimate of bill reductions by sector based on 2004 average revenue per Dth sold for each sector. This approach tends 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 EEA's commodity price forecast) it is probable that our estimate significantly understates ultimate bill reductions in the future. Table 2.10 shows estimated bill reductions by sector for the economic.

Table 2.10. 2016 Estimated Economic Potential Bill Reductions.

Sector	2004 Average $/Dth	2004 Number Customers	2016 Dekatherm Savings	2016 Bill Reductions	Average Per Customer
Residential	$12.3	435,446	16,281,361	$200,800,390	$461
Commercial	$7.4	44,661	15,402,791	$113,832,860	$2,549
Industrial	$2.4	4,742	329,520	$781,986	$165
Total	**-**	**484,849**	**32,013,673**	**$315,415,236**	**$651**

Note: This calculation is based on 2004 $/Dth (and 2004 Number of Customers), and therefore likely underestimates 2016 bill reductions.

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.

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 exemplary gas and electric efficiency programs. The assessment of the program scenario potential assume 5-years of program delivery at an average budget of $15 million per year, with 5-years post-program market effects. As already mentioned, neither the authors, NYSERDA, nor any of the advisory group members represent the selected funding level as a recommendation for future gas program funding. Rather, we provide it to further inform future discussions about appropriate future funding levels and program portfolios

In development of a program portfolio, we sought to meet certain criteria. These included: maintaining equity across sectors by matching sector-level spending to existing sectoral revenues; providing low-income services, set at 20% of the residential budget; and providing a balance between short-term resource acquisition efforts and longer-term market-transformation benefits. In addition, we sought to provide program services targeted to all Con Edison gas customers and to address all important end uses. Finally, we explicitly designed our programs around broad markets, rather than specific customer or technology types. In other words, we designed programs that would comprehensively address multiple opportunities within a particular facility, with strategies and services designed around specific market and supply channels to address the way transactions normally happen in the marketplace.

Central to our markets approach and focus on comprehensiveness and addressing each market given its unique characteristics, we believe the most effective and cost-effective approach to deliverying gas programs in the Con Edison service area is to integrate them with electric efficiency services. To that end, we assume integrated delivery of fuel-neutral, one-stop-shopping programs to combined gas and electric customers. Our budgets and penetration rates reflect this assumption. We have 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 we propose here.

Developing the optimized investment portfolio included:

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

The selected investment portfolio includes seven programs for the Con Edison service service area:

Cross Sector

- Space and water heating equipment
  - ♦ Heating, hot water, washers
  - ♦ Residential & Small commerical and industrial

Residential

- New construction (ENERGY STAR® Homes)
- Home performance with ENERGY STAR®
- Low-income retrofit

Commercial / Industrial

- New construction
- Existing construction
- Food service and processing

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

2.4.2. Program Scenario Potential 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 permutation (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[16]
- 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 within Con Edison service area, assuming integration with electric programs
- Developing program incentive costs based on program incentive level designs and estimated measure adoption rates
- 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 $75,000,000 over 5-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 customers because these offer the most cost-effective savings. Low-income customers would likely be eliminated entirely as they tend to be more costly to capture. Section 5 describes the program designs and the rationale for the investment portfolio development.

2.4.3. Savings Results

Pursuit of the program scenario would offer total savings in year 5 (2011) of 954 MDth (*i.e.*, the last year of the 5-year program delivery). Ultimate savings by year 10 (2016) would continue to

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16 We developed 3 separate penetration curves for each measure: 1) baseline penetrations assuming no program intervention; 2) overall penetrations assuming program intervention; and 3) program participation penetration rates. The latter 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 already would have installed the measure but do not bother to apply for an incentive. For market-transformation based programs, 3 can often be significantly less than 1 or 2. Appendix A and B provide penetration rates.

grow (although at a slower rate) due to post program market effects, and total 1,537 MDth. The largest single program savings would come from the Commercial and Industrial (C&I) Existing Construction program, followed by the Small Heating and Domestic Hot Water (DHW) Residential New Construction, Residential Home Performance, C&I New Construction, Food Service and Processing, 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 2.9 shows how 2016 annual impacts breakout by program.

Table 2.11. Incremental Annual and Cumulative Annual Energy Savings

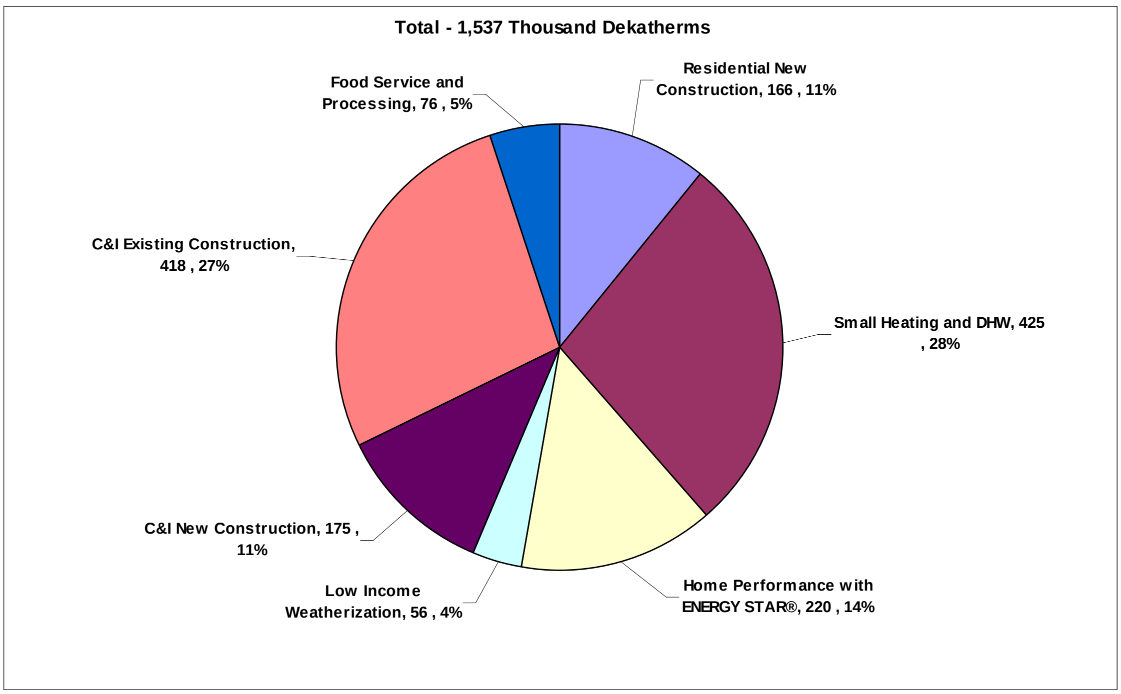
	Annual (Thousand Dtherms/yr)										Lifetime Savings (Thousand Decatherms)
Incremental annual	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	
Residential New construction	6	13	21	25	30	13	14	14	15	16	
Small Heating and DHW	22	40	51	61	71	34	35	36	37	38	
Home Performance with ENERGY STAR®	7	14	21	24	26	26	26	26	26	26	
Low Income Weatherization	12	12	12	12	12	-	-	-	-	-	
C&I New construction	6	11	18	25	32	14	16	18	20	22	
C&I Existing construction	32	52	81	100	130	36	41	45	49	54	
Food Service and Processing	3	5	8	11	15	7	8	8	9	9	
Total Programs	**86**	**147**	**212**	**259**	**314**	**130**	**138**	**147**	**155**	**164**	
Cumulative annual	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	
Residential New construction	6	19	40	65	95	108	122	136	151	166	3,579
Small Heating and DHW	22	62	113	175	245	280	315	351	388	425	8,153
Home Performance with ENERGY STAR®	7	20	42	66	92	117	143	168	194	220	4,275
Low Income Weatherization	11	22	34	45	56	56	56	56	56	56	973
C&I New construction	6	17	35	59	91	104	119	136	154	175	3,694
C&I Existing construction	32	84	151	234	334	338	339	365	391	418	6,455
Food Service and Processing	3	8	15	27	41	48	56	64	71	76	736
Total Programs	**86**	**232**	**430**	**671**	**954**	**1,051**	**1,149**	**1,276**	**1,405**	**1,537**	**27,865**

A word on definitions: incremental refers to savings in a given year associated only with new installations happening in that year; cumulative annual refers to the overall savings occurring in a given year (*i.e.*, reduction in gas requirements in that year based on both the 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 any given year.

Table 2.12. Incremental Annual and Cumulative Annual Peak Day Savings

	Peak Day (Thousand Dtherms/yr)									
Incremental annual	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New Construction	0.0	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1
Small Heating and DHW	0.1	0.2	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2
Home Performance with ENERGY STAR®	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2
Low Income Weatherization	0.1	0.1	0.1	0.1	0.1	-	-	-	-	-
C&I New Construction	0.1	0.2	0.2	0.3	0.4	0.2	0.2	0.2	0.3	0.3
C&I Existing Construction	0.3	0.5	0.7	1.0	1.3	0.3	0.4	0.4	0.5	0.5
Food Service and Processing	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Total Programs	**0.6**	**1.1**	**1.6**	**2.0**	**2.5**	**0.9**	**1.0**	**1.1**	**1.2**	**1.3**
Cumulative annual	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New Construction	0.0	0.1	0.2	0.4	0.5	0.6	0.7	0.8	0.9	1.0
Small Heating and DHW	0.1	0.3	0.6	0.9	1.2	1.4	1.6	1.7	1.9	2.1
Home Performance with ENERGY STAR®	0.0	0.1	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.3
Low Income Weatherization	0.1	0.1	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3
C&I New Construction	0.1	0.2	0.5	0.8	1.2	1.4	1.6	1.8	2.1	2.3
C&I Existing Construction	0.3	0.8	1.4	2.3	3.4	3.5	3.6	3.9	4.1	4.4
Food Service and Processing	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3
Total Programs	**0.6**	**1.7**	**3.2**	**5.1**	**7.4**	**8.1**	**8.9**	**9.8**	**10.8**	**11.8**

Figure 2.9. 2016 Energy Savings by Program and as % of Total Savings



2.4.3.1. Emissions Impacts

The program scenario would result in lifetime reductions of 1.9 million metric tons of CO_2, 481 metric tons of SO_2, and 247 metric tons of NO_x.

Table 2.13 shows annual and lifetime emission reductions.

Table 2.13. CO_2, SO_2, and NOx Emissions Reductions

	Emissions Reductions											
Cumulative Annual CO_2 (metric tons)	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**10-year Total**	**Lifetime Reductions**
Residential New Construction	373	1,184	2,518	4,122	5,991	6,794	7,642	8,537	9,477	10,461	57,100	222,840
Small Heating and DHW	1,414	3,951	7,178	11,012	15,426	17,500	19,617	21,776	23,978	26,222	148,072	482,513
Home Performance with ENERGY STAR®	391	1,220	2,482	3,938	5,465	6,992	8,518	10,045	11,571	13,098	63,720	255,450
Low-income Weatherization	656	1,311	1,967	2,623	3,278	3,278	3,278	3,278	3,278	3,278	26,226	56,984
C&I New Construction	552	1,674	3,407	5,801	8,875	10,100	11,507	13,088	14,822	16,714	86,541	364,765
C&I Existing construction	2,234	6,114	11,418	18,114	26,557	27,181	27,859	29,558	30,996	32,163	212,192	453,370
Food Service and Processing	139	416	851	1,471	2,280	2,663	3,065	3,526	3,903	4,197	22,511	41,949
Total Programs	**5,758**	**15,870**	**29,821**	**47,081**	**67,872**	**74,507**	**81,487**	**89,808**	**98,025**	**106,134**	**616,363**	**1,877,870**
Cumulative Annual SO_2 (metric tons)	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**10-year Total**	
Residential New Construction	0	0	0	1	1	1	1	2	2	2	10	38
Small Heating and DHW	0	1	1	2	3	3	3	4	4	4	26	56
Home Performance with ENERGY STAR®	0	0	0	0	1	1	1	1	1	2	8	32
Low-income Weatherization	0	0	0	0	0	0	0	0	0	0	3	6
C&I New Construction	0	1	2	3	5	6	6	7	8	9	49	210
C&I Existing construction	1	2	4	7	11	11	12	13	13	12	86	135
Food Service and Processing	0	0	0	0	0	0	0	0	0	0	1	3
Total Programs	**1**	**4**	**8**	**14**	**21**	**23**	**25**	**27**	**28**	**30**	**182**	**481**
Cumulative Annual NOx (metric tons)	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**10-year Total**	
Residential New Construction	0	0	0	1	1	1	1	1	1	1	7	27
Small Heating and DHW	0	0	1	1	2	2	2	3	3	3	18	55
Home Performance with ENERGY STAR®	0	0	0	0	1	1	1	1	1	2	7	29
Low-income Weatherization	0	0	0	0	0	0	0	0	0	0	3	6
C&I New Construction	0	0	1	1	2	2	2	2	3	3	15	63
C&I Existing construction	0	1	2	3	4	4	4	5	5	5	32	62
Food Service and Processing	0	0	0	0	0	0	0	0	0	0	2	5
Total Programs	**1**	**2**	**4**	**6**	**9**	**10**	**11**	**12**	**13**	**14**	**84**	**247**

2.4.4. Economic Results

The program scenario is highly cost-effective. Pursuit of this scenario would result in estimated net benefits to the economy of $122 million, with an overall benefit-cost ratio of 2.13. In other words, for every dollar invested in efficiency, the scenario would return $2.13 to the local economy.[17] The largest net benefits would come from the C&I Existing Construction program. Substantial net benefits would also come from the Small Heating and DHW, C&I New Construction, Residential New Construction programs and Home Performance with ENERGY STAR®. Table 2.14 and Figure 2.10 show economic results by program.

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[17] As noted above in Section 2.3.4.1. , we consider the estimates of net benefits conservative because gas avoided cost estimates exclude certain societal benefits from reduced gas consumption.

Table 2.14. 2016 Total Resource Net Benefits

	Total Resource Net Benefits $ (Million)									
Cumulative net benefits (benefits minus costs, present worth 2005)	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New construction	0	1	3	5	7	9	10	11	12	14
Small Heating and DHW	1	4	7	10	15	17	19	21	24	26
Home Performance with ENERGY STAR®	0	1	2	4	5	7	9	11	13	14
Low Income Weatherization	1	1	2	3	3	3	3	3	3	3
C&I New construction	0	2	4	7	10	12	15	17	20	22
C&I Existing construction	1	4	10	17	27	29	32	35	38	41
Food Service and Processing	(0)	(0)	(0)	0	1	1	1	2	2	2
Total Programs	**4**	**13**	**28**	**46**	**68**	**78**	**89**	**100**	**111**	**122**
Cumulative benefit/cost ratio 2005	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New construction	1.48	1.64	1.83	1.87	1.92	2.00	2.06	2.12	2.17	2.22
Small Heating and DHW	1.41	1.52	1.59	1.63	1.65	1.69	1.73	1.76	1.78	1.80
Home Performance with ENERGY STAR®	1.05	1.24	1.46	1.57	1.66	1.76	1.84	1.89	1.94	1.97
Low Income Weatherization	1.66	1.58	1.60	1.57	1.57	1.57	1.57	1.57	1.57	1.57
C&I New construction	1.45	1.57	1.70	1.81	1.87	1.96	2.04	2.12	2.19	2.25
C&I Existing construction	1.43	1.77	2.08	2.28	2.44	2.50	2.56	2.62	2.67	2.73
Food Service and Processing	0.54	0.71	0.92	1.08	1.21	1.33	1.44	1.54	1.64	1.73
Total Programs	**1.38**	**1.54**	**1.71**	**1.81**	**1.89**	**1.94**	**2.00**	**2.04**	**2.09**	**2.13**

Figure 2.10. 2016 Total Program Scenario Resource Net Benefits and as % of Total

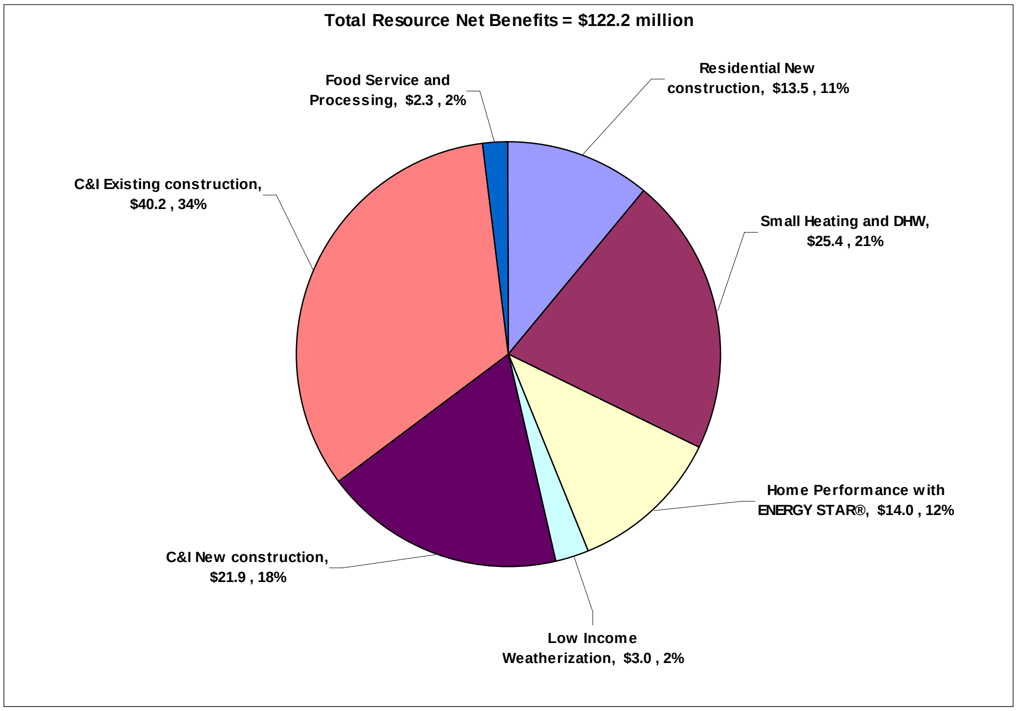

Table 2.15 shows the cost-effectiveness results for the gas system test. All programs are cost-effective from a gas system perspective, providing total net benefits of $127.2 million, and an overall BCR of 2.94. Figure 2.11 shows the distribution of net benefits by program from the gas system perspective.

Table 2.15. 2016 Gas Energy System Net Benefits in 2005$

Proposed Programs	Cumulative Net Benefits ($Million)*	Cumulative Benefit/Cost Ratio
Residential New Construction	$17.3	4.92
Small Heating and DHW	$36.0	3.45
Home Performance with ENERGY STAR®	$21.3	5.02
Low Income Weatherization	$2.0	1.32
C&I New Construction	$18.6	2.87
C&I Existing Construction	$30.8	2.40
Food Service and Processing	$1.2	1.39
Net Program Scenario Potential Savings	**$127.2**	**2.94****

*Cumulative Net Benefits = Benefits minus costs, present worth 2005.

** Cumulative B/C Ratio = Sum of all programs net benefits and costs/Sum of all programs costs. The B/C Ratio is based on the TRC test which excludes lost revenue and any quantification of environmental benefits.

Figure 2.11. 2016 Gas Energy System Benefits and as % of Total

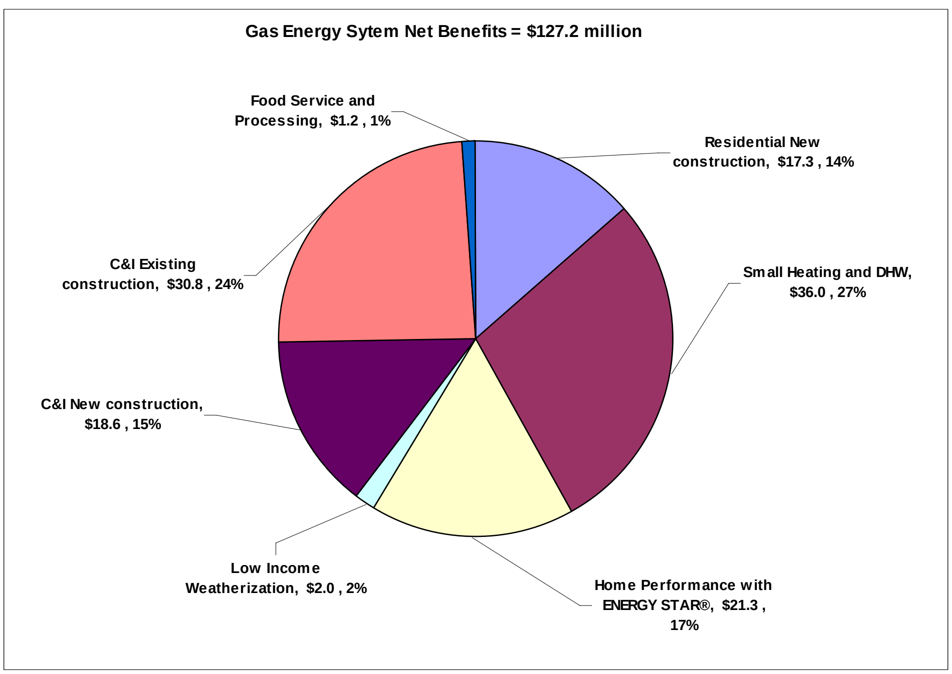

Table 2.16 shows the CSE for the program scenario potential. Capture of the program scenario potential would result in efficiency savings at an overall cost of $5.6/Dth, significantly lower than current and forecasted gas supply costs.

Table 2.16. Total Resource Levelized Cost Per Saved Dth.

	Total Resource Levelized Cost Per Saved Dekatherm $/Dth									
Cumulative	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New construction	7.89	6.91	6.00	5.83	5.58	5.31	5.09	4.90	4.74	4.60
Small Heating and DHW	9.55	8.74	8.25	8.01	7.79	7.61	7.47	7.35	7.24	7.16
Home Performance with ENERGY STAR®	11.65	9.65	8.02	7.30	6.85	6.36	6.05	5.83	5.67	5.54
Low Income Weatherization	8.76	9.15	9.02	9.13	9.13	9.13	9.13	9.13	9.13	9.13
C&I New construction	9.16	7.85	6.81	6.00	5.59	5.08	4.64	4.25	3.91	3.62
C&I Existing construction	13.09	9.92	7.88	6.80	6.04	5.73	5.42	5.14	4.87	4.63
Food Service and Processing	23.48	17.68	13.40	11.15	9.83	8.85	8.09	7.49	7.01	6.60
Total Programs	**10.46**	**9.04**	**7.89**	**7.30**	**6.85**	**6.53**	**6.25**	**6.00**	**5.79**	**5.60**

Table 2.17 shows the estimated total bill reductions by program for the program scenario. Overall, delivery of the selected portfolio would result in approximately $11 million/yr in bill reductions in 2016, assuming 2004 average rates. Note we do not show per customer bill reductions 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 like vary widely among individual participants.

Table 2.17. 2016 Estimated Program Potential Bill Reductions.

Program	2004 Average $/Dth	2016 Dekatherm Savings	2016 Bill Reductions
Residential New Construction	$13.4	166,455	$2,232,632
Small Heating and DHW	$13.4	425,318	$5,704,726
Home Performance with ENERGY STAR®	$13.4	219,684	$2,946,592
Low Income Weatherization	$13.4	56,091	$752,346
C&I New Construction	$10.9	175,107	$1,907,728
C&I Existing Construction	$10.9	418,339	$4,557,639
Food Service and Processing	$10.9	75,698	$824,704
Total	**-**	**1,536,693**	**$10,883,950**

Note: This calculation is based on 2004 $/Dth and therefore likely underestimates 2016 bill reductions.

2.4.5. Alternative Funding Scenarios

As noted above, we performed detailed analysis of what could be achieved with a program portfolio for a single funding scenario, due to limited budget and time. However, we provide here some preliminary estimates of potential at some different levels of funding. Readers are cautioned that these estimates are not the result of in-depth analysis conducted in this study, but rather an estimate based on prior experience with numerous other programs and potential studies in New York and other jurisdictions, and professional judgment. The other scenarios provided should also not be viewed as recommendations, but rather an attempt to give readers a sense of the likely impacts and some guidance on how to extrapolate results from our more detailed analysis.

We offer three other scenarios for consideration:

- **Maximum achievable potential** — a preliminary estimate of the portion of total economic potential that could be achieved through well designed, aggressive, fully funded programs paying 100% of the costs of all economic efficiency measures.
- **Spending 150% of the program scenario funding level** — a preliminary estimate of the likely additional savings that would be captured by increasing the $15,000,000 per year spending to $22,500,000 per year average spending.
- **Spending 50% of the program scenario funding level** — a preliminary estimate of the likely reduction in savings by decreasing the $15,000,000 per year spending to $7,500,000 per year average spending.

We estimate that maximum achievable potential over the 10-year period would be approximately 70% of the total 2016 economic potential, or 22.4 thousand Dth. This would represent an overall reduction of 19% of 2016 forecasted load, more than offsetting expected load growth over the 10-year planning horizon. Note that this maximum achievable would require program delivery for a full 10-years, as opposed to the program scenario that only analyzes programs for 5-years of delivery. This is because the ability to fully ramp up program delivery and build capability to capture maximum achievable at this aggressive level is unprecedented and consequently would take time and effort, and also because it would require maximum capture of all new construction savings in each year. We estimate the overall costs to pursue maximum achievable savings would require an average additional spending (in excess of measure costs) of approximately 30% to cover program delivery costs including general administration, marketing, tracking, technical assistance, monitoring and evaluation, and other non-incentive costs.

Our maximum achievable projections are based on professional judgment, based on having conducting numerous other potential studies (including an electric and renewable efficiency study in 2003 for NYSERDA), and having reviewed numerous potential studies, program evaluations, and documents researching the penetration rates and costs from the best efficiency programs throughout North America.

For the 50% and 150% funding level scenarios, we estimate that savings would be approximately 60% and 140%, respectively, of the estimated portfolio savings. In other words, at an average annual funding level of $7.5 million, total 2016 savings would be roughly 922 Mdth. At $22.5 million/yr, 2016 savings would be roughly 2,150 Mdth. The reason for greater yield (Dth saved per $ spent) at the 50% scenario and the lower yield at the 150% scenario is that as one moves up the efficiency resource supply curve the cost of capturing additional savings begins to increase. In addition, at the increased funding level we assume one might also increase incentive levels. 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.

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 we estimate. In general, however, we believe that because the levels of spending discussed are roughly an order of magnitude lower than those required to capture 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.

2.4.5.1. <u>Guidance on potential portfolio modifications</u>

While this study does not substitute for a more detailed program plan, once funding levels are established, we offer some suggestions on things to consider given different potential 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, we provide the following guidance:

- 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 following programs are fairly scalable up or down, because they focus on, or include significant components of, discretionary retrofit measures: Low-income, C&I Existing Construction.

- Residential Home Performance, while also focussing on retrofit measures, could be scaled down fairly easily, but would likely require some significant redesign to be ramped up significantly.[18]
- For significant drops in funding, one might want to consider eliminating the Food Service program and 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 programs. These technologies can still be promoted under these programs, but would likely not have the full market-transformation benefits anticipated from a more focused effort.
- The residential and C&I new construction programs could be ramped up or down somewhat, but are obviously constrained by the overall new construction activity occurring.

2.5. LOST REVENUE RECOVERY MECHANISMS

We were asked to review lost-revenue mechanisms and determine which approach or approaches might be most appropriate for gas efficiency programs in Con Edison's service area. We approached that question by considering the magnitude of the lost revenues in comparison to Con Edison's total revenues (and to the scale of other ratemaking components) and by considering regulatory precedents and practices in setting Con Edison rates.

We examined the existing ratemaking processes for Con Edison, and noted that: (1) Con Edison's rates are usually set for rate plans covering three or four years, (2) the Company has a number of substantial adjustment provisions in its rates, and (3) Con Edison has substantial deferrals of costs and credits. The first point is important in that it limits the extent to which lost revenues can accumulate prior to the next rate case. The other two points establish that either an adjustment or a deferral of lost revenues would be consistent with regulatory practice and expectations.

The analysis of lost revenues suggests that Consoldiated Edison may experience a loss of approximately $150,000 to $200,000 during the life of the pilot program. For the proposed program, lost revenues would likely be very limited, under $100,000, prior to the next rate case, assuming that occurs in November 2007.

In that rate case, and subsequent rate cases, base rates can be set to reflect reduction sales due to the then-planned efficiency programs. If the program spending, effectiveness, and distribution over rates and blocks turn out close to the projection, any net lost revenues would be minimal, and might well be negative. If Con Edison administers the programs, some lost-revenue recovery

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18 This program relies on training and using existing contractors already working with existing home performance. In addition, it piggybacks on existing electric delivery of this program. To substantially increase program activity would likely require both greater funding from the electric sector as well as hiring some turn-key contractors — possibly from outside the service area — to deliver it.

mechanism would still likely be necessary to remove any incentive for Con Edison to reduce or delay savings, or direct them to customers with lower lost revenues. If the programs are administered by NYSERDA or another third party, at funding levels determined by the Public Service Commission, no post-hoc adjustment for lost revenues should be necessary; the effectiveness of the programs is just one more uncertainty in the sales forecast, like economic growth, effects of Federal and state efficiency standards, and the influence of equipment manufacturers and contractors.

3. GAS SALES AND PRICE FORECASTS

3.1. REFERENCE CASE GAS SALES 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 and curves. Unlike other commercially available models for the gas industry, EEA does significant back-casting (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.

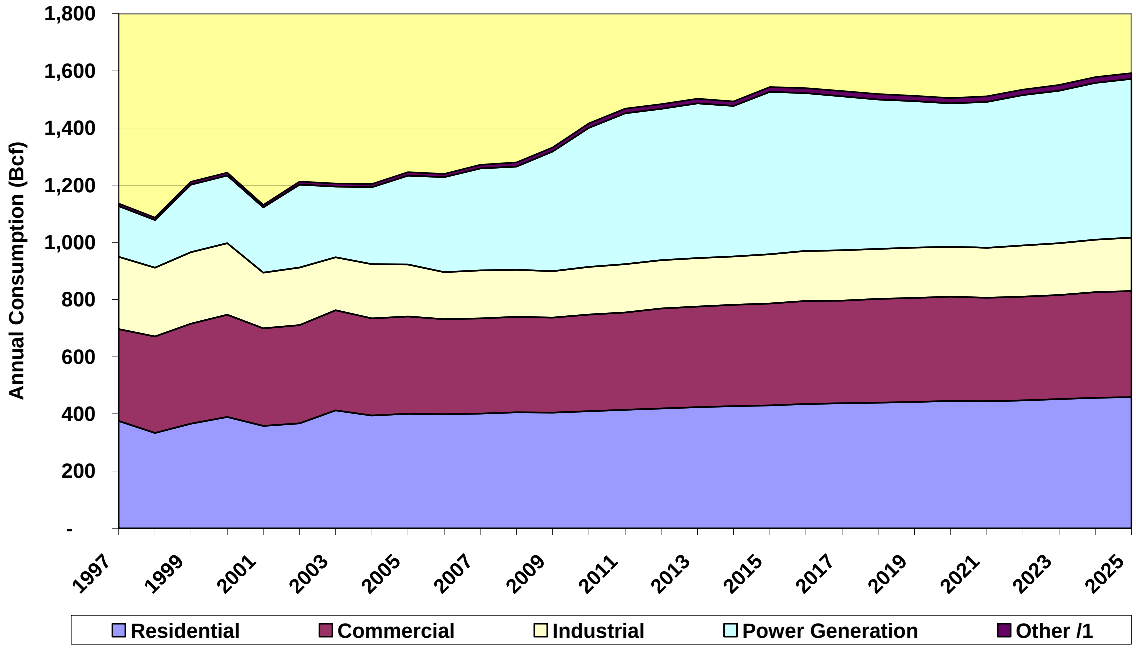
3.1.1. <u>Reference Case Assumptions</u>

EEA developed a reference case forecast specifically for this study of consumption and price based on their July 2005 forecast. This forecast uses EEA default assumptions that imports of liquifed 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 New York State region – particularly into the supply-constrained downstate region. The primary deviation in the reference case from the EEA forecast 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 State's renewable portfolio standard (RPS).

3.1.2. <u>Sales forecast growth by sector.</u>

In the reference case New York State annual gas consumption is forecast to grow by over 500 Bcf by 2025 to 1.7 Tcf as shown in Figure 3.1. The average annual growth rate from 2005-2025 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. 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. Most of this growth in power generation gas consumption occus before 2015. Average annual growth from 2005-2025 in the power sector is estimated to be 4.0%.

Figure 3.1. Projected Growth in N.Y. State Natural Gas Consumption by Market Segment.



Notes: 1. Other includes lease and plant fuel, and fuel consumed in transmission pipeline pumping.

During this period there is modest and steady growth in residential and commercial gas consumption. Average annual 2005-2025 growth is 0.9% and 0.6% for residential and commercial, respectively. However, there is no significant increase in industrial gas consumption (average 2005-2025 annual growth of 0.15%). 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 EEA model divides the State into three regions based on the major pipelines that supply the State as shown in parts of the State. Figure 3.2 shows New York City region (4); Western New York region (5); and Eastern New York (104). Figure 3.3 shows that nearly 60 % of the growth in gas consumption from 2004 to 2025 for New York State is concentrated in New York City and Long Island. This is mainly due to increased consumption in the power generation sector in the area. Gas consumption in the eastern portion of the state is projected to more than double from 2004 to 2025 to 275 Bcf per year. Consumption in Western New York grows, but at a slower pace relative to the other parts of the State.

Figure 3.2. EEA Model Subregions for N.Y. State

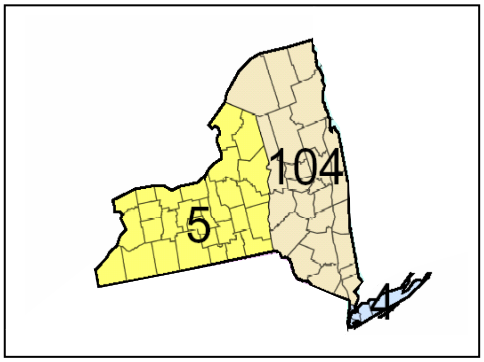
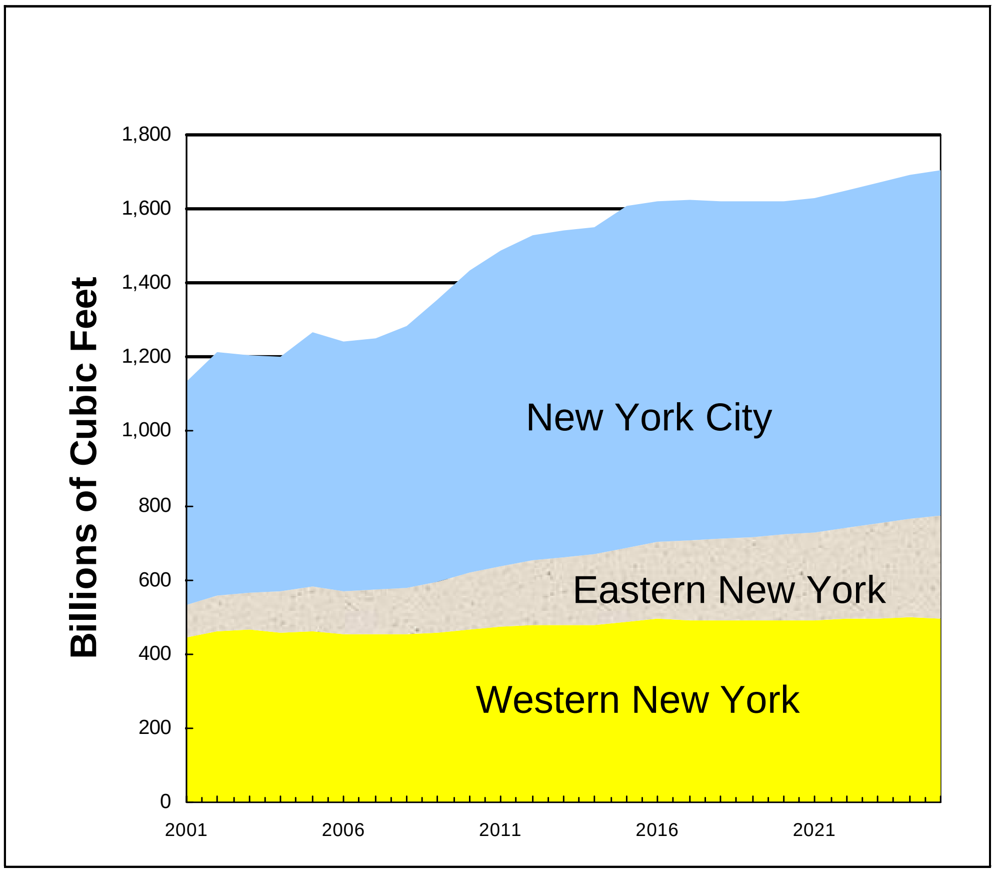


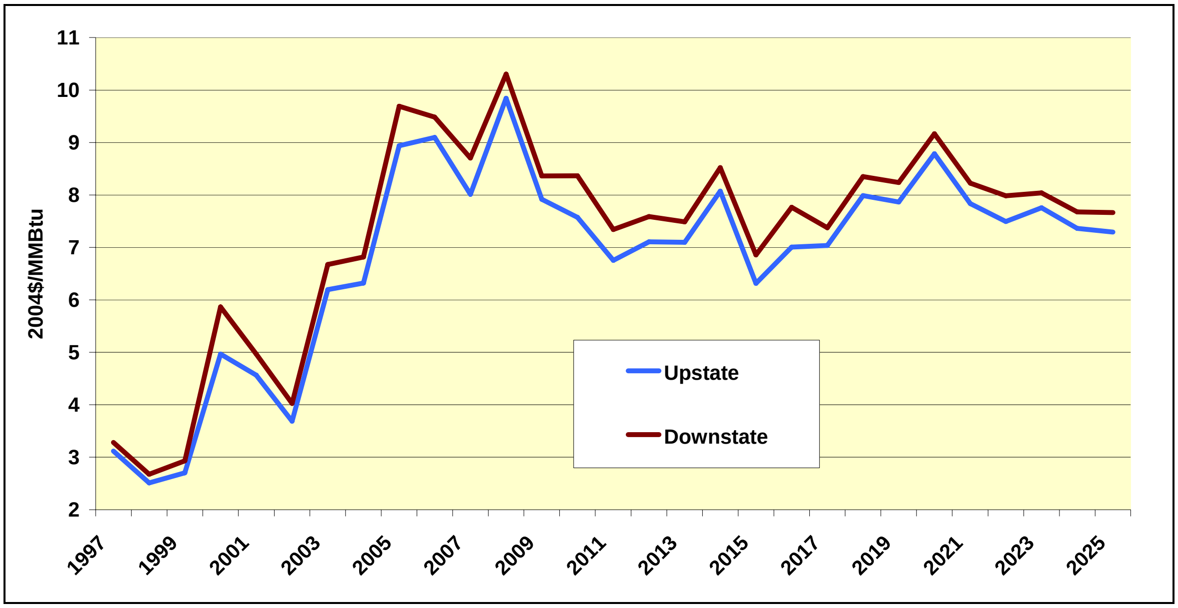
Figure 3.3. Projected Growth in N.Y. State Natural Gas Consumption by Region



3.1.3. <u>Reference Natural Gas Price Forecast</u>

Based on these assumptions and the project consumpton, 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 encompusing the rest of the state as shown in Figure 3.4. These prices reflect the forecasted North American wholesale price as referenced at the Henry Hub in Lousianna 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 3.4. Historical and Reference Forecast Average Annual Wholesale Natural Gas Prices for New York State.



Source: EEA, October 2005

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 signficaintly 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, have 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 longterm 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 volitile, driven by marketwide 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 moritoria regions on the outer continential self. These decisions, along with global oil prices and weather are likely to have greater impact on prices than domestic consumption patterns alone.

3.1.4. <u>Price Effects</u>

As we have seen in recent years, modest increases in natural gas consumption have produced dramatic increases in natural gas prices. This volatility results from a very tight supply situation discussed above. We would anticipate that any plan that reduces demand for natural gas, particularly in a constrained market such as New York, could have an impact on the price of natural gas. In 2003, ACEEE conducted an analysis using the EEA model of the price response to changes in natural gas demand from increased energy efficiency and renewable energy on natural gas prices. The study, along with a subsequent update in 2005, found that modest reductions in demand, even restricted to a single region resulted in disproportately large national wholesale price effects. One scenario in the 2003 study looked at reductions in natural gas consumption in New York resulting from expanded renewable generation. This scenario that reduced state natural gas consumption by about a 9 billion cubic foot produced a modest 0.5% reduction in national wholesale prices and 1.8% reduction in New York City hub prices in year five of the study period. Since the order of maginitude of savings from the Con Edison program scenario was projected to be an order of magnitude smaller than for the New York Renewables Scenario it was felt that the results of a price response run would not produce meaningful results. However, a statewide natural gas efficiency program would likely produce signficant results, so a price response analysis is planned for the scenario of a statewide natural gas efficiency program including the Con Edison program reductions.

3.2. AVOIDED GAS AND OTHER RESOURCE COST FORECASTS

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

- Commodity: The market prices of gas delivered to the city-gate in a normal year
- Peaking capacity: The costs of local capacity to cover the difference between normal and design 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

3.2.1. 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 city-gate (Brock 2005) and computes annual commodity costs for four load shapes (baseload, residential space heating, commercial water heating, and cooling). For weather-sensitive load shapes, the forecast uses data from Central Park weather.

3.2.1.1. Baseload Commodity

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

3.2.1.2. 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, we 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, we 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).[19] For commercial space heating, the balance point would be lower, since interior gain tends to be higher in these larger buildings. While balance point varies from building to building, we assume an average of 50° F. NOAA does not publish long-term average monthly HDDs for base temperatures other than 65° F. Consequently, to calculate the monthly HDD distribution for other temperature bases, we 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 price ratio resulting from the intra-month correlation of price and load, can be thought of as the typical ratio of the heating-load-weighted market price to the average daily

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[19] Con Edison uses a base temperature of 62° F in forecasting sendout. This may be a composite of residential and commercial building response. Use of the 62° base for residential space heating would increase avoided costs, compared to those used in this analysis. Therefore, the analysis is conservative.

price for the month, since the latter is the price forecast by EEA. For this study, the intra-month price ratio was computed for each calendar month using data across the five years, using the Transco New York price.[20]

Equation 1. Intra-Month Heating Price Ratio.

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

The ratios tend to be high in the winter and lower in the shoulder months, and higher with a 50° F balance point than a 65° F balance point. The average ratios, weighted by monthly HDDs, is about 1.08 with a 65° F balance point to about 1.20 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 heating commodity cost is significantly greater than the baseload commodity cost. The residential heating price is 30–60% higher than baseload; the commercial heating price is 80–120% higher than baseload.

3.2.1.3. Water-Heating Commodity

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

3.2.1.4. Cooling Commodity

For gas cooling, we 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 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

[20] For a small number of days, the 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.

and demand charges would be imposed), and with electric cooling covering off-peak periods and supplementing the gas chiller at peak.

The computation of avoided commodity for cooling load mirrors that for space-heating load. Table 3.1 shows avoided commodity costs for Con Edison.

Table 3.1. Avoided Commodity Costs for Con Edison (2005 $/Dth)

	Heating 65°F base	Heating 50°F base	Baseload	Water Heating	Cooling
2006	$12.23	$14.96	$9.79	$10.40	$9.88
2007	$10.53	$12.27	$9.00	$9.38	$8.69
2008	$11.76	$13.03	$10.66	$10.93	$9.55
2009	$11.20	$13.26	$8.64	$9.28	$6.86
2010	$10.67	$12.59	$8.65	$9.15	$7.45
2011	$9.54	$11.57	$7.58	$8.07	$7.33
2012	$9.18	$10.59	$7.85	$8.18	$7.08
2013	$9.42	$11.00	$7.73	$8.15	$6.76
2014	$10.29	$11.78	$8.81	$9.18	$7.92
2015	$9.71	$12.15	$7.08	$7.74	$6.48
2016	$9.86	$11.85	$8.02	$8.48	$7.38
2017	$9.47	$10.93	$7.61	$8.08	$5.92
2018	$9.98	$11.47	$8.63	$8.97	$7.98
2019	$10.34	$12.17	$8.51	$8.96	$7.80
2020	$10.93	$12.56	$9.47	$9.84	$8.74
2021	$10.53	$12.47	$8.49	$9.00	$7.55
2022	$10.01	$11.82	$8.25	$8.69	$7.37
2023	$9.67	$11.09	$8.30	$8.65	$7.50
2024	$9.56	$11.28	$7.93	$8.34	$7.39
2025	$9.59	$11.23	$7.91	$8.33	$6.86

3.2.2. 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 (or design) day.[21] 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. Con Edison uses the latter approach for most of its incremental peaking supply.

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

We have no information on Con Edison's cost of peaking capacity contracts. However, we do have estimates from New York State Gas and Electric (NYSEG).[22] NYSEG estimates a peaking capacity contract cost of approximately $83/Dth-day in year-2000 dollars, or approximately $94/Dth-day based on the cost of its Seneca Lake storage facility.

While New York gas utilities primarily use storage (including contracts) for peaking services, we examined the cost of propane as an alternative estimate of the cost of peaking 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), we estimated that propane-air equipment would cost about $250/Dth-day of capacity for capital costs and $45/year/Dth-day for O&M.[23] Based on other recent estimates by Con Edison, we estimate that real levelized carrying charges, covering depreciation, return, income taxes and property taxes, would be about 10% per annum. That produces a cost of $70/year/Dth-day for typical sites. Given the costs of land in Con Edison's service area, and the special problems of building in that congested region, we assumed a 20% locational adder, bringing the cost to $84/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, we simplified the problem by assuming that peaking capacity is required for the difference between sendout on a design peak day and on the average January day. We assume that the design day was equivalent to the day with the highest number of heating degrees HDD in the period 1995–2004, for which they have daily temperature data. We estimated the peaking cost per Dth of annual sendout as the annual capacity cost times the difference in HDDs between average January day and design day, divided by the annual HDD. Table 3.2 shows the resulting peaking cost in dollars per Dth.

Table 3.2. Peaking Costs

Dollars per Dth (2005 Dollars)	
Space Heating 65°F Base	$0.43
Space Heating 50°F Base	$1.04
Water Heating	$0.11

3.2.3. 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

22 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).

23 The estimate used by NYSEG is much higher, about $1,000/Dth-day. We did not include carrying charges on the inventory of propane at the injection plants.

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, with relatively small increments of load in some times and places requiring expensive upgrades, while other areas may be overbuilt for many years, so load growth has no effect on 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. Con Edison's latest such 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.

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.[24] For baseload, the avoided T&D cost per Dth is the annual cost divided by 365 days.[25] Table 3.3 shows the resulting T&D costs per Dth.

Table 3.3. Transmission and Distribution Costs

Dollars per Dth (2005 dollars)	
Space Heating 65°F Base	$1.56
Space Heating 50°F Base	$2.95
Baseload	$0.36
Water Heating	$0.66

3.2.4. Summary

Total avoided gas costs, in 2005 dollars, are summarized below by year and load shape in Table 3.4.

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24 Again, we used only the 65° F HDD computation for T&D loads.

25 Adding cooling load can impose some very local 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.

Table 3.4. Total Avoided Gas Costs (2005 $/Dth)

Year	Heating 65F base	Heating 50F base	Baseload	Water Heating	Cooling
2006	$14.23	$18.95	$10.14	$11.16	$9.88
2007	$12.52	$16.27	$9.36	$10.15	$8.69
2008	$13.75	$17.02	$11.01	$11.70	$9.55
2009	$13.19	$17.25	$8.99	$10.04	$6.86
2010	$12.66	$16.58	$9.01	$9.92	$7.45
2011	$11.53	$15.56	$7.94	$8.84	$7.33
2012	$11.18	$14.58	$8.20	$8.95	$7.08
2013	$11.41	$15.00	$8.09	$8.92	$6.76
2014	$12.29	$15.77	$9.17	$9.95	$7.92
2015	$11.70	$16.14	$7.43	$8.50	$6.48
2016	$11.85	$15.84	$8.38	$9.25	$7.38
2017	$11.46	$14.92	$7.97	$8.84	$5.92
2018	$11.97	$15.46	$8.98	$9.73	$7.98
2019	$12.33	$16.16	$8.86	$9.73	$7.80
2020	$12.92	$16.55	$9.83	$10.60	$8.74
2021	$12.52	$16.46	$8.85	$9.77	$7.55
2022	$12.00	$15.82	$8.61	$9.46	$7.37
2023	$11.66	$15.08	$8.66	$9.41	$7.50
2024	$11.55	$15.27	$8.29	$9.10	$7.39
2025	$11.58	$15.22	$8.27	$9.10	$6.86
2026	$11.98	$15.68	$8.67	$9.50	$7.45

4. ECONOMIC POTENTIAL

4.1. BASIC METHODS COMMON ACROSS SECTORS

This study analyzed the energy-efficiency potential in the residential, commercial, and industrial sectors for a 10-year period, from 2007 to 2016. This overview summarizes the basic methodology used to assess energy-efficiency potential in all three sectors, focusing on the following common areas of analysis:

- Market segmentation
- Technology and practice selection
- Measure characterization
- Economic analysis

Following this overview, we present more detailed discussion of the analysis and results for the residential, commercial, and industrial sectors.

4.1.1. Market Segmentation

We examined energy-efficiency potential arising in three basic 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 analyze the first two types 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 cost compared to the overall costs of building new homes, buildings, or facilities, or purchasing new products or equipment.

Efficiency retrofit opportunities are discretionary in the sense 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: application of supplemental measures, such as installation of a heat recovery system or early replacement of operational equipment, such as removal of existing inefficient water heaters and replacement with new high-efficiency equipment. Both the residential and the commercial analyses examined efficiency potential in all three efficiency market segments. The industrial analysis, however, 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.[26]

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26 This simplified characterization is necessary for the purpose of this analysis due to the inability to predict each individual site's motivation.

We segmented markets differently in each sector for assessing efficiency potential. The residential analysis segmented markets by building type (single vs. multifamily) and according to new construction, retail, and retrofit. The residential analysis also treated retail products differently because of the unique strategies necessary to influence adoption of these measures. The commercial analysis distinguished between new and existing buildings and between 10 building types, including larger multifamily buildings with central systems.[27]

Due to differences in market structure and data availability, each sector's analysis of savings potential employed a different approach to estimating the size of the underlying population for each market segment examined. The starting point for analysis was the EEA reference case forecast of sector level gas consumption, and existing Con Edison sector-level gas sales. All three sectors supplemented this data with additional public or 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 market characterizations estimated the quantity of existing equipment – or equipment gas usage – by facility type, the likely natural replacements over time, and purchases in 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 combine bottom-up and top-down approaches. From the top, gas usage is disaggregated into each segment, and then further by end use. Bottom-up detailed measure characterizations are then applied to the applicable disaggregated consumption estimates.

4.1.2. Technology and Practice Selection

We developed a comprehensive list of efficiency technologies and practices addressing all end uses, markets and building segments. For each measure we defined both the baseline (or existing stock in the case of retrofit) and efficient alternatives. We analyzed both technologies that are commercially available now and emerging technologies considered likely to become widely available over the next 5-years. Not included were any fuel switching measures or self generation, including combined heat and power. We recognize that these categories likely offer significant additional overall efficiency potential, however, in many cases would result in an increase in gas usage, while reducing electric usage.

The initial measure list was qualitatively screened to eliminate those measures where we believed either: the potential opportunity for efficiency would be very small; the measure was almost certainly non-cost-effective; or efforts to promote the measure through efficiency initiatives was unlikely to offer significant benefits.

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[27] Note, for purposes of reporting, we include all multifamily data within the residential sector for economic potential. Under the program scenario, we include larger multifamily buildings with central systems in the C&I programs, where they would be targeted.

4.1.3. Measure Characterization

For those measures that remained, we 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 lifetime. Individual measure characterizations were done not just on the technology basis, but also by market and building segment, resulting in literally thousands of individual measures analyzed.

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

Savings included not only gas impacts, but also, where appropriate, reductions (or increases) in other resource use, including electric and water consumption. For example, high-efficiency clothes washers often save both electricity and water in homes with electric-fired water heaters.[28] Some commercial building shell and HVAC optimization measures provide substantial electric benefits due to cooling requirements. The application of some technologies or practices, particularly in the industrial sector, often produce other non-resource benefits, such as productivity or product quality improvements. These benefits were not quantified and included in the economic potential assessment.

Measure characterizations were developed using data from numerous places, including prior potential assessments; published research, market assessment and evaluation studies; engineering calculations; and building simulation modeling for commercial HVAC and shell measures. 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 assume no on-going gas programs in Con Edison's service area. They do, however, assume existing electric programs will continue and take into consideration existing and likely future codes and standards.

4.1.3.1. Economic Analysis

Application of the per unit technology costs and savings, and estimated baseline penetrations, to the estimated existing and future market segment sizes yielded the total potential for each measure.

Careful attention was paid to changes in existing stock of equipment and systems over time. 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 market-driven measures. Similarly, major renovation results in replacement of equipment and also alters replacement cycles, both eliminating the

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

opportunity for retrofit measures and reducing natural replacement opportunities. Our model takes 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 economic potential consists of the technical potential remaining after removing those resources with costs (including O&M and other resource costs) in excess of avoided gas costs. In screening for cost-effectiveness, we take careful account of timing impacts that can shift costs or benefits. In the case of early-retirement retrofit for efficiency technologies analyzed in the residential and commercial sectors, the economic potential analysis reflected two important but often-overlooked timing elements:

- The first timing element concerns the reduction in expected savings from early retirement of a measure once the original equipment would have been replaced during the normal replacement cycle. At that point, the baseline shifts from the energy-intensity of the original equipment to that of the new equipment that would have been installed anyway.
- The second timing element has to do with the estimate of incremental costs for early-retirement investments. By interrupting the natural replacement cycle, early retirement permanently postpones the future replacement cycle. The economic potential analysis of energy-efficiency resources explicitly accounts for both the baseline shift and the equipment replacement deferral credit associated with early-retirement efficiency retrofits.

Similarly, where appropriate, we reflect likely changes in baseline market penetrations and efficiency equipment costs over time.

As discussed further below, avoided gas capacity and gas fuel costs were developed from EEA's detailed commodity price forecast for the downstate region and a variety of publicly available data on storage, transmission and distribution capacity costs in the Con Edison service area.

Finally, after removing non-cost-effective measures, we adjust for mutually exclusive and interacting measures. The total economic potential is substantially less than the sum of individual measure impacts considered independently. 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 would not likely do all three. For mutually exclusive measures, we generally give priority to the measure that is the most cost-effective, or provides the greatest customer savings. Based on our 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.

Interactions between measures are also critical to capture. 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 substantial as shown in the supply curve in

Figure 4.1. The economic potential is estimated at 16,281 thousand Dth in 2016, or 23% of forecast residential gas consumption. Peak-day impacts are 160 thousand Dth in 2016. Figure 4.2 and Figure 4.3 show how this potential breaks out by market and end use. Approximately 52.4% of the economic residential gas savings potential is in single-family buildings, with the remainder in multifamily buildings.

Figure 4.1. 2016 Residential Sector Economic Potenital Supply Curve

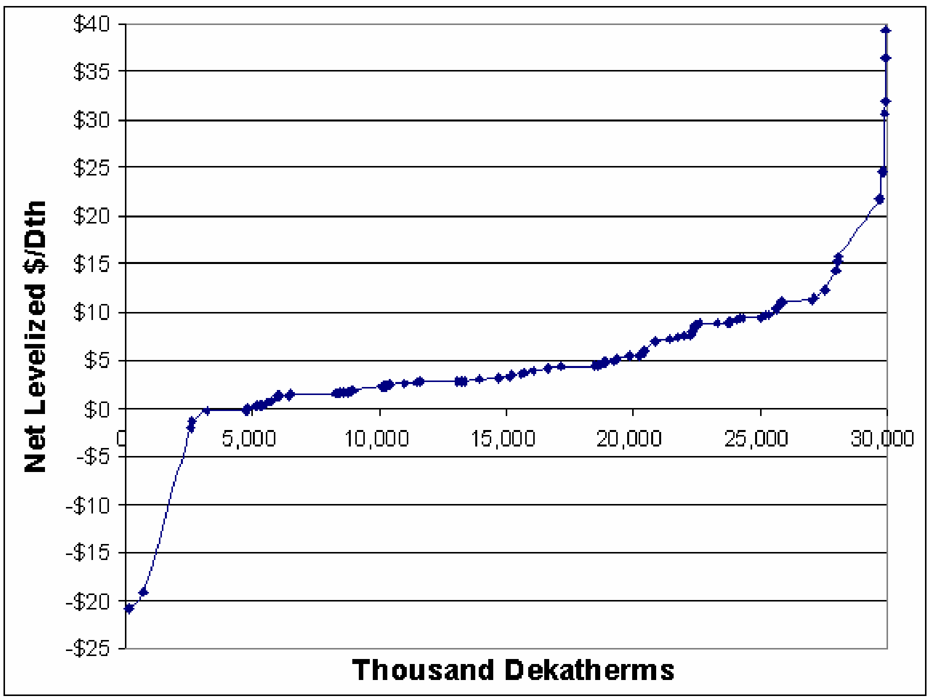


Figure 4.2. Residential Energy Savings by Market.

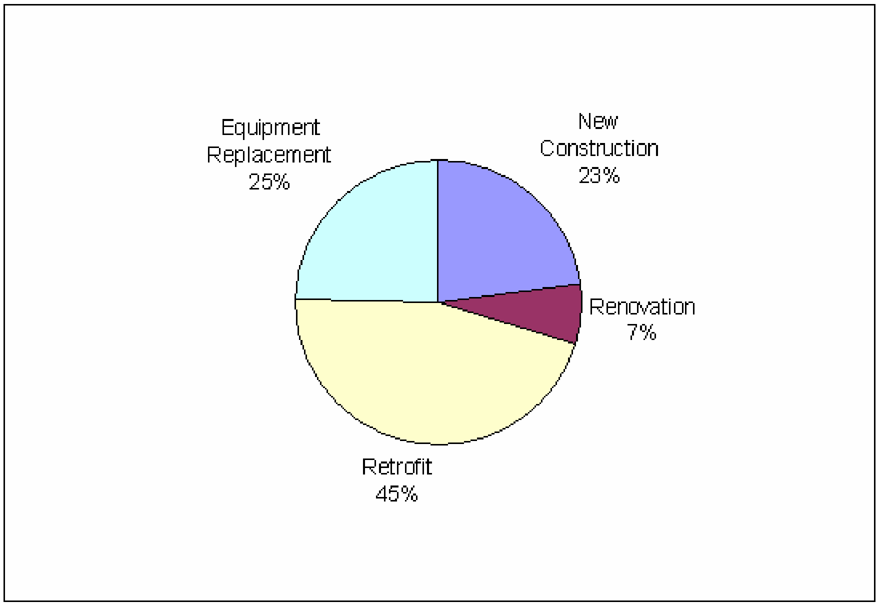
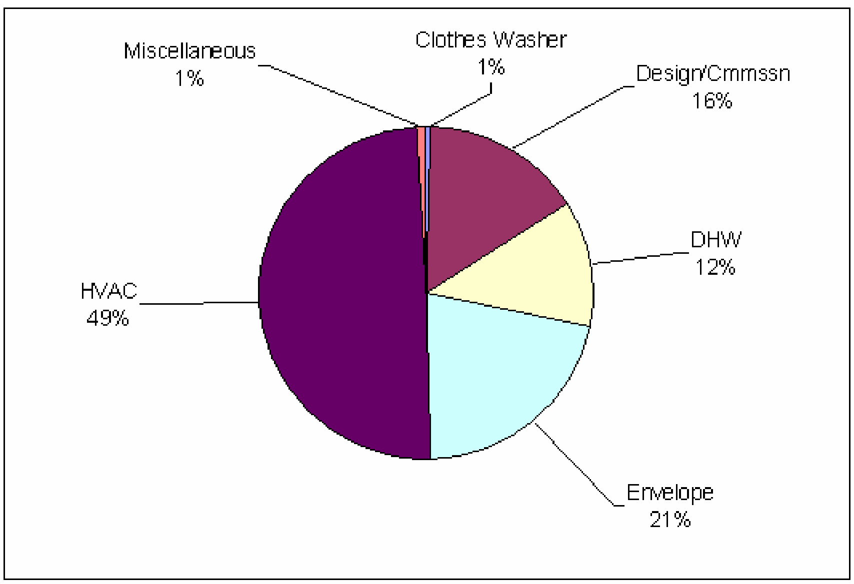


Figure 4.3. Residental Energy Saving by End Use



4.2.2. <u>Analysis Approach</u>

We estimated savings for 34 different efficiency measures for two different buildings types and – in most cases – for four different markets (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, different measure characterizations (life, per unit savings and incremental cost), different eligible markets and different baseline market penetrations were developed.

The residential analysis uses a “bottom-up” approach to estimating savings potential. It generally followed the following steps:

- Development of building and end-use disaggregations of current Con Edison sales
- Development of measure characterizations (per unit savings, per unit incremental costs, measure lives)
- Estimation of the size of the market for each efficiency measure
- Estimation of baseline market penetrations for each efficiency measure
- Calculations of economic potential

Building and end-use disaggregations served as the basis for both per unit savings assumptions and assumptions about the size of most efficiency measure markets – ensuring that our savings estimates were calibrated to Con Edison data. In general, savings potential for each efficiency measure is estimated using the following equation:

Equation 2. Residenital Savings Central Equation

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

What follows is a more detailed explanation of the key components of this approach.

4.2.3. <u>End-use disaggregation</u>

Con Edison provided its 2004 sales data, broken down into more than 130 different rate classifications and sub-classifications. It also provided monthly sales data for 2005 for each of these classifications and sub-classifications. We analyzed these data to first estimate the portion of its sales that are attributable to residential buildings. This included not only sales to what the company labels “residential and religious” but sales to “other public authorities” that are residential type buildings (*e.g.*, public housing authorities). The company’s data also enabled us to estimate how much of its residential sales were to single family (*i.e.*, 1 to 4 unit) buildings and multifamily buildings, as well as the portion of both single family and multifamily sales were to buildings using gas for space heating (versus those using it just for cooking and/or other smaller baseload end uses). Although they did not have specific data on the question, Con Edison staff indicated that they believed most multifamily sales were to buildings with central gas heating systems. Thus, we assumed that over 90% of all multifamily sales were to such buildings.

For both single family and the small number of individually-heated multifamily, we then broke sales down into estimates for different end uses. Those break-downs were baseline largely on data from Con Edison regarding the number of customers in different rate classifications and sub-classifications and data for New York state from the Energy Information Administration’s 2001 Residential Energy Consumption Survey (RECS). We further adjusted the heating component of the end-use disaggregations by adjusting for differences between heating degree days in 2004 and long-term averages. The end-use disaggregation for larger, centrally heated multifamily buildings see the commercial section for a discussion of our approach, and Appendix B for the break-out.

Based on these sources, we estimate that Con Edison serves approximately 925 thousand single-family residential households, with about 230 thousand of those using gas for space heating and water heating, as well as a variety of other end uses. The estimated disaggregation for single-family homes is shown in Table 4.1.

Table 4.1. Estimated End-use disaggregation for Single Family Homes.

Gas End Use	% With End Use	Number with End Use	Avg therms	Wtd Avg therms
Space Heating	25%	230,072	1,133	
Furnace	62%	142,803	1,133	175
Boiler	38%	87,269	1,133	107
Fireplace	5%	41,779	375	17
Water Heating	25%	230,072	179	44
Cooking	100%	925,526	35	35
Drying	35%	323,672	85	30
Pool Heating	1%	9,203	1000	10
				418

These end-use disaggregations serve as the starting point for all estimates of savings potential in the three markets affecting existing buildings: equipment replacement, renovation and retrofit. This ensures that our savings estimates are calibrated to actual Con Edison sales. Estimates of consumption from new construction were developed from sales forecasts for Con Edison. Those consumption estimates were further broken down by building type and end use based largely on historical permit data, information provided by the City of New York, a recent new construction baseline study that we conducted for the Long Island Power Authority, and RECS data.

4.2.4. <u>Measure Characterizations</u>

As noted above, we analyzed 34 different efficiency measures. These are indentified in Table 4.2.

After accounting for adjustments for different building types and different markets, that number grew to approximately 240 measure permutations. Some of the measures are competing measures, such as upgrades from different base levels of insulation.

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 Envelopee 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, we developed an assumption of per unit savings, per unit incremental cost, measure life and the various other characteristics necessary for cost-effectiveness screening. Per unit savings assumptions are all calibrated to the end-use disaggregations. For equipment measures, such as efficient water heating or heating equipment, we assumed baseline consumption would be lower than suggested by the disaggregations to reflect that fact that even a new standard piece of equipment would be more efficient than the old equipment being replaced and upon which the disaggregation was based. In general, savings estimates for efficient equipment were based on engineering calculations, as applied to the adjusted disaggregation consumption estimates. Savings assumptions for thermal envelope measures were also based on engineering estimates, adjusted down by 35% based on years of experience that suggests actual savings are much lower than pure engineering assumptions would suggest. Savings assumptions for various other measures, such as hot water conservation measures, pool covers and programmable thermostats, were based on a variety of different sources including U.S.

Department of Energy documents, NYSERDA program data, the Efficiency Vermont technical reference manual, and our own professional experience and judgement.

Assumptions regarding incremental costs and measure lives also came from a variety of sources. These include cost information from retailers, Technical Support Documents for various U.S. Department of Energy rule-makings on minimum federal efficiency standards, NYSERDA data, the Efficiency Vermont reference manual and our own professional experience and judgement.

4.2.5. <u>Market Size</u>

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, we generally assumed that the number of furnaces, boilers, water heaters, washers or other types of equipment sold each year was 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, we assumed that, each year, between 1% and 2% of all homes would undergo the kind of major renovation that might "open the door" to consideration of significant efficiency upgrades (*i.e.,* kitchen or bath remodels are not likely to lead to consideration of replacing a furnace early or upgrading insulation levels). We then used our professional judgement and experience in the New York area 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, we started with the entire population of residential customers and then adjusted down by (1) eliminating as candidates for early retirment of existing heating, water heating or other equipment all homes who were 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 who were projected to undergo major renovations of the 10-year analysis period; (3) applying "adjustment factors" to reflect the reality that many homes cannot be candidates for some efficiency measures either ecause 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).

The new construction market is the one market for which estimates of the size of the market were not based on the end-use disaggregations for existing homes described above. For this market, we started with EEA's forecast of growth in residential sales. That forecast had embedded in it assumptions regarding declining per household consumption for existing homes. That enabled us to estimate the magnitude of consumption associated with new homes. We 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 data information provided by the

City of New York regarding affordable multifamily housing it expects (*i.e.*, 10,000 units per year for the next decade), we were then able to estimate the fraction of new homes that were single family and multifamily. All new construction served by Con Edison was 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 shown in Appendix B.

4.2.6. Baseline Market Penetrations

A variety of different sources were used to estimate baseline market penetrations. These include industry data, Technical Support Documents for the U.S. Deparment of Energy's rule-makings on equipment efficiency standards, LIPA's residential new construction baseline study and other similar evaluations, and our own professional judgement. We also generally assumed that current baseline market penetrations would grow over time. For example, with respect to purchases of new residential furnaces, we assumed that the baseline market share for condensing (*i.e.,* AFUE of 90% or greater) models was 35%. That is consistent with GAMA data for the state of New York from the mid-1990s through the early 2000s. However, we assumed that market share would increase by 0.5 percentage points each year.

In addition, we looked closely at past and likely future electric efficiency program activity in the Con Edison service area to ensure that our savings estimates did not result in any significant "double-counting" of gas savings that may accrue from electric programs. In the residential sector, two programs in particular warranted examination: Home Performance with ENERGY STAR®, a program addressing retrofit opportunities in existing buildings; and the ENERGY STAR® New Homes program. Based on data available from NYSERDA at the time we of this writing, we estimate that only about ten Con Edison gas heating customers were served by the Home Performance program in 2005. We also estimate that fewer than ten Con Edison gas heated new homes participated in the ENERGY STAR® New Homes program in 2005. NYSERDA estimates that participation in both programs will grow by roughly 15% per year in the New York City region. However, because the starting points are so low, those significant growth rates would not lead to large numbers of Con Edison gas heated participants. Put another way, the effects of future electric efficiency programs on Con Edison residential gas usage is likely to be well within the error band around (and therefore essentially captured by) our baseline market penetrations rates.[29]

4.2.7. Economic Potential Calculations

The economic potential calculations were a conducted by incorporating the various assumptions described above into our cost-effectiveness screening tool. We further entered the assumption that 100% of all measures eligible for installation were installed. After identifying which measures passed screening, we made one additional adjustment for interactive effects. For example, we adjusted down the assumption regarding per unit savings from heating equipment up-grades to

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29 Indeed, if the electric efficiency programs continued as forecasted, they would by themselves (*i.e.,* absent a companion gas efficiency effort) produce only about one-thousandth of one percent of the residential economic gas savings potential we have estimated for Con Edison's service area over our ten year analysis period.

reflect the fact that there were a large number of thermal envelopee and duct efficiency measures that passed screening. Those measures will reduce thermal loads on residential buildings and, therefore, the amount of gas remaining to be saved through equipment upgrades. Similar reductions were made for duct measures (also adjusted for the effects of thermal envelope improvements)[30] and water heating equipment measures (adjusted for effects of efficient clothes washers using less hot water and other hot water conservations measures).

For the economic potential analysis – where we assume that 100% of all cost-effective measures are installed – these adjustments were fairly substantial. Indeed, we reduced heating equipment savings potential by between 8% and 23%, depending building type (single-family reductions were greater) and market (new construction reductions were greater).

Once the adjustments were made, we re-ran our screening tool to finalize estimates of cost-effective savings potential.

4.3. COMMERCIAL SECTOR ANALYSIS

4.3.1. <u>Overview of Results</u>

The savings potential from commercial efficiency measures is substantial as shown the commercial supply curve in Figure 4.4. Figure 4.5 shows how the economic potential is estimated at 15,403 MDth in 2016, or 31% of forecast commerical gas consumption. Peak-day impacts are 141 MDth in 2016. Figure 4.5, Figure 4.6, and Figure 4.7 show how potential breaks out by market, end-use and building segment.

By market, the largest opportunities are in replacement and remodeling, accounting for roughly half of the overall potential. The next biggest opportunities are in retrofit, with about a quarter of the overall economic potential.[31] New construction and major renovation are approximately equal, at about 11% of total potential each.

By building type, the greatest opportunities are in offices and retail, accounting for roughly half of the potential combined. Education, health and restaurant also offer substantial opportunities —

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30 For ease of analysis only (because there were fewer calculational adjustments necessary), we assumed that thermal envelopee measures came first and therefore needed no adjustment. Duct measures were assumed to come second and therefore were adjusted for improvements in thermal envelopee. Heating equipment measures were assumed to come last and therefore were adjusted for improvements to both thermal envelopee and ducts. Such adjustments could have been applied instead to thermal envelope measures. However, it would not have had a significant effect on the ultimate result because all major envelopee, duct and equipment measures would all pass screening even after adjustments.

31 Note, as discussed above in Section 2, if one were to target all retrofit opportunities first in 2007, rather than giving priority to waiting until natural replacement cycles occur over the planning horizon, some of the replacement potential would shift to retrofit, likely resulting in fairly equal shares among these markets.

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.[32]

Figure 4.4. 2016 Commerical Sector Economic Potential Supply Curve

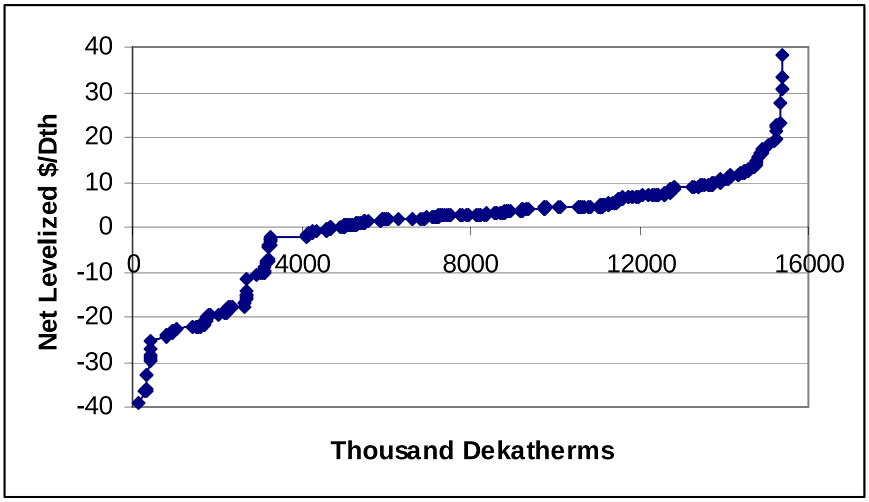
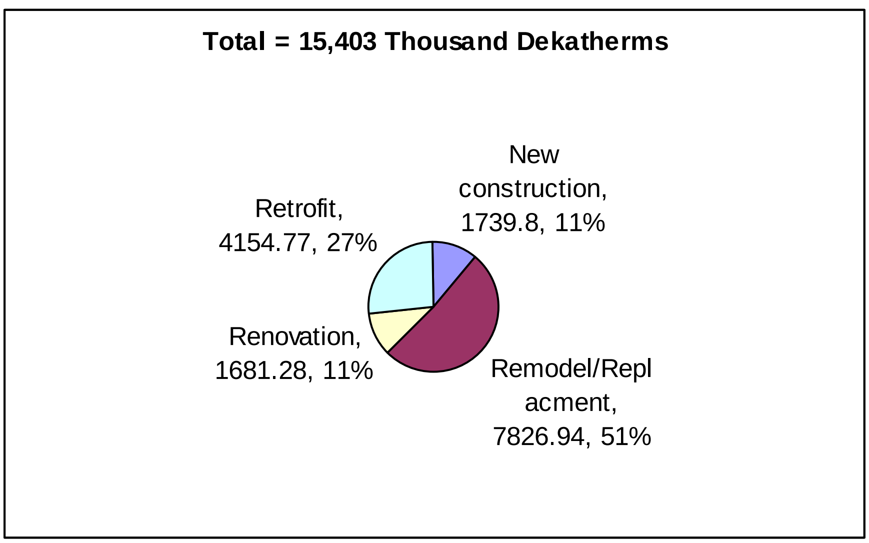


Figure 4.5. 2016 Commercial Savings by Market



32 Note, while larger multifamily buildings with central systems was analyzed based on opportunities from typically commercial measures, and are often treated as commercial gas accounts, we report their savings under residential.

Figure 4.6. 2016 Commercial Savings by End Use

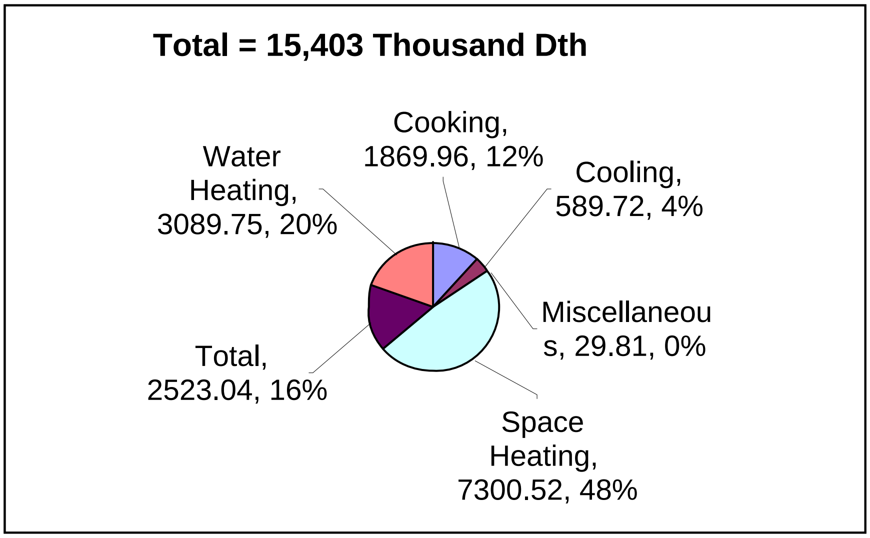
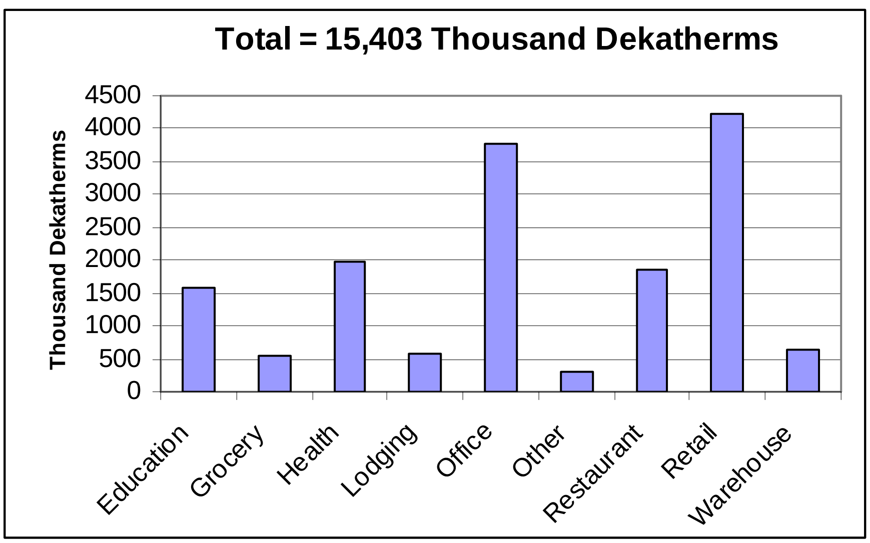


Figure 4.7. 2016 Commercial Savings by Building Type



4.3.2. Analysis Approach

We 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 (which resulted in 980 individual measures), separate measure costs, performance characteristics, and annual penetrations were estimated for baseline, economic, and program potential scenarios.

The commercial analysis uses 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 forecast commercial gas sales. These were then disaggregated by both building type and end use. These disaggregated loads were then further defined in terms of the portion feasibly applicable to each technology in each year for each market. We then multiplied the energy-savings potential for each measure (as a percent of baseline measure gas consumption) by the existing or expected consumption attributable to that measure for each building type to arrive at first-year measure potential. Finally, we apply base-case and economic potential penetrations 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 Central Equation

We applied various technology factors to the forecasted new or 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 simplified central 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 Per Year	X	Applicability Factor	X	Feasibility Factor	X	Turnover Factor (Existing Market-Driven only)	X	Savings Factor	X	Annual Net Penetration (Economic Potential - Base-case)

where:

- **Building End Use Dth Consumption Per Year** is the amount of gas usage in any given year for a given building type that is used 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 level 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 applicable end use that is technically feasible for conversion to the high-efficiency technology. Numbers less than 100% reflect engineering or other technical barriers that would 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, or renovation. This applies only to the renovation and replacement/remodel markets.
- **Savings Fraction** is the percent savings when compared to either existing stock or new baseline equipment for retrofit and market-driven markets, respectively of the high-efficiency technology.
- **Annual Net Penetration** is the difference between the base-case measure penetrations underlying the forecast and the measure penetrations assumed for economic potential.

The Market Segment Characterizations section that follows explains the load-disaggregation approach. The subsequent Measures Analyzed section provides more detail about the measures and markets analyzed and the development of measure-level factors. Detailed measure data are provided in Appendix B. Next, the Base-case Penetrations section describes the approach and major assumptions used to develop base-case measure penetrations. The Measure Interactions section describes the approach to dealing with both mutually exclusive measures and interactions between measures to avoid double counting.

4.3.2.2. Market Segment Characterizations

Current and forecast commercial gas usage constituted the starting point for characterizing the commercial market. We began with the Con Edison commercial 2003 gas sales data.[33] We then applied the EEA modeled forecast of commercial gas consumption for downstate New York to the existing data to develop a multiyear estimate of Con Edisonison commercial gas sales. This was further disaggregated into new and existing construction, based on the EEA exogenous model inputs. Overall commercial gas usage is expected to grow by only about 0.47% per year from 2007-2011 and 0.67% per year from 2012-2016. However, this reflects a higher growth rate for new construction and slightly decreasing consumption for existing buildings. Average annual new construction growth is expected to be approximately 0.8% per year from 2007-2011 and 1.0% per year from 2012-2016. Existing building consumption is estimated to decline approximately 0.3% per year during the full planning horizon. EEA's model relied on a EIA mid-atlantic forecast for commercial new construction activity.

4.3.2.2.1. Building Type Segmentation

Once historical sales were developed, we disaggregated it into ten building types.[34] Data from Con Edison on gas usage by building type was not available. As a result, we started with 1991

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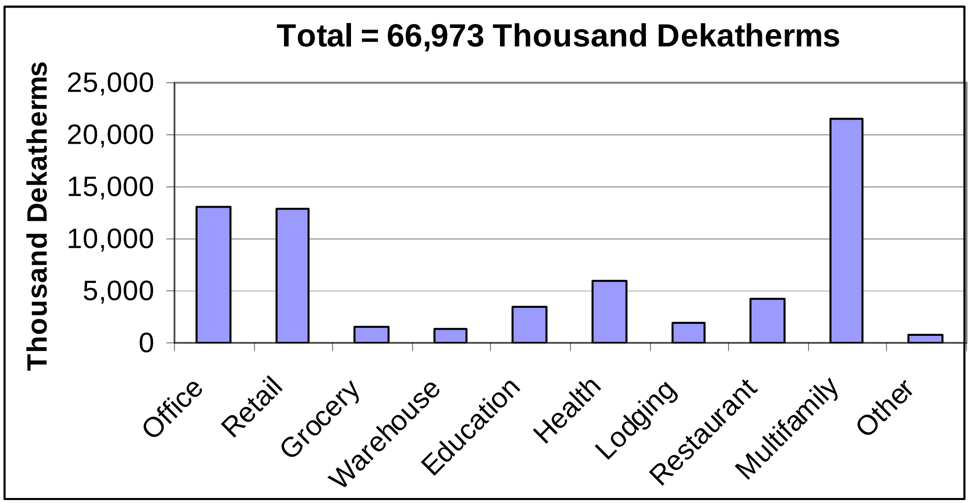
33 Con Edison 2003 Annual Report. Note, at the time the analysis began 2004 data was not yet available. While 2004 data became available from both the NYPSC and Con Edison during the analysis, there were significant inconsitencies in these data sources that were unresolvable, so we relied on the more fully vetted 2003 data.

34 Education, grocery, health, lodging, office, restaurant, retail, warehouse, multifamily and other.

electric disaggregated load in Con Edison service area by building type.[35] Based on average existing building energy intensities per square foot by building type for both electricity and gas, we then estimated the natural gas 1991 consumption by building type. To estimate current year building type gas shares, we relied on economic growth data (business-level GDP) by county from Economy.com.[36] No data on changes to energy intensities (Dth/$GDP) of specific business types and geographic areas were available. As a result, we assumed that energy intensities either remain constant or change in similar ways chronologically for each business type. As a result, we used the GDP growth rates to project annual changes to building-type gas sales. Figure 4.8 shows 2007 gas usage building type segmentation.

Figure 4.8. 2007 Existing Commercial Sales Forecast Disaggregation by Building Type



Larger multifamily buildings with central systems served by Con Edison are on residential rates, and we include their potential under residential results. However, because the gas efficiency opportunities are commercial in nature (*e.g.*,, large central boiler and water heating systems), we analyzed them under the commercial approach, and propose serving them with C&I programs. Existing gas usage for multifamily buildings with central systems was estimated based on Con Edison data.[37].

4.3.2.2.2. <u>End-Use Segmentation</u>

We further disaggregated building-type forecasts into five separate end uses, using end-use energy intensities (Dth/sq. ft.) by building type supplied by Regional Economic Research (RER). These

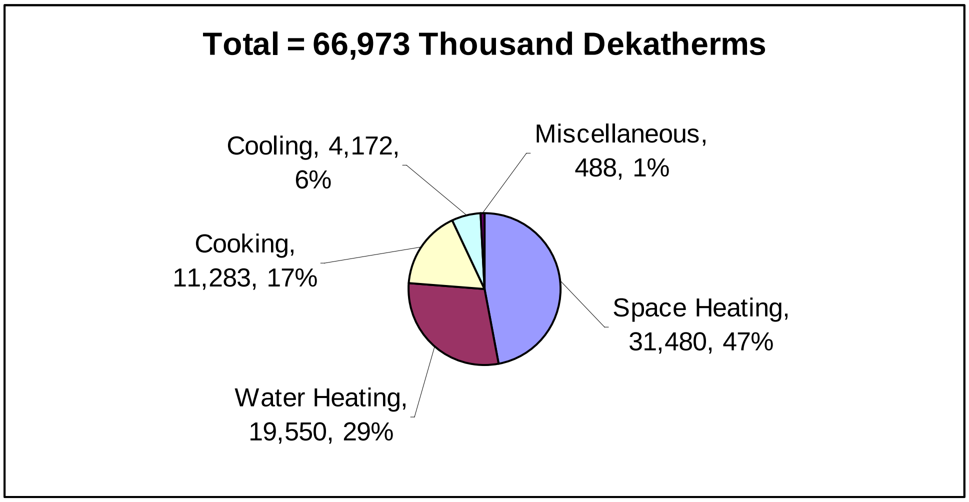
35 Xenergy, Con Edison Electric Efficiency Potential, 1991.

36 Economy.com data for New York City was used.

37 In addition to customers on Con Edison multifamily rates, we assume 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 (on the order of 9,000 housing units per year). As a result, we included these estimates in new construction for multifamily.

are based on RER modeling of a database of thousands of existing commercial facilities audits using New York City's Kennedy Airport weather station. Figure 4.9 shows 2007 estimated existing commercial construction gas usage by end use. Existing and new commercial gas consumption for 2007 and future year growth factors for are provided in Appendix B.

Figure 4.9. 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 rate of existing equipment. The turnover factor is the portion of existing equipment that will be naturally replaced each year due to failure, remodeling, or renovation. Turnover factors for the replacement/remodel market are based on the lives of the equipment measure. The estimated measure lives reflect both engineering service life and estimated remodel activity. In general, turnover factors are assumed to be 1 divided by the measure life. For example, we assume 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.[38] We defined major renovation to be either gut rehab, or complete replacement of HVAC or 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 either on an early retirement (retrofit) basis, at the time of natural replacement, or at the time of renovation or remodeling. To prevent double

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38 NYSERDA, Alternate Commercial Energy Code Standards for New York State, 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. 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.

counting, the model 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 the 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 remains 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 model 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 technology bundles covering space heating, cooling, service water heating, building shell, cooking, whole building (such as commissioning and recommissioning) and miscellaneous (such as pool covers) were analyzed. The analysis included those technologies that 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; retro-commissioning 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 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. Appendix B provides a more detailed list 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

Applicability factors represent the share of end-use level gas usage that is attributable to a particular technology. We drew on a variety of sources to develop applicability factors for each measure by building type. In general, we sought out data on market shares for different types and sizes of technologies, and weighted them 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, we developed separate applicability factors for each building type. Where building type data was not available, we used average data for the total commercial market for all building types. We relied on New York-specific data 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, New Jersey utilities, the Commercial Building Energy Consumption survey (CBECS) developed by EIA, ACEEE, and published market assessments and other potential studies. Appendix B shows applicability factors.

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 not be 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 5-years. Appendix B shows the feasibility factors.

Measure savings factors are calculated based on individual measure data and assumptions about existing stock efficiency (for retrofit measures), standard practice for construction and 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. Appendix B shows the measure savings factors.

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 retrofit construction and equipment and the high-efficiency alternative, which is typically lower. We take this approach because 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 clothes washer purchases. However, the average efficiency of clothes washers existing today in commercial buildings falls short of EPAct levels. We use a Baseline Adjustment Factor to adjust the savings downward in future years for retrofit measures. We assume 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. Appendix B shows the baseline adjustment factors.

Electric and water savings factors were also used to calculate non-gas resource impacts. Appendix B shows electricity (kWh/Dth-yr) and water (gallons/Dth-yr) impacts measures.

Annual to peak-day ratios were used to estimate the measure peak-day impacts. We used 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, and reflects building modeling using Kennedy Airport weather data, based on prototypical buildings developed from a national library of approximately 20,000 existing commercial building audits. Appendix B shows the annual to peak-day ratios.

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. Appendix B shows measure lives.

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, 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 City 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.

We generated measure costs per Dth annual savings ($/Dth) for each building type for each of the 40 technologies analyzed, based on building-type-specific data, and the market applied to. Appendix B shows the measure costs for retrofit and market-driven measures.

O&M cost impacts are consider in addition to measure installation costs. These reflect any incremental effects on operation and maintenance (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. O&M baseline and high-efficiency replacement component lives and costs per Dth saved are shown in Appendix B.

Deferal credits were captured to properly estimate the long-term societal costs of retrofit measures. Related to O&M costs, we accounted 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 10-years is retrofitted with a new, high-efficiency model, the customer no longer has to purchase a new one in 10-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. We recognize this societal value through a "deferral credit." We assume that 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). Appendix B shows the new baseline equipment installed costs used to calculate this "deferal credit."

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. We separately estimated base-case penetrations for each of the 40 technologies. In some cases, we use differing estimates by building-type, 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 EEA 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, we simply assume 5% of existing stock would likely be modified for retrofit reasons over the 10-year planning horizon (equivalent to assuming a 5% freeridership for the economic potential). We separately estimated base-case penetrations for each of the market-driven measures 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. Appendix B shows base-case penetrations.

"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%. Appendix B shows the retrofit not complete factors.

Competing Technologies are accounted for with the economic potential penetrations. For the economic potential, by definition, we assume 100% penetration 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, we first estimated the adoption of the measure offering the highest per-unit savings. 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 we assume 0% penetration of 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, retrocommissioning applies only for retrofit. As a result, the measures that interact with eachother differ for each market. We first rank the measures within a group that interact, typically by end-use. Although some measures, like commissioning, interact with all end uses. This ranking is based on per unit savings, or our 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 effect 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.

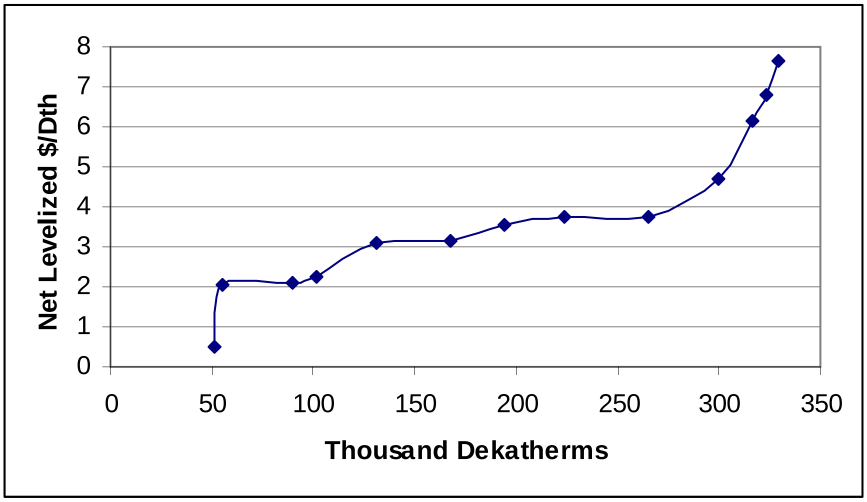
Note that we ignore both competing measure issues and interactions for the program scenario potential estimate. This is because the program scenario is sufficiently lower than likely maximum achievable potential. Consequently, we assume most customers are not pursuing numerous measures at once. Appendix B shows the interaction factors for each market.

4.4. INDUSTRIAL SECTOR ANALYSIS

4.4.1. <u>Overview of Results</u>

Industrial natural gas use in Con Edison is focused primarliy in light manufacturing (such as apparel and metals fabriaction) and food products (such as bakeries and processed meat facilities). We explored an array of 16 nautral gas efficiency measures, with the majority focused on industrial steam and hotwater use – the most important end uses. We found that 13 of these measures were cost-effective in the Con Edison service area for an economic potential of about 300 thousand Dth in 2016 as is shown in the supply curve presented in Figure 4.10. The potential for industrial natural gas savings in the Con Edison service area is less than in residential and commercial because the industrial natural gas use is quite modest.

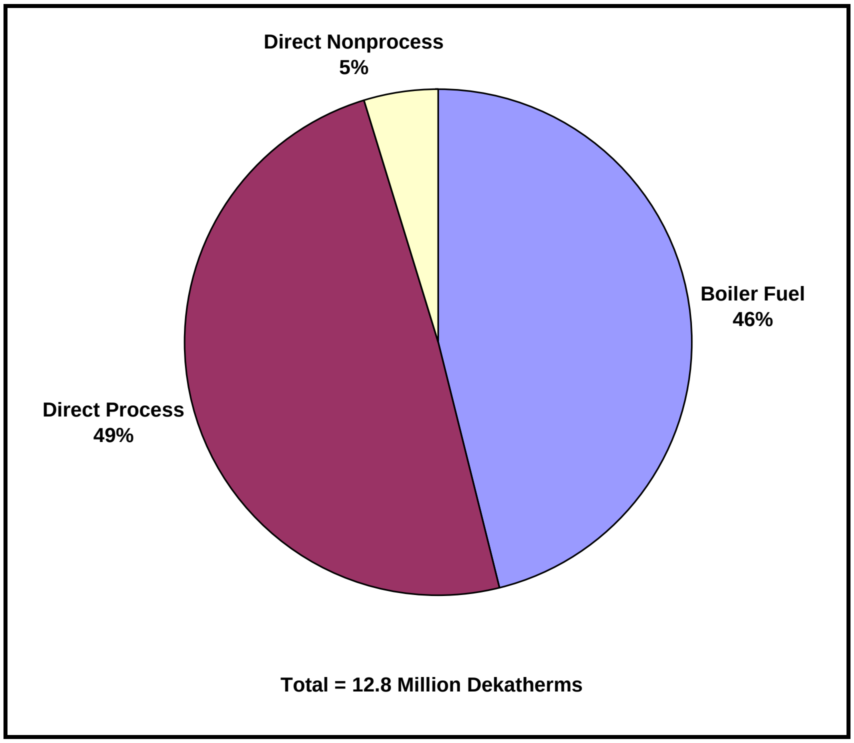
Figure 4.10. 2016 Industiral Sector Economic Potential Supply Curve.



4.4.2. <u>End-use disaggregation</u>

Industrial natural gas use in Con Edison service area can be grouped into three broad catagories, as shown in Figure 4.11, boiler fuel used to produce steam and hotwater that is used in industrial process and for conditioning the industrial buildings; direct processes heating application such as to cooking, baking, melting or drying; and direct nonprocess application which are almost exclusively natural gas fired unit spaceheaters. While direct process application are very site specific, the boiler and direct nonprocess applications cut across industrial, and many commerical facilities as well. As a result of the dominance on boiler related measures, we feel that a focus on the cross cutting applications may be more appropriate than a more segmented individual industry market focused approach as has been commonly used for electricity energy efficiency measures.

Figure 4.11. Disaggregation of Industrial Natural Gas End-Use (2006 projected).



4.4.3. Measures Analyzed

We breakdown the measures considered into three catagories that more or less follow these broad end-use groupings: steam, hotwater, space heating and direct process heating as shown in 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 two years for practice measures to 30-years for large capital measures such as boilers. For the shorted lived measures, we assume that they will need to be reimplemented at regular intervals as the savings depreciate.

In addition to measure life, we present in Table 4.5 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 end use.

Table 4.5. Industrial Natural Gas Energy Efficiency Measures Consider for Analysis[39]

#	End-Use	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 these measures to the industrial end-use catogories and assessing the economic viability of each measure we find that all but three of the measures – improved boiler sensors and controls, water conservation and heat exchanger maintenance – are cost-effective. Thus, we find an economic potential of 337 thousand Dth in 2016. As shown in Figure 4.12, two-thirds of the

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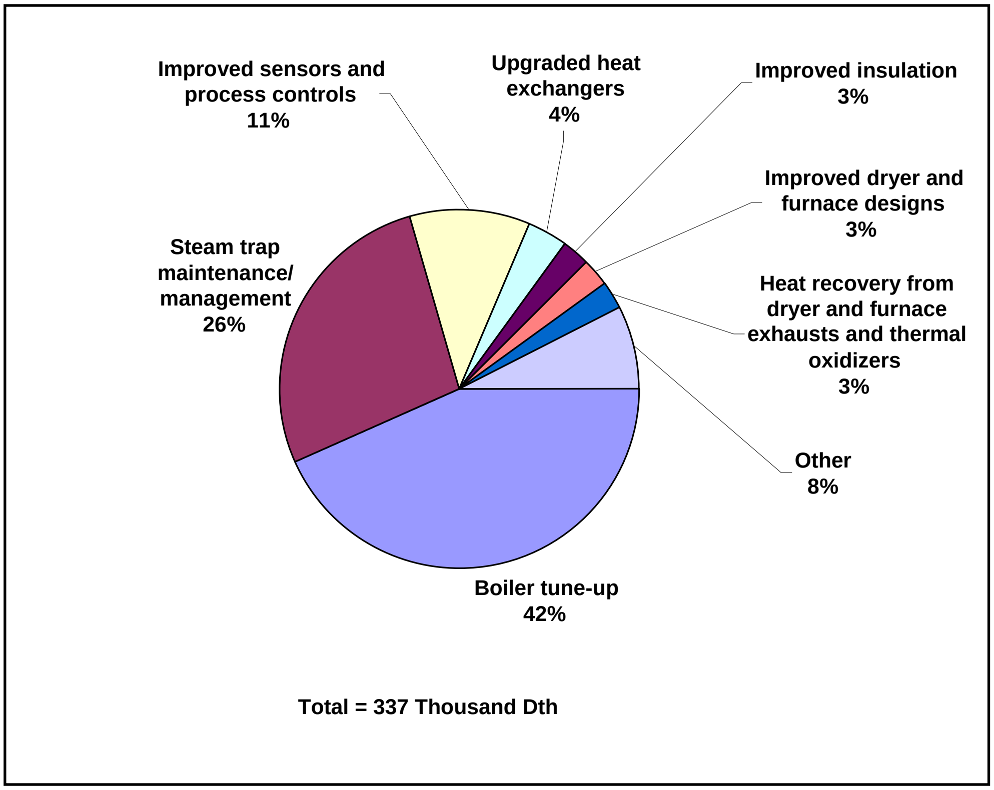
39 While many of the gas efficiency measures are related to gas fired steam boilers, none of this anlaysis relates to Con Edison's steam customers.

economic savings potential exists from the boiler tune-up and steam trap maintenance measures. Improved process sensors and controls offer an additional 11% of the savings, with the balance of the measures offering 4% or less of the total savings.

Figure 4.12. 2016 Industrial Energy Saving by Efficiency Measure.



4.4.4. <u>Market Segmentation</u>

Because of the modest size of the industrial savings potential and their concentration in the boiler area, a steam offering combining these two measures is the most promising area of economic savings opportunity. This focus would build to an existing service market that exist for steam services offered by a wide range of local and national providers. Many such entities are affiliated with the Steam Best Practicies initiative managed by the Alliance to Save Energy on behalf of the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy.

5. PROGRAM SCENARIO

5.1. PROGRAM DESIGN AND DEVELOPMENT

5.1.1. Establishment of Funding Levels

Our analysis of the program scenario potential for Con Edison assumed an average annual energy efficiency budget of $15 million over an assumed five-year program period. That funding level came from guidance provided by NYSERDA who, in consultation with the New York State Department of Public Service staff, concluded that a funding level of 1.1% of 2004 sales revenue would be a reasonable statewide gas energy efficiency funding level for analytical purposes.[40] Based on the PSC summary of average annual bill data, 1.1% of 2004 sales equates to $80 million statewide. The $15 million, assumed for Con Edison, was derived by applying Con Edison's relative proportion of statewide natural gas sales to the $80 million. As explained in Sections 1 and 2, this funding level should not be interpreted as a recommended funding level, and could be adjusted up or down. We provide the program scenario potential analysis to help inform and guide any future decisions about ultimate funding levels and programs.

The $15 million average annual budget was allocated to different sectors – residential, commercial, and industrial – in proportion to the revenues Con Edison receives from each sector.[41] As Table 5.1 shows, the end result was that about 46% of the budget would be focused on residential customers and the remainder on commercial and industrial customers.[42]

Table 5.1. Assumed Energy Efficiency Budget by Sector

Sector	2004 Revenues ($ Millions)	2004 Revenues (%)	Assumed Energy Efficiency Budget ($ Millions)
Residential	$571.0	46.1%	$6.9
Commercial & Industrial	$666.9	53.4%	$8.1
Total	$1,237.9	100.0%	$15.0

In addition, NYSERDA asked us to assume that 20% of the residential program spending would be

40 The New York State electric system benefit charge, as a percent of sales revenues, was 0.76% for SBC1 and 1.31% for SBC2. It is estimated at 1.52% for SBC3.

41 Based on 2004 revenues by rate class that were provided to us directly by Con Edison. In estimating economic potential by sector we include centrally-heated multifamily buildings in the "residential sector". However, for the purpose of estimating the portion of a efficiency budget that would be allocated to the residential sector, we include revenues from centrally-heated multifamily buildings in commercial revenues. This is because the strategies to address such buildings are more consistent with commercial and industrial program designs than residential program designs."

42 Commercial and industrial customers are consolidated here because programs to address commercial customers are also available to industrial customers. However, industrial sales are small – estimated at less than 1% of all Con Edison's revenues.

for low-income customers. That is comparable to the portion of electric SBC funding dedicated to low income customers.[43]

We developed program concepts that would be optimized and analyzed in detail at these spending levels. However, we also provide more qualitative assessments of the differences in program portfolios and savings that would be associated with both lower and higher funding levels.

5.1.2. Development of Program Portfolio

With funding levels established, the next step in estimating program scenario potential was to develop a portoflio of programs to analyze. Our approach to developing the porfolio had four major steps:

- Reviewing exemplary gas energy efficiency programs from across the continent to identify candidate programs for the Con Edison service area
- Reviewing existing electric energy efficiency programs in New York to identify opportunities to leverage current efforts
- Developing both a design philosophy and a set of policy objectives that the portfolio of programs would be designed to collectively meet
- Selecting a mix of programs that – together – balanced simultaneous desires for demonstrated success, leveraging of existing efforts and serving multiple policy objectives

5.1.2.1. Review of Exemplary Gas and New York State Electric Programs

5.1.2.1.1. Background: Exemplary Natural Gas Efficiency Programs

Energy efficiency programs have been offered in various forms for over twenty years. Such programs have taken a wide range of approaches—from efforts that tended just to provide 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. Over the past decade, "market-transformation" programs have been used to make strategic interventions in markets in order to cause fundamental changes in customer choices towards energy-efficient products and services, generally at a statewide or even regional scale. Today's best programs draw upon this rich history of program experience.

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 leading programs that are models worthy of emulation. ACEEE conducted national searches in each of these projects to identify candidate programs. Once ACEEE had identified a set of candidate

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43 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.

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 targeted at electricity savings. It included programs (about 60 total) that addressed all customer sectors (residential, commercial, industrial) and end-uses (lighting, space heating, cooling, appliances, industrial processes, etc.).

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 this project was to provide practical and successful program models for states and utilities to initiate or expand their natural gas energy efficiency efforts. This project provides a rich source of program information from which to develop program proposals and recommendations for the Con Edison service area. 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, from single-family households to large industrial facilities. Below we discuss the characteristics and common traits among this set of exemplary natural gas energy efficiency programs in order to help frame the development of our program recommendations for the Con Edison service area. Our conclusions are similar to those presented in an evaluation recently completed for NYSERDA (Zabetakis 2005).

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

ACEEE 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 (audits, economic/technical analysis of efficiency options, design recommendations, etc.), financial incentives (principally rebates or financing), and follow-up quality assurance and verification of results. The best programs tend to have a single point of contact with customers, who in turn may access other program services and expertise as needed. But the customer may only work 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 ACEEE found that this is a trait of entire portfolios of programs offered by a single organization. Again, the emphasis is on having a single point of contact for program services from the customer's perspective.

Most residential programs have historically tended toward a prescriptive approach to services, including 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 such elements 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 such services as blower door assisted infiltration reduction, duct sealing and insulation, in addition to the traditional key measures of high efficiency furnaces and building shell insulation. In addition to generating deeper savings, such whole house approaches also address health, safety, comfort, durability and other issues that are often critically important to consumers.

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

Programs targeting larger 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 larger customers, who tend to have more complex needs than smaller customers.

Financial incentives are a common feature to affect customer purchase decisions—both for residential and commercial/industrial customers. High efficiency technologies for natural gas applications—furnaces, boilers, process equipment, controls, *etc*—generally still carry a price premium over other technologies. While customers may recognize the long-term value of investing in the more efficient technologies, program experience is that financial incentives are still very helpful in motivating customers to purchase these technologies. This seems to be true across 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 ratcheted upward as "standard" equipment itself becomes more efficient, which may occur through adoption of standards or 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, yielding 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 study offer training and education for suppliers, retailers, and contractors—even for programs primarily offering financial incentives as their key service.

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

Evaluation is also a critical element of successful programs. The programs selected and profiled in ACEEE's study often represent several years of program evolution. The programs have used evaluations to assess performance and make 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 broader program plans. Early in a program's life, the emphasis may be on process evaluation—assessing the quality of services and customer response 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 similar findings. This evaluation identified the following features of successful natural gas energy efficiency programs:

- Strong relationships among contractors, retailers and trade allies
- Strong training program
- Well designed and executed program management and monitoring
- Results-based marketing and promotion
- Consistent delivery of marketing and promotion messages
- Stability of regulatory treatment over time
- Responsiveness to customers and quality of service
- Appropriate incentive levels for both service providers and consumers

5.1.2.1.3. A Model Portfolio of Exemplary Natural Gas Energy Efficiency Programs

In developing recommendations for natural gas energy efficiency programs in New York, we first consider what would comprise a "model portfolio" of natural gas energy efficiency programs. By "model portfolio" we mean a comprehensive set of programs that spans customer markets and principal customer end-uses of natural gas. We develop this portfolio with the perspective that New York is a state with a significant winter heating demand for natural gas as a fuel for space heating of buildings—both residential and commercial.

Three dimensions can be used to define different types of 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—working to address the myriad market barriers that exist for energy-efficient technologies and services. The basis for a model portfolio of programs, therefore, is built on examining the market segments and identifying these barriers.

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

- High first costs
- Lack of familiarity with technology or design practice on the part of architects, engineers, vendors, or contractors
- Lack of awareness, familiarity, or comfort on part of customer of the energy and non-energy benefits of technology or design practice
- Lack of quantification of cash value of energy (and non-energy benefits) as compared the to funding source for the project to determine cash flow impact of energy efficiency technology or design practice
- Design or decision-making sequences or timing that inhibit considering energy efficiency options

While many of these obstacles are present in discretionary retrofit projects, other obstacles include:

- The full cost of project is borne by customer[44]
- Introducing new technology or design practice in a situation where the existing technology is "working" creates risk and uncertainty for the customer
- "Discretionary" retrofit implies its relatively lower level of priority on the part of the customer

The exemplary programs we have identified and profiled have successfully addressed these common barriers. Examination of these leading programs shows that they fall into different

44 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.

categories largely defined according to customer category and market segments, with some possible further designation according to targeted end-use. In looking at these programs, however, we still some areas for improvement. These areas are:

- 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 applications and interaction. 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 similarly be integrated to provide customers and service providers a single, seamless interface with all eligible and applicable programs and services.

As we examine development of program concepts and designs for New York, this emphasis on integration of fuel types, customer applications, program services and program administration serves 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 are available for certain measures. While there is some coverage of natural gas energy efficiency measures, the State's existing programs principally address electric end-uses.

Expanding existing electric programs to include or otherwise expand services that address natural gas end-uses offers a number of potential benefits, which include:

- An established program identity or "brand"
- Established marketing and communication channels
- Customer and service provider experience and familiarity with the programs
- Experienced program staff and/or contractors
- An 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 will participate (many are often simultaneously interested in gas and electric efficiency opportunities)

These advantages can yield program cost savings since some of the 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 as to the desirability of expanding NYSERDA's existing programs to include greater coverage of natural gas energy efficiency options. This 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, we present the major findings from our review of the State's electric efficiency portfolio relative to inclusion of natural gas energy efficiency.

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

The State clearly offers a large 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 readily adaptable to include specific provisions for natural gas energy efficiency, we found a few natural gas market segments that would not readily be captured by merely expanding existing State programs. Before we identify and discuss these market segments, however, we present three key overall principles that we believe 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/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 opportunities through different programs. There may be specific end-uses and technologies for which a very targeted program would be the most appropriate, but the easier it is for customers and service providers to address all potential measures via a single program or contact, the greater the chance the customer will 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 there are significant cost differences between the standard and high-efficiency product.

With these overarching program principles in mind, we next identify the opportunities that exist in New York's existing portfolio of programs that could readily be expanded to address natural gas energy efficiency.

5.1.2.1.5. <u>Residential Programs</u>

5.1.2.1.5.1. Residential Audit/Information Program

No current program of this type is offered by NYSERDA. We do not see this as a deficiency, as audit and information-only programs do not lead to significant levels of energy savings. To achieve such savings requires linkages to programs and services that provide customers sufficient incentives and assistance to implement measures recommended by audits.

5.1.2.1.5.2. 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 do not generally include any kind of financial incentive (such as rebates or discounted financing), although both electric and natural gas appliances and equipment are promoted to residential customers.

In ACEEE's review of exemplary programs, we found that programs to increase sales of high efficiency (>90% AFUE) natural gas furnaces and boilers generally rely on rebates to achieve greater sales. These products still command a price premium that is not readily overcome without such incentives. Perhaps the best example to illustrate this point is provided by comparing the market for natural gas furnaces in Wisconsin and Michigan—two states with similar climates and demographics. Wisconsin natural gas utilities offered rebates on high efficiency furnaces from 1980s into the 1990s. Michigan utilities have not offered such rebates. Wisconsin's natural gas furnace market is "transformed"—high efficiency furnaces are the norm for both new construction and replacement markets (greater than a 90% market share compared to standard efficiency models). In Michigan, meanwhile, standard efficiency furnaces are the norm and high efficiency furnaces remain a small part of the market. Wisconsin's public benefits program, which has replaced utility programs, continues to offer rebates on selected high efficiency furnaces.

5.1.2.1.5.3. Residential High Efficiency Windows Program

NYSERDA offers no program specifically targeting high efficiency windows. However, high efficiency windows are addressed as part of the New York ENERGY STAR® Labeled New Homes Program and the Home Performance with ENERGY STAR® existing homes program.

5.1.2.1.5.4. Residential New Construction Program

NYSERDA's ENERGY STAR® new homes program does not provide incentives to customers to encourage them to include high efficiency natural gas furnaces, water heaters and appliances. While the ENERGY STAR® standards are increasing in 2006, there likely still is room for customers to install natural gas appliances and equipment that offer higher efficiency than the ENERGY STAR® standards. There also will be federal tax credits available for two years, beginning in 2006, for purchase of high efficiency appliances.

5.1.2.1.5.5. Residential Technical Assistance—Multifamily Buildings

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

5.1.2.1.6. <u>Commercial/Industrial Programs</u>

5.1.2.1.6.1. Small Business Program

Program services mostly exist, but through different programs. There is no single "package" of small business services. Because of the extreme and varied market barriers among small business, integration of these varied offerings into a single, simple to use, fuel-neutral service would provide enhanced customer service, service provider participation, economies of scale, and maximize participation.

5.1.2.1.6.2. Commercial Cooking Equipment Program

No specific program is offered by NYSERDA. In theory, this equipment can qualify under the C&I New construction program as custom measures. However, because of the nature of purchases of these devices, a successful effort will require more focus, including upstream marketing and perhaps financial incentives to vendors, distributors and manufacturers, as well as engagement with trade associations.

5.1.2.1.6.3. Commercial/Industrial Building and Equipment Retrofit Programs

NYSERDA doesn't yet offer a full-fledged program specifically targeted to early retirement of existing inefficient equipment such as boilers and furnaces 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 a separate focus on this market with differing trade ally engagement and customer financial incentives.

5.1.2.1.6.4. Industrial Process Efficiency Program

The industrial programs and services 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 opportunity is targeted marketing and program promotion to customers with high potential. Another opportunity is to promote selected high efficiency technologies that are common across 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 into seamless delivery as a single set of services that address all barriers simultaneously, participation and comprehensiveness could be improved.

5.1.2.2. Recommendations and Priorities for Expanding Existing NYSERDA Portfolio

NYSERDA has a large portfolio 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 of New York's electric utility industry. This portfolio of programs provides a solid foundation upon which to expand programs and services to encompass an additional emphasis on natural gas energy efficiency. Many of the existing programs could readily be expanded in this manner. We do not presuppose NYSERDA as a program administrator for gas efficiency programs, and note that LIPA and NYPA also have significant electric efficiency programs. Below we discuss benefits of some sort of centralized administration, regardless of who the administrator is. We use the term NYSERDA here simply because we reference its electric programs. We have two main recommendations to guide the expansion of NYSERDA's existing portfolio.

First, we recommend that the State restructure existing programs to integrate electric and natural gas energy efficiency within a single program offering as a primary step to target and achieve significant levels of natural gas savings.

Second, we recommend that New York consider some targeted natural gas programs or services that address principal natural gas end-uses, such as residential furnaces and commercial/industrial boilers. These targeted efforts might still be structured under the umbrella of existing programs, but there would be specific marketing and possibly incentives to get customers to implement energy efficiency measures. The objective of these targeted efforts would be to reach high numbers of customers quickly and provide services to enable them to make changes quickly in order to achieve significant natural gas savings.

For programs in Con Edison's service area, the NYSERDA programs could be expanded to be available to Con Edison customers, as is being done with selected pilot programs. It also would be possible for Con Edison or a third party to run separate but coordinated programs with those offered by NYSERDA.

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, we believe it is important to have aggressive programs than can reach large numbers of customers quickly and effectively influence energy efficiency improvements in primary natural gas end-uses, such as space heating. As we showed earlier in our review of exemplary programs, there are some excellent examples available. NYSERDA's portfolio 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. The current tight natural gas conditions suggests that this longer-term strategy be complemented with some "rapid deployment" of "high volume" programs and services that can reach large numbers of customers quickly and can have very immediate impacts on their natural gas use and associated costs. This is the primary new opportunity we see in expanding services within the State's existing portfolio of programs.

5.1.2.3. Design Philosophy and Policy Objectives

5.1.2.3.1. Design Philosophy

Our design philosophy has several key components. These include:

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

Both our review of exemplary programs and our own direct experiences with delivering programs in the field and working closely with others who do or manage such delivery suggest that energy efficiency programs are most effective if they are designed around markets for the products or services whose sale they are designed to influence. There are a number of important implications of this approach. To begin with, it suggests that programs usually need to be multifaceted – simultaneously implementing a variety of strategies (financial incentives, outreach to key trade allies, technical training or other technical support, marketing, etc.) necessary to address all 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, we prefer a small number of larger programs that are comprehensive 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, it is important to recognize that key trade allies often provide products or services to multiple markets. To maximize effectiveness, programs must address that complexity. That means that some programs will 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 both residential and small commercial customers. Thus, where it makes sense, we designed programs that cross "sectoral" boundaries just as the market actors they are designed to influence do.

We assumed that gas energy efficiency efforts would be integrated with electric energy efficiency efforts wherever feasible and practical. This assumption acknowledges the realities that many efficiency technologies save both gas and electricity and that many of the 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 as they are the antithesis of "cream-skimming". However, their longer-term pay-offs are often substantially greater. Moreover, we believe their short-term costs 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.

5.1.2.3.2. **Policy Objectives**

Efficiency program portfolios can be designed to address a variety of different 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. We developed a portfolio that strikes a fairly even balance between these three objectives.

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

Our portfolio addressed equity concerns in several ways. Perhaps most important was the decision to allocate funding to the residential, commercial and industrial sectors in proportion to the revenues from those sectors. Also important was the decision to set aside 20% of the residential sector budget for services to low-income customers. Finally, we attempted to develop a portolio that would address as many of the major end uses for as many different building types and sub-markets as possible.

5.1.2.4. **Portfolio Selected for Analysis**

The energy efficiency portfolio that we analyzed for Con Edisonison has seven programs.[45] They are:

- ENERGY STAR® Homes (residential new construction)
- Small Heating & Water Heating Equipment (residential & small commercial equipment sales)
- Home Performance with ENERGY STAR® (residential retrofit)
- Low-income Weatherization (residential retrofit)
- Commercial & Industrial New Construction

45 We recommend programs be delivered statewide if funding for New York gas efficiency programs are established. Under this scenario, we recommend an eighth program, Large Industrial, to address process and high pressure steam/high temperature insulation opportunities. Because Con Edisonison's service area has a very small presence of the types of large industry sectors that would benefit from this program, we have not modeled it here, and it is shown in Table 5.2 because, to the extent statewide programs are established and a large industrial customer of Con Edisonison existed, they could participate.

- Commercial & Industrial Existing Buildings (C&I planned equipment replacement and retrofit)
- Food Service and Processing (commercial kitchens and industrial food processing sectors)

As Table 5.2 shows, these programs collectively address most of the major gas efficiency opportunities for most buildings types. Descriptions of each of these programs are provided in the next section.

Table 5.2. Mapping of Programs to Markets and Technology Opportunties

	Market															
	Residential									Commercial				Industrial		
	Existing Buildings						New Construction			Existing Bldgs		New Constr.				
	Low Income			Non-Low Income			All									
Technology Opportunity	Single Family	Small Multi-Family	Large Multi-Family	Single Family	Small Multi-Family	Large Multi-Family	Single Family	Small Multi-Family	Large Multi-Family	Small	Medium/ Large	Small	Medium/ Large	Small	Medium	Large
Building Shell measures	4	4	6	3	3	6	1	1	5	6	6	5	5	5,6	5,6	8
Heating and DHW equipment, prescriptive	2	2	6	2,3	2	6	1	1	5	2	2,6	2	2,5	2,5,6	2,5,6	8
HVAC and DHW custom measures	4	4	6	3	N/A	6	1	1	5	6	6	5	5	5,6	5,6	8
Low Pressure Steam and Hydronic Systems	N/A	N/A	6	N/A	N/A	6	N/A	N/A	5	6	6	5	5	5,6	5,6	8
Low Temp Insulation	N/A	N/A	6	N/A	N/A	6	N/A	N/A	5	6	6	5	5	5,6	5,6	8
Food service technologies	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7	7	7	7	7	7	N/A
Misc. custom measures	N/A	N/A	6	N/A	N/A	6	N/A	N/A	5	6	6	5	5	5,6	5,6	8
Industrial Process and Custom Measures	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5,6	5,6	8

Programs

1 Residential New construction
2 Small Heating and DHW
3 Home Performance
4 LI Weatherization
5 C&I New construction
6 C&I Existing construction
7 Food Service
8 Large Industrial

Notes:

1 C&I New construction, C&I Existing Construction and Large Industrial programs will use key account managers for selected large customers to package and deliver services.
2 Although its principle target market is single family homes, Home Performance program can treat some small multi-family units as well (if they are owner-occupied).
3 Large multi-family is used as a proxy for buildings with central heating systems.

5.1.3. Program descriptions

5.1.3.1. Residential New Construction

5.1.3.1.1. Overview

The residential new construction program would be an extension or expansion of NYSERDA's current ENERGY STAR® Labeled Homes residential new construction program. 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 have 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 a number of important 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 in Con Edison's service area and greater penetration of important gas efficiency measures

5.1.3.1.2. 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.

5.1.3.1.3. 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, 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 very efficient tankless water heaters (which are not required under the current federal program or discussions regarding the statewide program in 2006).

5.1.3.1.4. Program Strategies

- **Technical assistance**. The program will 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 will provide ENERGY STAR® certification to homes completed to the ENERGY STAR® standard.
- **Financial incentives.** The program will provide incentives to builders (or their home-buyers) for homes constructed to the ENERGY STAR® standard. Initially, we assume the average incentive will be approximately $1000 for single family homes and $750 per multifamily dwelling unit, plus additional incentives for installation of ENERGY STAR® gas heating equipment, efficient gas water heaters (both standard models with EF of 0.63 and more efficient tankless models), super-efficient clothes washers. 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 will 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.

5.1.3.1.5. Joint/Coordinated Delivery

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

Program Budget. This program analysis assumes a budget of approximately $5.0 million in real 2005 dollars, over and above the existing electric program's contributions, for over the five year program period.

5.1.3.2. Small Heating & Water Heating Equipment

5.1.3.2.1. 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, water heaters and clothes washers. 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 market barriers to achieve this goal. Key among these are: (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 key strategies to address these barriers:

- Incentives for the sale or purchase of efficient equipment
- Consumer marketing campaign 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 (*i.e.*, on how to sell efficiency)
- Technical training for contractors on how to install efficient gas heating equipment

5.1.3.2.2. Target Market/Eligibility

The program targets all residential dwellings and small commercial customers (whether existing or new) into which a new gas furnace, gas boiler, rooftop unit, infrared heater, or water heater is installed. We envision furnaces and boilers above about 200,000 BTUh would be addressed under the C&I New and Existing Construction programs. This is because these sizes are larger than those sold in residential markets, and often involve a different set of vendors and contractors. However, the exact cut-off point should be determined by more market research about the current make up of the upstream market actors in Con Edison and surrounding areas. Residential customers buying clothes washers would also be targeted. 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. We envision that customers participating in the other programs (either residential or C&I) would take advantage of this program in a seamless, integrated way through their primary program channel. We recommend a separate program, however, because we believe to effect long-term market-transformation and capture high penetration rates separate upstream strategies for these market actors are necessary.

5.1.3.2.3. 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 ENERGY STAR® standard exists, 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 the State. We envision infrared heating units would be promoted as well as high efficiency unit heaters that meet the forthcoming EPACT standard. The program also promotes standard water heaters 5% to 10% more efficient than the federal standard and tankless water heaters (typically with energy ratings 30% or more greater than the current federal water heater standard). Finally, it promotes the most efficient clothes washers with (*i.e.*, substantially more efficient than even the ENERGY STAR® standard).

5.1.3.2.4. 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.*, approximatley $300 for an ENERGY STAR® furnace or tankless water heater).[46] It offers a rebate of $50 for a super-efficient clothes washer. Incentives may be payable to the consumer, the HVAC contractor or the builder.

- **Consumer Education**. The program will use a variety of vehicles for educating consumers about the benefits of efficient heating and water heating systems. This will include distribution of an educational materials through a website, contractors interested in promoting the program, point of purchase materials in retail stores that sell targeted products (*e.g.*, Sears, Home Depot, Lowe's) and other vehicles. Yellow page ads and other advertising venues would also be considered. Finally, the program will 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 & Training**. The program will include regular meetings with local HVAC distributors and contractors. The purpose of the meetings will be 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 will also include outreach to Sears, Home Depot, Lowe's and other retailers who sell heating equipment, water heating equipment and clothes washers to consumers. Such outreach would include provision of point-of-purchase displays, on-site promotions and other site activities.

5.1.3.2.5. 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. Given these linkages, the program would endeavor to convince as many contractors as possible to go beyond just selling efficient equipment

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46 Tankless water heaters would likely also be eligible for federal tax credits.

and begin to provide whole building treatment of efficiency opportunities as part of the Home Performance program.

Program Budget. The program analysis assumes spending of $16.7 million in real 2005 dollars for the five-year period,.

5.1.3.3. <u>Home Performance with ENERGY STAR®</u>

5.1.3.3.1. <u>Overview</u>

The Residential Home Performance with ENERGY STAR® Program promotes comprehensive retrofit of cost-effective measures, as well as related health and safety improvements, for existing residential housing. Its long-term goal is to transform the home improvement market to optimize energy efficiency while simultaneously ensuring the comfort, safety and well-being of occupants. The program must overcome various market barriers to achieve this goal. Key among these are: (1) consumers' lack of reliable information on the benefits of efficiency-related improvements beyond energy cost savings; (2) specialty contractor "tunnel vision" which limits their interest or understanding regarding impacts of their trades to the building as a whole; (3) lack of contractor skills/tools for diagnosing and selling holistic improvement strategies; (4) higher first costs for comprehensive strategies than for installing limited "piece-meal" measures; and (5) inability of consumers to identify knowledgeable contractors (or for knowledgeable contractors to differentiate themselves in the market).

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

- Technical "building science" training for remodelers, HVAC contractors, insulation contractors and other home improvement contractors
- Promotion of Building Performance Institute (BPI) certification – both to interested contractors (marketing and financial incentives to defray certification costs) and to consumers
- Financial assistance for contractors purchasing necessary diagnostic equipment (*e.g.,* blower doors)
- Rebate of $1000 for improvements projected to achieve at least 25% savings in gas heating energy use when services are provided by a BPI accredited contractor
- Discounted financing for consumers purchasing home improvements from BPI certified contractors
- Consumer marketing on the benefits of a comprehensive approach to efficiency related improvements and the qualifications of BPI certified contractors
- Extensive outreach and marketing of program services to remodelers, HVAC contractors, insulation contractors, and other home improvement contractors
- Sales training for contractors (for example, on how to sell efficiency via solving building performance problems such as moisture-related issues or other indoor air quality problems)

5.1.3.3.2. Target Market/Eligibility

The program targets all existing residential dwellings, but with a focus on home-owners wishing to solve perceived building performance problems or who are remodeling.

5.1.3.3.3. Efficiency Measures/Standards

The program promotes a variety of efficiency measures, focused primarily on thermal envelope (*e.g.*, blower-door guided air sealing, insulation upgrades) and HVAC system (*e.g.*, duct sealing, furnace efficiency upgrades) improvements. BPI standards are used to govern installation practices and strategies.

5.1.3.3.4. Program Strategies

- **Training and Certification**. The program will start by heavily subsidizing technical training on building science issues that affect energy efficiency, comfort, durability, health and safety and other key consumer concerns. The goal of the training will be to enable technicians to obtain BPI certification and their firms to obtain BPI accreditation so that they can sell themselves to consumers as energy efficiency and building science experts. The program will also promote sales training to contractors, to better enable them to explain the multiple benefits of efficiency improvements to their customers.
- **Financial Incentives**. The program will offer substantial financial incentives (rebates plus existing low cost financing) to consumers who invest in home improvements through BPI certified contractors. The program will also provide modest financial incentives to contractors to defray the cost of investing in critical diagnostic equipment (*e.g.*, blower doors).
- **Consumer Education**. The program will use a variety of vehicles for educating consumers about the benefits of a comprehensive approach to retrofits. This will include distribution of an educational brochure through a website, and promotion of BPI-certified contractors and ENERGY STAR® rated products. To minimize cost, the program will consider using existing ENERGY STAR® and Home Performance with ENERGY STAR® publications and promotional material used elsewhere.
- **Contractor Outreach & Training**. The program will include dedicated staff time to recruit residential retrofit contractors to become BPI-certified and to participate in the program. Training also will be provided to interested contractors, as well as financial assistance for diagnostic equipment purchases and certification fees.

5.1.3.3.5. Joint/Coordinated Delivery

Most importantly, the program will be integrated with the existing Home Performance program. Wherever possible, program services will be also integrated with other programs (*e.g.*, outreach to HVAC contractors through the Small Heating and Water Heating, ENERGY STAR Labeled Homes and/or Low-income programs) to maximize effectiveness and eliminate redundancy.

Program Budget, Savings and Cost-Effectiveness. The program analysis assumes a budget of approximately $6.0 million in real 2005 dollars, over and .above the existing electric program's contributions, for the five-year program period.

5.1.3.4. Low-Income Retrofit

5.1.3.4.1. Overview

The Low-income Retrofit program is designed to improve energy affordability for low-income customers. To achieve this objective, it must overcome several market barriers. Key among these are: (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 upgrade efficiency 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.

This program will 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

5.1.3.4.2. Target Market/Eligibility

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

5.1.3.4.3. Efficiency Measures/Standards

All cost-effective efficiency measures will be installed in each home (no cost cap). Cost-effectiveness will 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 (attic, wall, basement, duct, etc.)
- 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 sources.

5.1.3.4.4. Program Strategies

- Customized building efficiency assessments . Each home visited through the program will receive a thorough assessment and identification of all cost-effective efficiency opportunities. Simple field protocols will be used to determine site-specific cost-effectiveness.

- Free direct installation of all cost-effective efficiency measures. There will be no cap on spending per home, as long as all measures are cost-effective.
- Customer education. Each participant will receive advice on options to further reduce energy use through behavioral changes that would not involve significant sacrifices in amenity. Particular emphasis will be placed on discussions of thermostat use.

5.1.3.4.5. Joint/Coordinated Delivery

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

Program Budget. The program analysis assumes a budget of approximately $6.9 million in real 2005 dollars for over the five-year program period.

5.1.3.5. C&I New Construction

5.1.3.5.1. Overview

The C&I new construction program would be an extension or expansion of NYSERDA's current programs targeted at this market. This currently includes the Energy Smart C&I New Construction. It would promote the construction of high performance business facilities, with the long-term goal of transforming markets in which 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, realtors and others); (3) limited technical skills to address key elements of efficiency; (4) instituional 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, realtors and others to differentiate between efficient and standard new buildings.

The program would employ a number of important 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 start of the design phase, and build interest to engage with all relevant market allies throughout the design and construction process
- Technical and design assistance and training to design professionals, vendors, contractors, developers, builders and ultimate building occupants
- Financial incentives to design professionals (to cover incremental design and analysis costs), developers, builders and ultimate occupants to construct high performance buildings. These 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 (*e.g.*, New York City funded affordable multifamily housing construction, where the program administrator would work close with the New York City Department of Housing Preservation and Development).

5.1.3.5.2. <u>Target Market/Eligibility</u>

The program targets all new construction and major renovation of commercial and industrial facilities. Multifamily buildings with central heating systems would also be addressed through this program. Of particular note is 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.

5.1.3.5.3. <u>Efficiency Measures/Standards</u>

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

We envision that the program would promote some standard efficiency measures through standard, or "prescriptive" offerings. These 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 analysis.

5.1.3.5.4. <u>Program Strategies</u>

- **Marketing and outreach.** The program will aggressively identify new construction activity prior to the design phase whenever 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. Where that is not possible, the program would begin engagement with customers after the design phase has already begun, however, this often restricts some options and makes it harder to promote comprehensive and integrated design measures throughout the building.
- **Technical and design assistance**. The program will provide extensive and comprehensive technical and design support to design professionals, developers, builders, contractors, and customers. This will include reviewing designs, recommending design modifications, identifying efficient products and their vendors, providing on-site guidance regarding installation of efficiency measures and other support as needed. Where possible, the program will seek to use existing market professionals, including customer's own design team, to perform analysis in an effort to build awareness and capability.
- **Financial incentives.** The program will provide incentives to customers, and service providers to offset incremental design, analysis and construction costs. We assume incentives would cover 50% of incremental efficiency costs. The program will also integrate EPACT efficiency criteria and incentives where possible. For example, a customer achieving 50% improvement (either whole building or HVAC system) over baseline practices could qualify for federal incentives.

- **Training.** We envision the program would promote market-transformation through training offered to architects, engineers and contractors on various equipment, design and building practices.
- **Commissioning.** The program would promote third party commissioning services to ensure that new buildings actually operate and achieve the efficiency intended.

5.1.3.5.5. Joint/Coordinated Delivery

Program services will be integrated with other programs to maximize effectiveness and eliminate redundancy. In particular, as noted above, it would be integrated with the existing programs serving C&I new construction as well as the Small Heating and Water Heating program.

Program Budget. This program analysis is based on a budget of $11.4 million in real 2005 dollars for the five year program period.

5.1.3.6. C&I Existing Buildings

5.1.3.6.1. Overview

The C&I Existing Buildings program would be an extension or expansion of NYSERDA's current programs targetted at existing C&I facilities. It would promote the installation of high efficiency equipment and systems in existing business facilities (both at the time of planned investments and for discretionary retrofit), with the long-term goal of transforming markets to one in which most consumers and contractors take advantage of currently deployable 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 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 and others); (3) limited technical skills to address key elements of efficiency; (4) perception of risk that efficiency technologies may not perform as expected; and (5) an inordinate 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 all 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 on the technical and financial aspects of efficiency
- Financial incentives to consumers and service providers to offset some of the first costs of efficiency. These would be similar to current incentive offerings for electric efficiency.

5.1.3.6.2. Target Market/Eligibility

The program targets all existing commercial and industrial facilities. Multifamily buildings with central heating systems would also be addressed through this program. The program would address both retrofit and market driven opportunities. We note that in practice there is a continuum from pure discretionary retrofit to pure market-driven opportunities, and that it is often difficult for program administrators to make clean distinctions between them.

5.1.3.6.3. Efficiency Measures/Standards

This program would promote all cost-effective gas efficiency measures, either at the time of planned investment or on a discretionary retrofit basis. Measures would be promoted if they were cost-effective based on all costs and benefits, including electric savings. The integration of gas and electric program efforts 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 fuels benefits. This is particularly true of building shell measures.

We envision that the program would promote some standard efficiency measures through standard, or "prescriptive" offerings. These might include high efficiency heating and hot water systems, and various controls and other measures that are generally cost-effective and whose incremental costs do not vary significantly from one building to another. All other cost-effective opportunities would be promoted as "custom" measures, based on site-specific analysis.

5.1.3.6.4. Program Strategies

- **Marketing and outreach.** The program will aggressively market to customers and other relevant market allies, including vendors, contractors and designers. A key strategy for larger commercial and industrial customers will be "key customer representatives" who build long term relationships with these customers. Because it is often difficult to time intervention at the moment that a customer is planning an investment, building long term relationships is critical to success in this market. For those larger commercial and industrial customers, the goal is to have them engage with the program administrators whenever opportunities are investigated. The program will 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 will provide extensive and comprehensive technical assistance to consumers, contractors and designers/specifiers. This will include reviewing specifications, recommending modifications, identifying efficient products and their vendors, providing on-site guidance regarding installation of efficiency measures and other support as needed.
- **Financial incentives.** The program will provide incentives to customers, and service providers to offset incremental design, analysis and construction costs. For our analysis we assume incentives would cover 50% of incremental efficiency costs for market-driven measures and 25% of full installed cost for retrofit measures. The program will also integrate EPACT efficiency criteria and incentives, where possible. For example, a customer achieving 50% improvement (either whole building or HVAC system) over baseline practices could qualify for federal incentives.

5.1.3.6.5. Joint/Coordinated Delivery

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

Program Budget. This program analysis is based on a budget of $25.3 million in real 2005 dollars for the five year program period.

5.1.3.7. Food Service and Processing

5.1.3.7.1. 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; and (5) 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
- Possbile point of purchase and cooperative advertising with equipment vendors

5.1.3.7.2. 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, etc.), as well as small industrial food processors (such as bakeries). We envision that 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. We recommend a separate program, however, because we believe to effect long-term market-transformation and capture high penetration rates separate upstream strategies for these market actors are necessary, particularly since many food service equipment are purchased and installed directly by consumers through retail channels.

5.1.3.7.3. 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).

5.1.3.7.4. Program Strategies

- **Incentives**. The program will 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 through an upstream "buydown" approach, depending on the product and its market supply channel.
- **Consumer Education**. The program will use a variety of vehicles for educating consumers about the benefits of efficient equipment. This will 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 will explore options for marketing partnerships with manufacturers, distributors, and retailers that leverage marketing dollars by requiring industry contributions.
- **Distributor**, Vendor and Retailer Outreach & Training. The program will include dedicated staff time for regular meetings with distributors, vendors and retailers. The purpose of the meetings will 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 will 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.

5.1.3.7.5. 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.

Program Budget. The program analysis is based on a budget of $3.6 million in real 2005 dollars for the 5-year period.

5.1.4. 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 will be installed in each year; (2) market effects – both the fraction of program penetration rates that will 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 will persist and produce savings in the five years following the end of the program;[47] and (3) program budgets. Each of these is discussed further below.

5.1.4.1. 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, we are 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. We believe that 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, in this analysis, we 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.

For example, our 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 we analyzed for the Con Edison service area. 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, we assumed that level could be reached in Con Edison's service area after 3 to 5-years of program implementation. We estimate 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. We separately estimate penetrations for each measure, based both on other program experience, our understanding of the particular markets and market barriers, and expectations about future codes and standards. Appendix A and B provides 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.

5.1.4.2. Market Effects

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

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47 Market-transformation effects can often be expected to persist more than five years after the end of a program. However, our analysis was limited to a 10-year period, five with programs and five following without.

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 – because the customer did not want them for other reasons).

In developing assumptions about such spillover effects, we carefully considered results of evaluations of NYSERDA's programs as well as those of others in other jurisdictions. For example, in the case of the Home Performance program, we used the 44% spillover rate that was estimated by Summit Blue's evaluation of NYSERDA's program.[48] With respect to spillover associated with incentives for clothes washers, we assumed 50%, which is approximately the value found in recent evaluations of the same incentive offering from Efficiency Vermont. In other cases where there were no directly analogous programs with evaluations of spillover, we used judgement 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 we do 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.

5.1.4.3. Program Budgets

Our estimated program budgets are partly a function of assumed in-program penetration rates because significant portions of most program budgets are variable. 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. We estimated other components of program budgets – including costs associated with program management, marketing, outreach to and training of trade allies, and

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48 We also assumed the 17% free rider rate that came from the same evaluation so that the net-to-gross ratio is the same as estimated by Summit Blue.

evaluation – based on our 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 in Con Edison's service area and the service territories of other programs with which we are familiar. We did not explicitly attempt to adjust for such differences because we did not think it would have a significant affect on the bottom line results of our analysis (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 our analysis did assume, in several cases, integration with existing electric energy efficiency programs. For example, in the ENERGY STAR® Labeled New Homes program, we assumed that Con Edison would be able to add onto existing incentive offers rather than cover the full incentive cost of the design we analyzed itself.

5.1.4.4. <u>An Iterative Process</u>

Because a significant portion of most program budgets is dependent on assumed penetration rates, development of savings estimates is necessarily a somewhat 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 available (an average of $15 million per year in the case of our Con Edison analysis). This initial analysis could theoretically produce spending levels that are dramatically different from the available portfolio budget (or its sectoral allocations), necessitating revisions to the portfolio. However, that was not the case for this analysis. Put another way, we were able to make only relatively minor refinements to penetration rates and budget line items to get the budget to "line up" with the average of $15 million per year (with the attendant sector allocations discussed above) that was deemed available for the purpose of our analysis.

5.2. PROGRAM SCENARIO POTENTIAL RESULTS

Table 5.3 and Table 5.4 present the incremental annual and cumulative annual gas savings and peak-day gas savings, by program, estimated from pursuit of the program scenario. The cumulative annual gas savings in 2011, the fifth and final year assumed for program activity, represents approximately 0.8% of total forecast gas sales in that year. The cumulative annual gas savings in 2016 – after another five years of post-program effects – represents approximately 1.3% of total forecast sales in that year. Figure 5.1 shows 2016 energy savings by program.

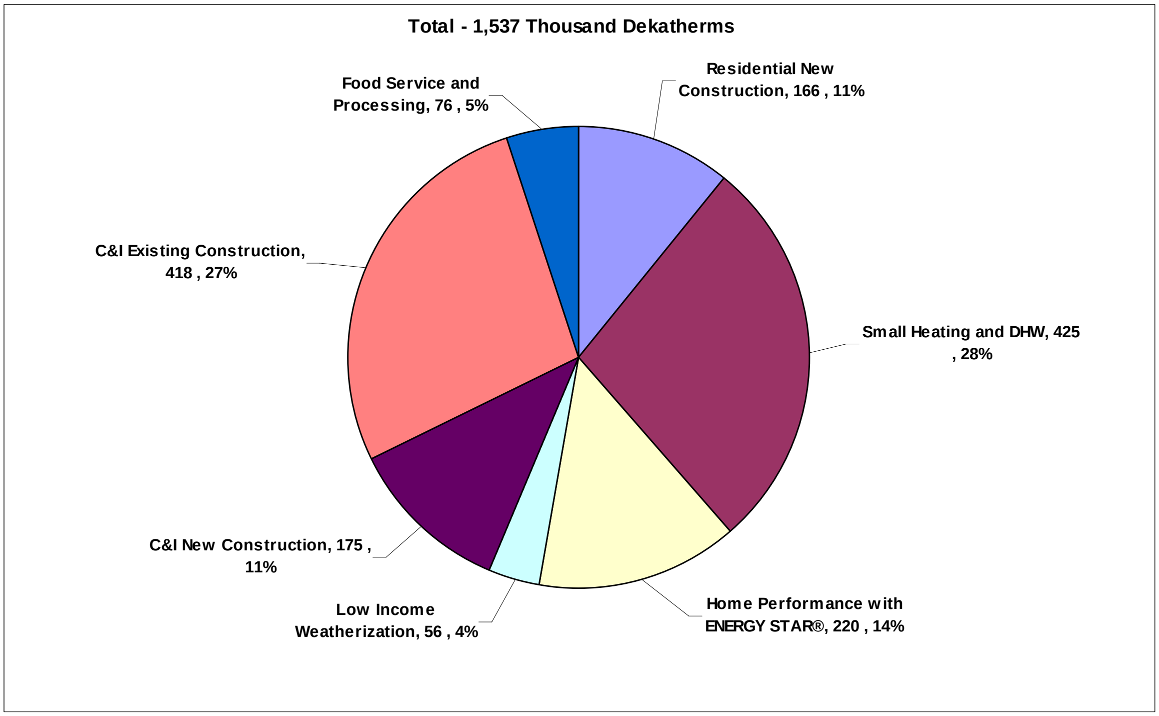
Table 5.3. Annual Energy Savings by Program

	Annual (Thousand Dtherms/yr)										Lifetime Savings (Thousand Decatherms)
Incremental annual	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	
Residential New construction	6	13	21	25	30	13	14	14	15	16	
Small Heating and DHW	22	40	51	61	71	34	35	36	37	38	
Home Performance with ENERGY STAR®	7	14	21	24	26	26	26	26	26	26	
Low Income Weatherization	12	12	12	12	12	-	-	-	-	-	
C&I New construction	6	11	18	25	32	14	16	18	20	22	
C&I Existing construction	32	52	81	100	130	36	41	45	49	54	
Food Service and Processing	3	5	8	11	15	7	8	8	9	9	
Total Programs	**86**	**147**	**212**	**259**	**314**	**130**	**138**	**147**	**155**	**164**	
Cumulative annual	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	
Residential New construction	6	19	40	65	95	108	122	136	151	166	3,579
Small Heating and DHW	22	62	113	175	245	280	315	351	388	425	8,153
Home Performance with ENERGY STAR®	7	20	42	66	92	117	143	168	194	220	4,275
Low Income Weatherization	11	22	34	45	56	56	56	56	56	56	973
C&I New construction	6	17	35	59	91	104	119	136	154	175	3,694
C&I Existing construction	32	84	151	234	334	338	339	365	391	418	6,455
Food Service and Processing	3	8	15	27	41	48	56	64	71	76	736
Total Programs	**86**	**232**	**430**	**671**	**954**	**1,051**	**1,149**	**1,276**	**1,405**	**1,537**	**27,865**

Table 5.4. Peak Day Savings by Program

	Peak Day (Thousand Dtherms/yr)									
Incremental annual	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New Construction	0.0	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1
Small Heating and DHW	0.1	0.2	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2
Home Performance with ENERGY STAR®	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2
Low Income Weatherization	0.1	0.1	0.1	0.1	0.1	-	-	-	-	-
C&I New Construction	0.1	0.2	0.2	0.3	0.4	0.2	0.2	0.2	0.3	0.3
C&I Existing Construction	0.3	0.5	0.7	1.0	1.3	0.3	0.4	0.4	0.5	0.5
Food Service and Processing	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Total Programs	**0.6**	**1.1**	**1.6**	**2.0**	**2.5**	**0.9**	**1.0**	**1.1**	**1.2**	**1.3**
Cumulative annual	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New Construction	0.0	0.1	0.2	0.4	0.5	0.6	0.7	0.8	0.9	1.0
Small Heating and DHW	0.1	0.3	0.6	0.9	1.2	1.4	1.6	1.7	1.9	2.1
Home Performance with ENERGY STAR®	0.0	0.1	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.3
Low Income Weatherization	0.1	0.1	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3
C&I New Construction	0.1	0.2	0.5	0.8	1.2	1.4	1.6	1.8	2.1	2.3
C&I Existing Construction	0.3	0.8	1.4	2.3	3.4	3.5	3.6	3.9	4.1	4.4
Food Service and Processing	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3
Total Programs	**0.6**	**1.7**	**3.2**	**5.1**	**7.4**	**8.1**	**8.9**	**9.8**	**10.8**	**11.8**

Figure 5.1. 2016 Energy Savings by Program



As Table 5.5 and Table 5.6 show, over the full analysis period, all of the programs that we analyzed are estimated to be highly cost-effective. Benefit-cost ratios for 2016 range from 1.57 to 2.73, with an average of 2.13. That translates to net economic benefits of approximately $122 million for the entire portfolio. The average levelized cost per therm saved from 2016 cumulative saving is estimated to be $5.60/Dth.

Table 5.5. Total Resource Net Benefits and Benefit-Cost Ratios

	Total Resource Net Benefits $ (Million)									
Cumulative net benefits (benefits minus costs, present worth 2005)	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New construction	0	1	3	5	7	9	10	11	12	14
Small Heating and DHW	1	4	7	10	15	17	19	21	24	26
Home Performance with ENERGY STAR®	0	1	2	4	5	7	9	11	13	14
Low Income Weatherization	1	1	2	3	3	3	3	3	3	3
C&I New construction	0	2	4	7	10	12	15	17	20	22
C&I Existing construction	1	4	10	17	27	29	32	35	38	41
Food Service and Processing	(0)	(0)	(0)	0	1	1	1	2	2	2
Total Programs	**4**	**13**	**28**	**46**	**68**	**78**	**89**	**100**	**111**	**122**
Cumulative benefit/cost ratio 2005	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New construction	1.48	1.64	1.83	1.87	1.92	2.00	2.06	2.12	2.17	2.22
Small Heating and DHW	1.41	1.52	1.59	1.63	1.65	1.69	1.73	1.76	1.78	1.80
Home Performance with ENERGY STAR®	1.05	1.24	1.46	1.57	1.66	1.76	1.84	1.89	1.94	1.97
Low Income Weatherization	1.66	1.58	1.60	1.57	1.57	1.57	1.57	1.57	1.57	1.57
C&I New construction	1.45	1.57	1.70	1.81	1.87	1.96	2.04	2.12	2.19	2.25
C&I Existing construction	1.43	1.77	2.08	2.28	2.44	2.50	2.56	2.62	2.67	2.73
Food Service and Processing	0.54	0.71	0.92	1.08	1.21	1.33	1.44	1.54	1.64	1.73
Total Programs	**1.38**	**1.54**	**1.71**	**1.81**	**1.89**	**1.94**	**2.00**	**2.04**	**2.09**	**2.13**

Table 5.6. Levelized Cost of Saved Energy

	Total Resource Levelized Cost Per Saved Dekatherm $/Dth									
Cumulative	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential New construction	7.89	6.91	6.00	5.83	5.58	5.31	5.09	4.90	4.74	4.60
Small Heating and DHW	9.55	8.74	8.25	8.01	7.79	7.61	7.47	7.35	7.24	7.16
Home Performance with ENERGY STAR®	11.65	9.65	8.02	7.30	6.85	6.36	6.05	5.83	5.67	5.54
Low Income Weatherization	8.76	9.15	9.02	9.13	9.13	9.13	9.13	9.13	9.13	9.13
C&I New construction	9.16	7.85	6.81	6.00	5.59	5.08	4.64	4.25	3.91	3.62
C&I Existing construction	13.09	9.92	7.88	6.80	6.04	5.73	5.42	5.14	4.87	4.63
Food Service and Processing	23.48	17.68	13.40	11.15	9.83	8.85	8.09	7.49	7.01	6.60
Total Programs	**10.46**	**9.04**	**7.89**	**7.30**	**6.85**	**6.53**	**6.25**	**6.00**	**5.79**	**5.60**

These savings would, in turn, produce significant reductions in emissions of various pollutants. As Table 5.6 shows, lifetime reductions of 1.9 million metrric tons of CO_2, 481 metric tons of SO_2 and 247 metric tons of NO_x would result from the portfolio.

Table 5.7. Emissions Reductions Associated with Projected Gas Savings.

	Emissions Reductions										
Cumulative Annual CO_2 (metric tons)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Lifetime Reductions
Residential New Construction	373	1,184	2,518	4,122	5,991	6,794	7,642	8,537	9,477	10,461	222,840
Small Heating and DHW	1,414	3,951	7,178	11,012	15,426	17,500	19,617	21,776	23,978	26,222	482,513
Home Performance with ENERGY STAR®	391	1,220	2,482	3,938	5,465	6,992	8,518	10,045	11,571	13,098	255,450
Low-income Weatherization	656	1,311	1,967	2,623	3,278	3,278	3,278	3,278	3,278	3,278	56,984
C&I New Construction	552	1,674	3,407	5,801	8,875	10,100	11,507	13,088	14,822	16,714	364,765
C&I Existing construction	2,234	6,114	11,418	18,114	26,557	27,181	27,859	29,558	30,996	32,163	453,370
Food Service and Processing	139	416	851	1,471	2,280	2,663	3,065	3,526	3,903	4,197	41,949
Total Programs	**5,758**	**15,870**	**29,821**	**47,081**	**67,872**	**74,507**	**81,487**	**89,808**	**98,025**	**106,134**	**1,877,870**
Cumulative Annual SO_2 (metric tons)	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	
Residential New Construction	0	0	0	1	1	1	1	2	2	2	38
Small Heating and DHW	0	1	1	2	3	3	3	4	4	4	56
Home Performance with ENERGY STAR®	0	0	0	0	1	1	1	1	1	2	32
Low-income Weatherization	0	0	0	0	0	0	0	0	0	0	6
C&I New Construction	0	1	2	3	5	6	6	7	8	9	210
C&I Existing construction	1	2	4	7	11	11	12	13	13	12	135
Food Service and Processing	0	0	0	0	0	0	0	0	0	0	3
Total Programs	**1**	**4**	**8**	**14**	**21**	**23**	**25**	**27**	**28**	**30**	**481**
Cumulative Annual NOx (metric tons)	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	
Residential New Construction	0	0	0	1	1	1	1	1	1	1	27
Small Heating and DHW	0	0	1	1	2	2	2	3	3	3	55
Home Performance with ENERGY STAR®	0	0	0	0	1	1	1	1	1	2	29
Low-income Weatherization	0	0	0	0	0	0	0	0	0	0	6
C&I New Construction	0	0	1	1	2	2	2	2	3	3	63
C&I Existing construction	0	1	2	3	4	4	4	5	5	5	62
Food Service and Processing	0	0	0	0	0	0	0	0	0	0	5
Total Programs	**1**	**2**	**4**	**6**	**9**	**10**	**11**	**12**	**13**	**14**	**247**

From a gas systems perspective, total present value net benefits would be $127 million, or approximately 104% of the TRC net benefits. The benefit-cost ratio under the gas systems test would be 2.94. Table 5.8 shows the gas system test net benefits and benefit-cost ratio.

Table 5.8. 2016 Net Benefits and Benefit-Cost Ratios.

Cumulative net benefits (benefits minus costs, present worth 2005)	$ (Million)
Residential New construction	$ 17.3
Small Heating and DHW	$ 36.0
Home Performance with ENERGY STAR®	$ 21.3
Low Income Weatherization	$ 2.0
C&I New construction	$ 18.6
C&I Existing construction	$ 30.8
Food Service and Processing	$ 1.2
Total - Program Scenario Potential	**$ 127.2**
Cumulative benefit/cost ratio 2005	**2016**
Residential New construction	4.92
Small Heating and DHW	3.45
Home Performance with ENERGY STAR®	5.02
Low Income Weatherization	1.32
C&I New construction	2.87
C&I Existing construction	2.40
Food Service and Processing	1.39
All Programs - Program Scenario Potential	**2.94**

5.3. ADMINISTRATION RECOMMENDATIONS

There are a variety of different models that could be considered for administration of gas energy efficiency programs in Con Edison's service area. The question of administration can be subdivided into three subsidiary questions:

- **Integration with existing electric programs**. Will Con Edison's gas programs be integrated with existing electric programs (*i.e.*, there is a single program design, with some "twists" that are applicable to Con Edison's and possibly other gas service territories),[49] or are they completely separate?
- **Uniquely local or common statewide gas program designs**. Will Con Edison's gas programs be unique to its own service area and therefore different from those of other gas utility service territories or are they identical to other gas programs in the state?
- **Local or statewide administration**. Will Con Edison's programs – whether identical to others in the state or not – be delivered and managed by Con Edison or delivered and managed by a statewide entity.[50]

Needless to say, there are advantages and disadvantages to different approaches to each of these questions. These are explored further below. Note that for analytical purposes only, we assumed that (1) programs would be integrated with existing electric programs, and (2) that the programs were not necessarily statewide.

Integration with Existing Electric Programs

As noted above, we believe that there are significant advantages to integrating program delivery with delivery of existing electric programs. This reduces confusion in the market, 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 our analysis.

One of the issues that arises when electric and gas programs are integrated is the allocation of program costs – for financial incentives, marketing, training, administration and/or 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.

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49 For example, several years ago Efficiency Vermont and Vermont Gas reached agreement on a common statewide program design, with the only difference being that incentive levels are higher in Vermont Gas' service area. There is also extensive collaboration between the two entities, including some joint delivery (*e.g.*, all technical support to builders and all energy ratings are performed by Efficiency Vermont).

50 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.

he New Jersey electric and gas utilities faced this very 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 or the other. For example, financial incentives for efficient lighting were allocated 100% to electric ratepayers. For costs that were associated with generating both gas and electric savings, they used a cost-effectiveness screening tool loaded both gas and electric avoided costs to estimate the magnitude of the economic benefits associated with each type of savings (including both 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 or the other, electric ratepayers paid 62% of the cost and gas ratepayers paid 38%.

A similar approach could fairly easily be developed for any program in New York once there is agreement on the magnitude of avoided costs and the gas and electric savings the program will generate."

Local and Statewide Programs

Although our analysis did not assume gas energy efficiency programs would necessarily be offered consistently statewide, we believe that such consistency would be ideal – especially for programs addressing more market-driven opportunities such as new construction and equipment purchases. For such programs, statewide consistency allows not only greater efficiency in service delivery, but also greater impact on the market due to consistency in messages and requirements imposed on builders, developers, architects, HVAC contractors and others who often work across service area boundaries. Such consistency is not so important when providing discretionary retrofit services, such as through a Low-income Retrofit program.

Had we assumed that there would be consistent statewide gas energy efficiency programs in our analysis, the results would have been a little different. For one thing, we may have had a slightly different program portfolio. For example, we may have included a market-transformation program to promote the sale and purchase of ENERGY STAR® windows. We did not include such a program in the portfolio we analyzed because we did not believe that the market was large enough in just Con Edison's service area to effectively interact with manufacturers and achieve program objectives. Had we assumed consistent statewide programs, our analysis would also likely have suggested a little more savings could be had from the programs that we did analyze due to higher penetration rates in some markets that would have been possible with greater consistency in messages to trade allies.

Local or Centralized Administration

If designed well – and this is an important caveat – we also generally believe that some form of centralized statewide administration is preferable to utility-by-utility administration, at least for market-driven programs addressing new construction and equipment purchases. Centralized administration offers both 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. Had we assumed that there would be centralized administration of the programs, our estimated budgets for Con Edison would have been a little lower. That would have freed up some funds to spend on greater market penetrations which, in turn, would have led to slightly greater savings. We also recommend that under any type of administration, the PSC consider performance based arrangements, including financial incentives to the administrator for exemplary performance.

6. LOST REVENUE RECOVERY MECHANISMS

6.1. LOST REVENUES

Conservation programs will usually reduce ratepayer bills, and hence utility revenue, by a larger amount than they will reduce utility costs. Under traditional ratemaking, the difference between the reduction in revenue and the reduction in costs would represent a reduction in utility earnings. This difference is generally known as the utility's "lost revenues."

Customer bill reductions continue to exceed utility cost savings until the utility files a new rate case incorporating the reduction in its test year, the commission acts on the rate case, and the new rates take effect. If the efficiency programs continue to reduce customer consumption in a manner not reflected in setting rates, lost revenues start to accumulate again after the rate case. In New York, rates are set based on forecasted sales, which can reflect both (1) measures that are already installed or committed and (2) the effects of planned programs.

This report deals primarily with the economics and feasibility of a system-wide Con Edison energy-efficiency program, subject to a specified budget. That program, or one of similar scale, might be implemented as a part of Con Edison's next rate case, which is likely to take effect in the fall of 2007, or as an expansion of the state-wide System Benefits Charge (SBC) through which electric energy-efficiency programs are currently funded. In the meantime, under the terms of the order in Case No. 03-1671, Con Edison firm ratepayers are funding a pilot energy-efficiency efficiency program, for which only firm customers are eligible, for up to $5 million.

The lost-revenue analysis must thus consider the following three types of programs:

- The pilot program funded by Con Edison and implemented by NYSERDA, lasting from roughly October 2004 to October 2007. The order in Case No. 03-1671 provides for Con Edison to recover its revenues lost from the pilot program. The program, including lost revenues, is funded by a $5 million assessment on firm customers over.
- A more extensive program, modeled as running for 5-years, with another five years of post-program effects, with higher funding levels and Con Edison implementation.
- The more-extensive program, but funded through an SBC-like charge and implemented by a non-utility party.

These three program structures illustrate important differences, as follows:

- The pilot program has very limited funding and much of the savings would occur shortly before or even after the next rate case; the order provides for Con Edison's recovery of lost revenues.
- For the larger potential Con Edison program, increased funding and the full operation between rate cases would increase lost revenues. But the program is likely to be designed before the end of the rate case, so its anticipated effects can be incorporated in base rates. Only the difference between the projected and post-hoc estimated effects might be subject to any later adjustment.

- With SBC funding and non-utility administration, the magnitude and timing of the larger program may be similar to the Con Edison option, but the reduction in sales is less sensitive to Con Edison's behavior. The projection of sales and revenues in each rate case would reflect the expected effects of the energy-efficiency programs, as they would any other drivers of load (building starts, federal and state efficiency standards). The Commission could choose to reflect differences between the projected and implemented program, or not, but any such adjustment is likely to have less effect on the program outcome than would be the case with Con Edison control of the program.

The magnitude of the utility's lost revenues for each affected bill depends on marginal block of the delivery rate, that is, the block in which the customer's usage is actually reduced. Since each customer's usage varies from month to month, and many of Con Edison's rates include two or three rate blocks, the lost revenues will vary from customer to customer (even among customers on an individual tariff) and month to month. No lost revenues result from any reconciling charges, such as the gas charges. For the interruptible rates, only Con Edison's share of the margin is lost revenue.

6.1.1. <u>Estimating Lost Revenues from the Program Scenario</u>

6.1.1.1. <u>Residential Programs</u>

For residential programs, it is reasonable to assume that most measures will be installed for customers with gas space heating (Service Classification #3). A single-family home is likely to have monthly usage in the first block of the rate (less than 9 Dth) in the summer, reducing base revenues by $5.4/Dth. In the winter, that home would have usage in the second block (9–300 Dth), and lost revenues would be $3.9/Dth. A reasonable approximation would be to assume that lost revenues are $3.9/Dth for reductions in heating load, $4.5/Dth for water-heating load (60% winter, 40% summer), and $4.7/Dth (the average of summer and winter marginal revenues) for other end uses.[51]

Multifamily residential housing presents a more complex situation. Some gas use will be billed to the individual units for cooking, drying and water heating under service class (SC) #1 (which has only one price block), or for space heating and other uses under SC #3 (generally in the first block, or perhaps the second block in the winter). Other use will be billed to the building for central water heating and space heating under SC#3, in the second and third blocks, depending on the size of the building and the season. We assume that the latter arrangement will be more common in the treated buildings, resulting in lost revenues of $3.1/Dth for space heating (the third-block rate), $3.4/Dth for water-heating load (60% in the winter at the third-block rate, 40% in the summer at the second-block rate), and $3.5/Dth (the average of the second- and third-block rates) for other uses.

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51 Considering the uncertainties, there is no point in using more than two significant figures.

Some portion of residential gas use is on lower rates, including SC#13 (seasonal off-peak), interruptible transportation and various general-service rates.[52] Because we do not have data on the share of residential load on those service classifications, the lost revenues estimated using the assumptions in this section are likely to be over-stated.

6.1.1.2. Commercial, Industrial, and Institutional Programs

Estimating lost revenues for commercial programs is more complicated than for residential programs, because of the large amount of interruptible service and the existence of individually negotiated contracts. The pilot program is limited to firm load, so interruptible rates become relevant only if a broader program is implemented.

For firm sales, the delivery rate for SC#2 heating is $3.6/Dth under 300 Dth/month and $2.4/Dth over that level; for SC#2 non-heating it is $3.0/Dth under 300 Dth/month and $2.1 above. Assuming that the load reductions for heating customers are evenly distributed across the two blocks, the average lost revenue for heating measures would be $3.0/Dth. For other end uses, sales reductions may be on either the heating or non-heating rate, and in either the higher or lower block of the applicable rate. Assuming that 50% of firm non-heating load is on the higher heating rate (SC#2, Rate II), and that 50% of the savings from non-heating conservation affects bills that are over 300 Dth/month, energy efficiency for firm non-heating load would produce average lost revenues of $2.8/Dth.

Based on Con Edison's 2004 PSC report, about 45% of Con Edison's non-residential distribution deliveries are on interruptible tariffs and about 55% on firm tariffs, mostly SC#2. The margins on the interruptible tariffs are set by Con Edison every month in response to market conditions, and are generally very low, often $0.10/Dth in peak winter heating months (December to February) and averaging about $1.20/Dth. Con Edison's interruptible margins have been large enough that the Company retains only 10% of incremental interruptible margins, with the remainder credited to firm customers. Hence, Con Edison's lost revenues on interruptible sales are only about $0.01/Dth in December–February and $0.12/Dth in other months. Since about 70% of HDDs are in the three peak months, average interruptible lost revenues would be about $0.05/Dth for heating load.[53] Simply weighting across the months produces lost revenues of $0.09/Dth for flat loads. Water-heating lost revenues would be about $0.08/Dth.

Some of the sales lost due to energy efficiency may free up city-gate gas or delivery capability and allow addition interruptible sales or deliveries. During much of the year, both gas supply and deliver capacity are adequate, and no customers are interrupted. During the constrained period, some of the conserved gas will be resold, but no data on the magnitude of those potential resales were available for this project. These additional interruptible sales would offset only a very small

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52 The pilot program approved in Case 03-G-1671 only serves firm customers. The programs described in this report would cover all customers.

53 This value would rise for long periods of interruption, which would reduce the winter share of interruptible sales for heating.

portion of the revenues lost due to energy efficiency for firm sales, since the interruptible rates are so much lower than firm.

Since clothes-drying, cooking, and some other uses cannot be switched to oil, it is likely that the percentage of space-heating use that is interruptible would be greater than the percentage of total Con Edison deliveries. Assuming that 50% of the lost sales for commercial heating load are on firm rates, the weighted average lost revenues would be $1.5/Dth for commercial heating in broad energy efficiency programs that include interruptible customers.

Assuming that 40% of water-heating and other non-heating uses are on interruptible rates, the average lost revenues for water heating would thus be about $1.7/Dth.

6.1.2. Determining Lost Revenues for Cost Recovery

The purposes of lost-revenue recovery are to fairly compensate Con Edison for a program it is supporting, and to remove any reluctance by Con Edison to cooperate with all cost-effective gas energy efficiency . Recovery of lost revenues is particularly important in the context of multi-year rate plans, during which Con Edison might experience large and unpredictable revenue losses from energy-efficiency programs.[54]

Ideally, recovery for lost revenues would exactly match lost revenues (however those are defined), but there is a trade-off of precision with administrative effort and cost. Poorly-designed lost-revenue recovery can encourage the utility to direct programs away from customers on rates that produce lost revenues higher than the utility's recovery and toward customers that who would produce lost revenues lower than recovery. These concerns are reduced if the utility has less control over the program, for example if:

- The funding level for gas energy efficiency is set by law or rule (as it is in several states in the Northeast) than if the utility is an important player in setting the budget.
- The program is designed and implemented primarily by a third party (such as NYSERDA), rather than the utility.

This report defines lost revenues as the full difference between Con Edison's revenues with the energy-efficiency portfolio and the level of those revenues if the portfolio had not existed. This is different from a historical or time-series perspective, in which revenues are only lost if sales are lower after the energy-efficiency program than before, either on a customer basis or a system basis. The differences are significant.

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54 This discussion assumes the use of an explicit mechanism for tracking and recovering lost revenues. Various jurisdictions, including New York, have avoided the need for this detailed accounting by fixing the level of revenues that the utility is allowed to retain and adjusting future rates to offset any deviations from this revenue target. This approach has some advantages, including avoiding the need for detailed computation of lost revenues, reducing risks of weather variation to both the utility and customers, and removing utility incentives to increase sales. On the other hand, the revenue-stabilization approach increases risks to customers in economic downturns and removes utility incentives to encourage local economic development. Development of a revenue-stabilization mechanism is beyond the scope of this report.

In the historical perspective, efficiency programs for new construction create no lost revenues, since the loads are all incremental to previous levels, and a utility would be eligible to recover lost revenues only if its sales were actually falling. This approach may be equitable if the forecast used in setting the current rates excluded sales increases due to new construction, or even all sales increases. Whether the historical perspective is fair or not, it would still create an adverse incentive for the utility, since encouraging energy efficiency would reduce utility earnings. The practical effect may be small; if the energy-efficiency program is generally involved with construction projects early in the design process, there may be no revenue effect until the building is completed and occupied, which would be several years later, perhaps after the next rate case. If the revenue effects of just-completed program activities (let alone future activities) were reflected in setting the new rates, no other lost-revenue adjustment would be necessary for those new-construction projects.

6.1.2.1. Sales Reductions: Magnitude and Timing

The lost revenues resulting from improved energy efficiency should reflect the actual reduction in sales resulting from the program. The lost sales due to the program may be less than the efficiency improvements from the specific measures for two reasons. First, some of the improvements may have occurred without the program.[55] Second, especially for low-income customers who pay their own gas bills, improving heating efficiency may allow customers to afford a higher thermostat setting.

Lost revenues occur from the time that the energy-efficiency investment first reduces sales until revised base rates go into effect. Depending on the nature of the program, the sales reduction may occur before, simultaneous with, or well after the date at which an incentive is paid or other program services delivered. In the case of new-construction design assistance, sales reductions may lag program expenditures by a couple years.

For some measures, most importantly space heating, gas savings vary widely by month, so it is important to incorporate seasonal variation in estimating lost revenues. For example, a space-heating efficiency investment in April is likely to have little effect on revenues until the following November.[56]

One complication arises in that, to the extent that load reductions due to efficiency frees up Con Edison gas for sale to interruptible sales customers, and frees up space in Con Edison pipes for delivery of more gas to interruptible delivery customers, Con Edison retains a portion of the margin. To some unknown extent, efficiency investment may allow Con Edison to add a small

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55 Such “freeridership” relevant for lost-revenue determination may be less than the corresponding effect for cost-effectiveness determination, especially for retrofit programs. Even if the customer would have adopted some of the efficiency measures, the reductions may have occurred much later, so most or all of the reductions in the current rate plan may be due to the program.

56 In principle, the computation of lost revenues could reflect actual weather conditions in each month, but this complication is unnecessary. Con Edison already has a weather-normalization clause, so the Company keeps only the revenues it would receive in normal weather.

amount of interruptible margin to offset the lost revenues. Since interruptible margins are so much smaller than firm margins, the moderation of lost revenues from lost firm revenues would be a very small. Even for lost interruptible sales, only a minority of lost revenues are likely to be recovered through increased sales to other, lower-priority customers. The modeling of this effect is beyond the scope of this study.

6.1.2.2. Mapping Energy Savings into Rate Classes

Each of the conceptual programs would serve customers on multiple rate schedules. For example:

- **Residential New Construction**: This program will include single-family homes on SC#3 (residential heating), as well as multifamily and mixed-use buildings and units within those buildings on SC#3, general-service heating (SC#2 Rate II), off-peak and interruptible rates (SCs #12 and #13) and negotiated contracts.[57] Some savings may occur in units on SC#1 (residential non-heating) in buildings with central heating systems on SC#3, and a small amount of gas-fired cooling for residential loads is on SC#3A. Savings within a building may reduce usage on multiple tariffs. Tracking or estimation methods must reflect the distribution of savings among these tariffs.
- **Small Space and Water Heating**: This program would serve customers on all the tariffs listed in Residential New Construction, plus some businesses on the non-heating rate (SC#2 Rate I) within centrally heated buildings.
- **Home Performance**: This residential retrofit program would affect mostly SC#3, although a small amount of savings may be in water heating, clothes drying and cooking in homes on SC#1.[58]
- **Low-income Weatherization**: This program would affect sales in SC#1, SC#2 Rate II, SC#3, SCs #12, and #13 and negotiated contracts.
- **Commercial & Industrial New Construction and Existing Buildings**: These savings would be on accounts in SC#2 Rates I and II, including the air-conditioning rate; SC #12; and negotiated contracts. Some related residential uses might be on SC#1, #13, or occasionally SC#3.
- **Food Service and Processing**: While cooking would be on SC#2 Rates I and II, most of these savings in this program would apparently be in water heating, which could also be served under SC #12. Both cooking and water heating can be on negotiated contracts.
- **Large Industrial**: These savings may be spread across SC#2 Rates I and II, SC #12, and negotiated contracts.

6.1.2.3. Identifying Marginal Blocks in the Firm Rates

Determining the mix of tariffs from which sales will be lost does not determine the average lost revenues, since most rates have more than one commodity rate. The minimum charge in SCs #1,

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[57] Most of the sales tariffs have corresponding transportation tariffs with the same delivery rates. For this discussion, those corresponding transportation tariffs need not be differentiated from the sales tariffs.

[58] Approximately 100,000 more multifamily residential customers have their own water heaters than space heaters.

#2, #3, and #13 cover the first 0.3 Dth monthly. Since very few bills would fall in this range (and those are mostly due to billing errors and vacancies), lost-revenue computations could probably ignore this factor.

Since SC#1 has only a single rate above 0.3 Dth per month, every Dth of savings results in the same lost revenues.

For SC#2, Rates I and II, and SC#3, there are three usage blocks, breaking at 9 Dth and 300 Dth per month. The tracking or estimation system must determine the fraction of saved usage in each of the blocks, which will vary both with the size of the customer and the month.

To further complicate matters, SC#2 has an air-conditioning rate option (which is discussed separately below) with two blocks breaking at 120 Dth/month and three riders (E, F, and G) that lower the basic rate over 25 Dth/month, adding a new block from 25 to 300 Dth, and reducing the rate for more than 300 Dth.

Both SC#1 and SC#3 have low-income discount provisions; the share of savings on those discounts must be tracked or estimated.

By comparison, SC#13 is relatively simple, with just two blocks, breaking at 120 Dth/month.

We do not know how the negotiated contracts are structured; it is likely that lost revenues will need to be determined on a customer-specific basis.

6.1.2.4. Special Issues in Interruptible Rates

The delivery charges in the interruptible rates are set monthly, and vary by priority (which is determined in part by customer usage and alternative fuel) and class (residential versus non-residential). The margins vary widely, as does Con Edison's share of the margin, so lost-revenue computations will probably need to be based on actual interruptible margins for each month.

6.1.2.5. Special Issues for the Air-Conditioning Rates

The air-conditioning rates SC #3A and provision 2 in SC #2, introduce yet additional complications in determining lost revenues. Both air-conditioning and other uses on SC#2 or #3 are billed through a single meter. Each air-conditioning rate provides the customer with 6.2 Dth/month of discounted gas for four months, for each ton of rated capacity of the air-conditioning equipment. Actual cooling load may be greater or less than the air-conditioning allowance. Total building load is likely to be larger than the air-conditioning allowance, at least in hot months.

Any gas energy saved in gas-cooled buildings, whether in reductions in cooling load, water heating, or other end uses, will reduce revenues at the same rate. During the four summer months, that rate may be one of the air-conditioning block rates or one of the normal block rates. In the other eight months, load reductions will all be at the normal block rate. Hence the lost revenues system must account for additional potential marginal rates.

In addition, reductions in cooling load may result in downsizing of the air-conditioning equipment, and hence in the size of the discount block. Downsizing is most likely to occur in new construction projects. Reduction of the discount block will reduce, and may even eliminate, lost revenues. Hence, it may be necessary to track the downsizing of cooling equipment, in addition to reductions in cooling load and improvements in cooling efficiency.

6.1.3. Methods for Recovery of Lost Revenues

Lost revenues, estimated as described above, can be recovered through a combination of three approaches:

- **Forecasting expected sales reductions** in setting rates in a general rate case results in higher unit rates, allowing the utility a fair opportunity to recover the revenue level the Commission allows. This approach is not applicable to the Con Edison pilot program; in the next rate case, this approach would be straightforward and consistent with the Commission's approach to setting rates.
- **Automatic adjustment clauses** permit utilities to recover costs outside rate cases. The schedule for recovery can be independent of the schedule of rate cases (which for Con Edison occur only every few years), and the utility's cash flow can be largely maintained.
- **Deferral accounting** allows the utility to accumulate costs, usually with an interest credit, until they can be included in a general rate case or other ratemaking proceeding. Deferred accounting mechanisms also maintain utility earnings but do nothing for cash flow until the deferred account is reflected in rates. No additional proceedings are required, although the utility may file rate cases more frequently if the deferred balance grows very large. Since the costs are not actually recovered from customers until after a full review, they receive the usual level of regulatory protection.

The lost revenues from Con Edison gas energy-efficiency programs are unlikely to be large enough to create cash-flow or financial problems under any combination of these approaches. As shown in Appendix D, the lost revenues from the pilot program, including interest charges, are likely to be under $200,000 at the time of the next rate case, if the projections of the timing of installations are in NYSERDA's Program Plan for the pilot prove to be correct (NYSERDA 2005). If the effective date of the savings is later than NYSERDA's projection, the lost revenues would be lower.

For a larger program described in Section 5, lost revenues would vary with the rate of program ramp-up and saturation, and with the interval between the program start and the next rate case. If Con Edison does not file a rate case until after 2016, and if Con Edison is allowed to recover lost revenues post-program market effects, lost revenues could accumulate to the $25 to $30 million range, but this is a very unlikely possibility. Since the program is modeled in the report as starting in January 2007, if the next rate case is timed to match the expiration of the current rate plan, with an effective date of October 2007, the lost revenues prior to that rate case would be only about $50,000. If the program runs for three years before the next rate case, lost revenues might be in the range of $1.5 to $2.5 million, including interest. After the first rate case, whenever it occurs, most lost revenues could be captured in base rates, and any after-the-fact lost-revenue adjustment would be much smaller.

Deferrals are widely used in Con Edison ratemaking. For example, the order in Con Edison's most recent gas rate case cites the following costs that are "subject to reconciliation and deferral accounting:"

- Property taxes, plant additions, pensions and other post employment benefits (OPEBs), environmental remediation work, a pipeline integrity program, and gas and steam system interference work.
- Deferred taxes, lost and unaccounted for gas and steam line losses, the gas efficiency and migration programs, World Trade Center (WTC) expenditures and losses from property sales. Case 03-G-1671, Order Adopting the Terms of a Joint Proposal, September 27, 2004, page 5.

Con Edison also has rate adjustment mechanisms, including the Gas Cost Factor for firm sales customers, the Weather Adjustment for firm customers, and the Monthly Rate Adjustment, which includes the following:

- A Non-Firm Revenue Credit for firm customers, flowing through the customer share of interruptible margins
- The Gas Facility Costs Credit Provision
- The Transition Surcharge for Capacity Costs
- The Research & Development Surcharge
- The Gas Energy Efficiency Surcharge
- The Transition Adjustment for Competitive Services
- The Property Tax Reconciliation Surcharge
- The Low-income Reconciliation Adjustment

Combining forecasting energy efficiency with either deferral or a rate-adjustment approach would be consistent with the Public Service Commission's ratemaking treatment of Con Edison. However, deferral appears to be more appropriate at this time, both for the small lost revenues prior to the 2007 rate case and for any reconciliation between forecast and achieved lost revenues in subsequent rate-case cycles. The lost revenues from the pilot program could be deferred until the 2007 rate case, or covered by an increase or extension of the efficiency surcharge used to raise the original $5 million for the pilot program.

If the large-scale energy-efficiency programs are funded by a Commission-mandated charge (either as part of the SBC or as a separate mechanism) and implemented by NYSERDA or another third party, the lost revenues for the energy-efficiency program can probably be reflected entirely in sales forecasts in rate cases, especially if rate cases occur every few years.

7. APPENDICES

A. RESIDENTIAL ANALYSIS DATA INPUTS AND RESULTS

B. COMMERCIAL ANALYSIS DATA INPUTS AND RESULTS

C. 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

D. LOST REVENUE RECOVERY MECHANISMS

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