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- The Blackstone Group
- CNT Energy
- Insight Property Services
- J.T. Katrakis and Associates

North Shore Gas Company Energy Efficiency Potential Study

Program Years 4, 5 and 6

May 2013

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EXECUTIVE SUMMARY

Natural gas prices today are about half what they were only a few years ago. This has diminished the economic incentive for consumers in all sectors to use gas more efficiently. There are fewer cost-effective energy efficiency measures, and fewer net benefits associated with measures that remain in the cost-effective category.

With this condition as a backdrop, we estimate the annual therm savings that North Shore Gas Company (North Shore Gas) could achieve through its energy efficiency programs. Table ES-1 shows the time periods under review in this study, along with the associated statutory energy savings targets and our achievable energy efficiency estimates.

Table ES-1
North Shore Gas
Efficiency Targets and Achievable Potential

Program Year	Time Period	Efficiency Target (% of sales)[1]	Efficiency Target (millions of therms)[2]	Base Case Achievable Efficiency Potential (millions of therms)
4	June 2014-May 2015	0.8%	2.2	1.2 – 2.1
5	June 2015-May 2016	1.0%	2.8	1.2 – 2.1
6	June 2016-May 2017	1.2%	3.3	1.2 – 2.1

Our base case analysis assumes that North Shore Gas can purchase gas supplies at $0.37 per therm in each of the three program years. We derive this estimate using natural gas futures contract prices for deliveries over the next 24 months. As the table shows, we estimate that if the utility promotes all measures that on a per-therm basis cost less than this supply cost, it can reasonably expect to capture between 1.2 and 2.1 million therms of energy savings per year for each year in question. While in this base case North Shore Gas is close to hitting the target for program year 4, the top of the range still lies below the target. It falls more noticeably short of the statutory savings targets for program years 5 and 6.

North Shore Gas could likely achieve greater energy savings under a combination of higher gas prices, higher incentive payments[3] and a shift in focus to the commercial and industrial sector. The latter two items are under its control; the first one is not.

Under current conditions, a reasonable achievable energy efficiency target for North Shore Gas lies in the range of 1.2 to 2.1 million therms per year, which amounts 0.4 to 0.8 percent of utility sales. Revamped program focus and incentive policy changes, when coupled with an increase in gas prices could push the North Shore Gas efficiency achievability to levels at or above the program year 4 level.

[1] 220 ILCS 5/8-104 requires that utilities use 2009 annual sales as the reference point for this calculation.
[2] Source: The North Shore Gas Light and Coke Company and North Shore Gas Company, *Energy Efficiency Market Potential Study Request for Proposal*, June 26, 2012.
[3] We modeled a scenario in which North Shore Gas increased its incentive payments to 100 percent of incremental cost. The fact that we analyze this scenario does not imply that such an incentive approach necessarily represents good public policy.

STUDY OVERVIEW

BACKGROUND

Energy Efficiency Goals

Illinois statutes require that North Shore Gas implement energy efficiency programs to meet annual savings targets.[4] Table 1 sets forth the efficiency goals by program year. The shaded years represent those under review in this analysis.

Table 1
North Shore Gas
Energy Efficiency Goals by Program Year

Program Year	Time Period	Efficiency Target (% of sales)[5]	Efficiency Target (millions of therms)[6]
1	June 2011-May 2012	0.2%	
2	June 2012-May 2013	0.4%	
3	June 2013-May 2014	0.6%	
4	June 2014-May 2015	0.8%	2.2
5	June 2015-May 2016	1.0%	2.8
6	June 2016-May 2017	1.2%	3.3
7	June 2017-May 2018	1.4%	
8	June 2018-May 2019	1.5%	
9+	June 2019 and beyond	1.5%	

Program Budget Limit

The statutes also limit utility energy efficiency program spending to 2 percent of utility revenues. This places a $5.3 million upper bound on the North Shore Gas program budget.[7]

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[4] See 220 ILCS 5/8-104. The statute assigns part of the energy efficiency obligation to the Illinois Department of Commerce and Economic Opportunity (DCEO), which is responsible for low-income and public institution sectors. For North Shore Gas the annual percentage savings goals apply to the remaining load, i.e., that not assigned to DCEO.
[5] 220 ILCS 5/8-104 requires that utilities use 2009 annual sales as the reference point for this calculation.
[6] Source: The Peoples Gas Light and Coke Company and North Shore Gas Company, *Energy Efficiency Market Potential Study Request for Proposal*, June 26, 2012.
[7] *Ibid*.

CUSTOMER DATA COLLECTION

In order to estimate how the customers on the North Shore Gas system could save energy, we first have to know how much gas those customers consume and for what purpose. This section provides background information on how we assembled that data.

BILLING DATA—ALL SECTORS

North Shore Gas provided us with a billing extract for the residential, commercial and industrial sectors that contained the following data:

- *Premises-level detailed usage data* Monthly billing data allowed us to weather-adjust usage from the 2011-2012 time period in order to estimate total annual gas consumption for each premises. In addition, the weather-adjustment techniques provide a means to isolate annual space heating load for each premises.

- *A sector indicator* (residential, commercial or industrial).

- *A premises-type indicator* Principally, we used this indicator to isolate and remove governmentally-owned premises that would fall under DCEO's purview.

- *Service class code indicator* This allowed us to stratify on meter configuration (mainly residential), space heat/no space heat and to identify large volume demand commercial and industrial customers.

- *Renter/owner premises type* This indicator was used with the premises-type indicator to identify and segregate governmentally-owned premises.

We used stratified random sampling based on rate class and usage to draw a sample of premises for which we later received personally identifiable information. We used those premises as the sampling frame for phone survey completion.

RESIDENTIAL SECTOR SURVEYS AND SITE VISITS

We conducted telephone surveys for 696 of North Shore Gas residential customers using a sampling design stratified by customer gas usage, distributed across the sector segments as follows:

Table 2
Residential Telephone Survey Completions by Segment

Segment	No. of Surveys
Single-family homes	648
Individually-metered apartments or condominiums with gas space heating	42
Individually-metered apartments or condominiums with no gas space heating	2
Master-metered apartments or condominiums	4

The short survey allowed us to gather information about basic end uses, housing characteristics, recent appliance purchases and energy-related behaviors. The residential survey instrument is attached as Appendix C.

These surveys provided useful information, but to do a thorough job in assessing potential we needed more detailed information. We followed up on the survey with 47 site visits to a subset of customers who completed the telephone survey. These visits lasted approximately two hours, which allowed us to inspect the residence and determine more specifically the type and efficiency of the appliances, and also to inspect the building shell and perform a blower door test, where possible. We interviewed residents to gather additional information about behavioral aspects of energy use. The site visits were distributed among the residential customer segments as follows:

Table 3
Residential Site Visits by Segment

Segment	No. of Visits
Single-family homes	44
Individually-metered apartments or condominiums with gas space heating	2
Individually-metered apartments or condominiums with no gas space heating	0
Master-metered apartments or condominiums	1

The heavy focus on single-family homes reflects the fact that North Shore Gas has relatively few multi-family residences. The residential site visit instrument can be found in Appendix D.

COMMERCIAL AND INDUSTRIAL SECTOR SURVEYS AND SITE VISITS

We used a similar combination of surveys and site visits in the commercial and industrial sector. This customer group presents some challenges not present in the residential sector.

- Commercial and industrial customers are a heterogeneous group, ranging in scope and scale from a beauty salon to a big box retail store to a manufacturing operation. We identified the following sectors, split between larger volume and smaller volume categories:
    - Larger volume
        - Office
        - Hospital
        - Hotel
        - Education
        - Industrial
        - Other
    - Smaller volume
        - Offices
            - Medium
            - Smaller
        - Warehouses
        - Food sales
        - Food services
        - Retail
        - Private education
        - Religious
        - Exhibition/recreation
        - Health care
            - Hospitals and large clinics
            - All other health care

    - Service
    - Commercial laundry
    - Lodging
    - Industrial

- In the residential sector, it is fairly easy to connect via telephone with a person in a household who can respond to basic questions about energy use in the home (e.g., do you have a gas range?). The same cannot be said in the commercial and industrial sector where the person who pays the bills (usually the point of contact in the utility billing system) may not have any idea as to how the company uses natural gas. Therefore, it can take a considerable amount of time for the survey taker to find a person who can accurately respond to the questions. This makes commercial and industrial surveys more expensive to complete.

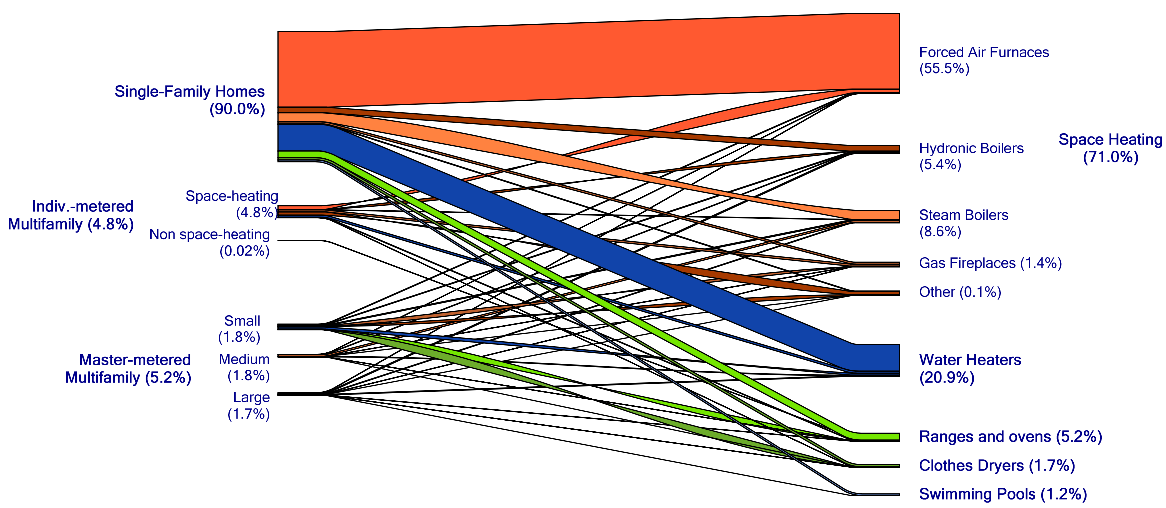
We completed 356 telephone surveys in the commercial and industrial sector spread across the various customer segments. The commercial and industrial telephone survey instrument can be found in Appendix E.

Just as is the case for residential customers, surveys provide us with useful, but limited information. While site visits can provide much of the missing information, to conduct such visits across all of the segments identified above so as to achieve statistically significant estimates in each segment would be cost prohibitive. As a pragmatic compromise, we instead conducted a limited number of site visits (30) designed to gather additional general information about this diverse sector. The commercial and industrial site visit form is attached as Appendix F.

END USE ALLOCATIONS

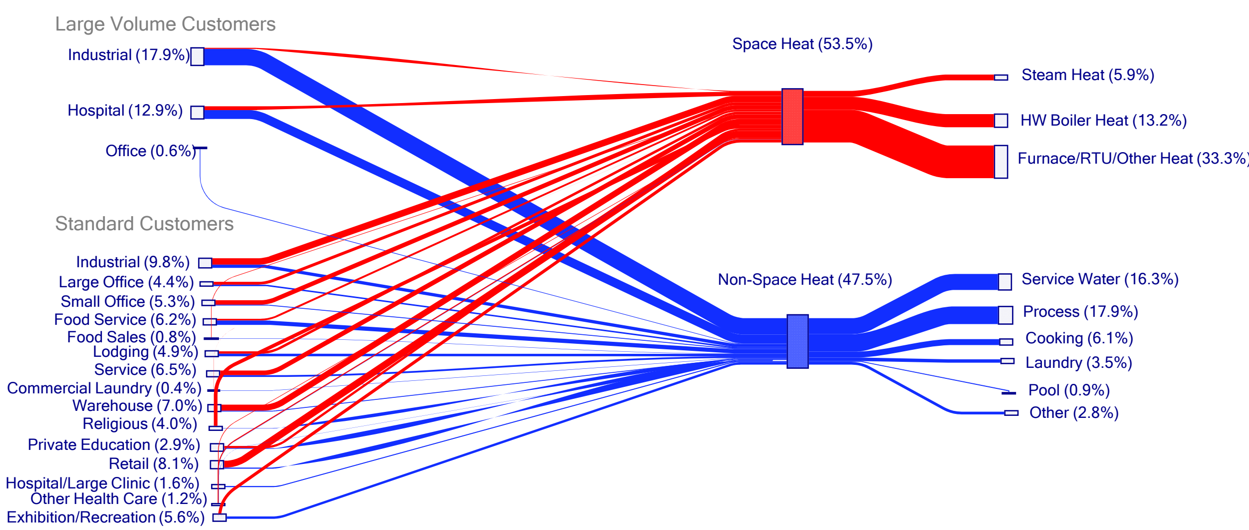
The data we assembled allowed us to get a better picture of the North Shore Gas system. We were able to untangle segment information and place it into end use categories. See diagram below.

North Shore Gas Residential Therms



We were able to do the same for the commercial industrial sector. See diagram below. This knowledge was critically important because the energy efficiency opportunities follow the gas flows. Where there is greater flow, there typical is a greater efficiency opportunity.

North Shore Gas Commercial/Industrial Therms



MEASURE-LEVEL ANALYSIS

We compiled an array of energy saving measures for the residential and commercial/industrial sectors. Together, the various data inputs for the compiled list of measures serve as building blocks for estimating technical, economic and achievable energy efficiency potential. The following are the measure-specific inputs that were estimated for the customer segments within each sector.

Table 4
Energy Efficiency Measure Analysis

Measure Input	Description	Sources of Information
Measure applicability factor	Measure applicability is the portion of energy within each end use that apply to the energy saving measure. Applicability factors can be thought of the portion of the end use where savings are technically feasible.	- Telephone surveys - Site-surveys - Literature review - Engineering judgment
Energy efficiency saturation factor	The applicable portion of the end use energy that is already energy efficient	- Telephone surveys - Site-surveys - Literature review - Engineering judgment
Technical savings rate	The average end use percent savings that can be expected when the measure is applied to inefficient equipment.	- Illinois Technical Reference Manual - Literature review - Engineering judgment
Incremental cost	The cost to upgrade to efficient equipment. For an end of life measure, this is the difference in cost to install an efficient version of the technology over an assumed base case technology. For retrofit measures, it is the total cost to implement the measure (total equipment replacement cost, labor, etc).	- Illinois Technical Reference Manual - Literature review - Engineering judgment
Measure useful life	The estimated number of years that the technology is assumed to be in service	- Illinois Technical Reference Manual - Literature review - Engineering judgment

When estimating economic and achievable potential, we compared a calculated levelized cost of conserved energy against an assumed avoided cost, principally $0.37 and $0.63 per therm, as the threshold for evaluating measure cost-effectiveness. The former figure reflects current gas prices; the latter represents the gas price North Shore Gas used in developing the plans for program years 1 through 3. We used an assumed real discount rate of 5.3 percent when levelizing the cost of conserved energy across each measure's useful life.

The resulting set of measure-level inputs is provided in Appendix B of this report. Note that the values in Appendix B are averaged across the different segments within each sector (weighted according to each segment's share of aggregate base-case achievable potential for the measure).

ACHIEVABLE ENERGY EFFICIENCY POTENTIAL

TYPES OF POTENTIAL

A study of this sort typically provides estimates of three types of energy efficiency potential: (1) technical potential, (2) economic potential and (3) achievable potential. While the first two estimates may be of intellectual interest, it is the last that has practical significance. We define technical and economic potential here, and provide numeric point estimates for interested readers. We devote the majority of the report to achievable potential, which is the metric that relates to the statutory targets.

- **Technical potential**—the amount of efficiency savings available if all customers immediately switched to the most energy efficient appliances. This estimate assumes that consumers will move to the most efficient model regardless of whether so doing is cost effective. For North Shore Gas we estimate technical potential to be 577 million therms, which is 41 percent of utility sales.

- **Economic potential**—the amount of efficiency savings available if all customers immediately switched to the most energy efficient appliances that are cost effective. This estimate requires an avoided cost benchmark to enable us to determine whether a measure passes that economic test. For North Shore Gas, at an avoided cost of $0.37 per therm, we estimate economic potential to be 178 million therms, which is 14 percent of utility sales; at an avoided cost of $0.63 per therm, we estimate economic potential to be 296 million therms, which is 24 percent of utility sales.

We noted at the outset that the Illinois Department of Commerce and Economic Opportunity is responsible for serving the low-income customers in North Shore Gas service territory. But those customers can, if they choose, participate in the North Shore Gas programs as well. As such, we calculate energy efficiency potential for those customers, but we do not count those figures in our estimates shown above. We estimate that the technical potential for low-income homes would be approximately 167 million therms. At $0.37 per therm, we estimate economic potential to be 43.1 million therms and 73.1 million therms at $0.63 per therm.

THE ACHIEVABLE POTENTIAL CONCEPT

Unlike the concepts of technical and economic potential, which are abstract theoretical notions, achievable potential estimates reflect practical realities. It is obvious why technical potential, which includes no consideration of measure cost, is not likely to represent a realistic energy savings target. The issue with economic potential, however, is less obvious. After all, if a measure is cost effective, won't all customers implement the measure without prodding from the utility?

In real, rather than stylized, markets certain well-documented barriers reduce adoption rates for efficient technologies. For example, the principal-agent (split-incentive) conflict often arises in landlord-tenant situations. If the landlord pays for efficiency improvements, but the tenant captures the benefits of those improvements via lower energy bills, the landlord has little incentive to make those improvements. The fact that the efficiency measure is cost effective to society (i.e., the tenant's benefits exceed the landlord's costs) is not relevant when the cash inflows and outflows accrue to different parties.

Yet, there are more fundamental issues at play here. One is the rate of technological diffusion in any market. Technologies merge into markets in a three-stage process: invention, innovation and diffusion.

Someone invents a product, someone else makes it ready for the market and then customers adopt it over time.

Numerous studies suggest that diffusion of energy efficient technologies into the market place proceeds at a deliberate, not rapid, pace. (Jaffe, 1994) Even if there are no other barriers, the market transforms from inefficient to efficient appliances in an evolutionary manner, as technologies prove themselves and as customers become more aware of them. This slow pace of diffusion is also due in part to the fact that customers often replace inefficient appliances only near the end of the equipment's useful life.

When high-efficiency furnaces first came on the market in the 1980s, customers did not rush *en masse* to install them. Rather, as existing furnaces reached the end of their useful life, some customers replaced those furnaces with high-efficiency models. This staging of equipment replacement alone substantially slows the rate of adoption for long-lived high-efficiency appliances, even if moving to the more efficient model is cost-effective and all customers adopt the measure at time of replacement.

The economic potential concept has no time dimension. If replacing a measure with a more efficient appliance is cost effective, under the economic potential concept we assume that the action takes place immediately. In practice most customers wait until equipment fails, or is near the point of failure, before even considering installing a more efficient appliance.

Note that if there are no other barriers to efficiency adoption, over the long run the energy savings ultimately achieved will equal the economic potential estimate, though there could be a considerable lag before the two estimates meet. But there is more to the gap between economic and achievable potential than differences in assumptions about the pace of diffusion.

Numerous studies dating back to the 1980s have found that the implicit discount rates that customers use to make energy efficiency decisions are noticeably higher than market rates. (Dubin, 1984) Applying high discount rates when estimating the present value of future energy bill savings will produce lower dollar savings estimates than those that would result if one used a lower discount rate. In our analysis we used a real discount rate of 5.3 percent, as suggested by the Illinois Technical Reference Manual (TRM).[8] In contrast, many customers use discount rates well in excess of 20 percent.

This means that just because energy analysts using a 5.3 percent discount rate find certain measures to be cost effective does not mean that customers using a 25.3 percent rate will necessarily reach the same conclusion for those measures. This gap between economic and achievable potential is not a matter of time, but rather of economic perspective. The analyst finds the measure to be cost effective; the customer does not. The passage of time does not change that conclusion.

Such high customer discount rates are often hidden in *ad hoc* decision making processes. This applies to not only to residential customers, but to business customers, as well.

> Corporations appear to pay less attention to finance theory and rely instead on practical, informal rules of thumb. (Graham, 2002)

For example, the payback method, which is such a rule of thumb, has widespread acceptance in corporate practice. This finding is somewhat baffling on its face because anyone who has taken a corporate finance course learns about the substantial disadvantages of the payback method:

[8] A real discount rate is the rate after inflation.

> This result is surprising in the sense that financial textbooks have stressed the shortcomings of the payback criterion for decades: it ignores the time value of money and the value of cash flows beyond the cutoff date, and the cutoff is usually arbitrary. (Graham, 2002)

The support for the use of such informal tools is often of questionable validity. For example, some justify the use of the payback method because it is easy to apply. That is true, but as an argument standing alone it lacks a sense of credibility. Administrative ease is of little value if the method provides inaccurate results.

But in other cases the reasons for using informal practices may have merit. For example, engineering-economic calculations might not include all of the relevant costs, such as inconvenience costs (the hassle factor). Those engineering-economic calculations also do not recognize the fact that some customers do not have access to funds necessary to make the efficiency improvement, even if the utility will fund part of the cost of the efficiency upgrade in the form of an incentive payment.

Even more worthy of consideration is that the payback method, while overly simple in appearance, may actually mirror advanced options valuation models, which can produce more accurate estimates of economic value than the standard engineering-economic approach. (Kihm, 2009) This is especially true in situations where uncertainty is high and dynamic in nature:

> As a number of finance scholars have pointed out, the answers provided by crude rules of thumb such as payback often resemble the solutions produced by optimal decision rules that account for the option-like features of many investments, particularly in the evaluation of highly uncertain investments. (Graham, 2002)

Therefore, before we're too quick to criticize market participants for sloppy decision making practices, we should consider the possibility that the methods they employ serve rational purposes. It may not be that our achievable potential estimates are too low; it may in fact be that our economic potential estimates are too high. Nevertheless, regardless of why there is a gap between economic and achievable potential, that gap exists and a potential study needs to reflect that notion.

CALCULATING ACHIEVABLE ENERGY EFFICIENCY POTENTIAL

With the achievable potential concept now in mind, let's step through the entire calculation of achievable energy efficiency potential. We examine high-efficiency furnaces for single-family homes in the North Shore Gas residential sector. The process is step-by-step and reductionist in nature.

1. Determine the total space heating load for single-family residences (we explain later how we arrive at this figure)
    a. 123,000,000 therms

2. Determine the portion of that load that could install a high-efficiency furnace (we exclude here houses that have boilers and houses with furnaces that cannot accommodate a high-efficiency upgrade, e.g., homes for which the special venting of the furnace presents technical problems)
    a. 91,000,000 therms

3. Determine the portion of that load that doesn't already have a high-efficiency furnace
    a. 55,000,000 therms

4. Determine the per-unit technical savings rate (how much gas does one save by installing a high-efficiency model instead of a standard-efficiency version)
    a. 13 percent

5. Calculate the technical savings potential (multiply (3) by (4))
    a. 7,200,000 therms

6. Test to see whether the cost of conserved energy (discussed later) for this measure is less than the avoided cost—if it is, use the figure from (5); if not set this value to zero. The economic test is not shown here, but the measure is cost-effective)
    a. 7,200,000 therms

7. Determine how much of this potential savings is associated with furnaces to be replaced this year (the typical adjustment is 1/useful life, which here is 1/20 because furnaces last about 20 years and customers tend replace them at the end of life, not before)
    a. 5%

8. Determine the annual potential savings associated with a furnace that could be upgraded to a high-efficiency model in a given year (multiply (6) by (7))
    a. 360,000 therms per year

9. Determine what percentage of this potential savings is associated with furnaces whose owner can be enticed through the North Shore Gas program to install the high-efficiency model (this does not include free riders)
    a. 30% (this is the achievability factor)

10. Apply the achievability factor to the available potential savings (multiply (8) by (9))
    a. 108,000 therms per year

This suggests that North Shore Gas can expect to save only about 100,000 therms per year promoting high-efficiency furnaces to single-family customers.

The key issue is estimating the achievability factor—we cannot point to just one source in that regard. We relied on a review of efficiency programs across the country, including the annual report on efficiency programs published by the American Gas Association. (American Gas Association, 2012) We also relied on the judgment of the experienced analysts who worked on the study.

That is not to say that we can estimate this variable with precision. Nevertheless, we can step through the logic to demonstrate why the achievability factor is not likely to be close to 100 percent. We just discussed the market barriers issue, which looms large here. Let's examine the makeup of the customers that North Shore Gas is trying to persuade in this regard. It is not likely those with an environmental or sustainability interest. They likely already have a high-efficiency furnace. And if they don't, they are likely to install one when they need to replace their existing furnace, whether or not North Shore Gas has a program. It is also not likely to be some of the people who have sophisticated financial and economic skills because they can determine that the high-efficiency furnace is cost-effective in its own right.

Note that all of these customers just mentioned will likely take an incentive payment from North Shore Gas if it offers it to them. But none of them contributes toward achievable efficiency potential. They are all free riding on the program.

The customers the program is aimed at are those who would not install the high-efficiency furnace if not for the incentive payment. This is group is not likely to include large numbers of efficiency advocates, but rather the energy efficiency skeptics. Some in this group will focus only on the upfront cost. Others are not interested enough in efficiency to explore their options. Some find the process to apply for the incentive to be a hassle. All of these factors suggest that the achievability factor is likely to be less than 50 percent for this skeptical group.

After reviewing efficiency programs and the literature, we developed the following achievability factors for major sectors for the base case.

Table 5
Achievability Factors by Segment
Base Case

Segment	End-of-Life Replacement	Retrofit
single-family non-low-income	27.0%	0.9%
single-family low-income	6.0%	0.2%
multi-family individually-metered non-low-income	15.0%	0.5%
multi-family individually-metered low-income	6.0%	0.2%
small multi-family master-metered non-low-income	15.0%	0.5%
small multi-family master-metered low-income	6.0%	0.2%
medium multi-family master-metered non-low-income	15.0%	0.5%
medium multi-family master-metered low-income	6.0%	0.2%
large multi-family master-metered non-low-income	15.0%	0.5%
large multi-family master-metered low-income	6.0%	0.2%
small and medium commercial	30.0%	1.0%
large commercial	30.0%	1.0%
industrial	30.0%	1.0%

The factors reflect the degree to which North Shore Gas might encounter barriers to energy efficiency adoption. Note that the achievability factors for multi-family homes are lower than that applied to single-family homes. The split-incentive problem is more likely to occur in the former sector than the latter.

Some might be wondering why the achievability for retrofits is so low. This has to do with inertia. When someone's furnace expires (end-of-life replacement) that forces the customer into the market. He or she must purchase a new furnace, so at least some of them will consider going with a high-efficiency model if enticed by an incentive payment. The retrofit market suffers from a lack of a stimulus. One never has to add insulation to the attic, for example. The utility first must motivate the customer to think about the possibility of making an efficiency improvement before it can begin to try to persuade the customer to do the most efficient activity.

The American Gas Association report mentioned above finds that a typical gas utility efficiency program serves about 3 percent of its customers each year, counting both retrofit and end-of-life replacement customers. When we calculate the broad participation rate across all sectors, our analysis shows a 3.4 percent participation rate for North Shore Gas.

AVOIDED GAS COST

Our base case assumption for the avoided natural gas cost over the study period is $0.37 per therm. We base this estimate on the $0.32 per therm 24-month NYMEX strip price, and add a $0.05 per therm surcharge to reflect transportation and storage costs.[9] With this avoided cost as the benchmark, an energy efficiency measure that costs less than $0.37 per therm is cost effective; measures that cost more than $0.37 per therm are not.

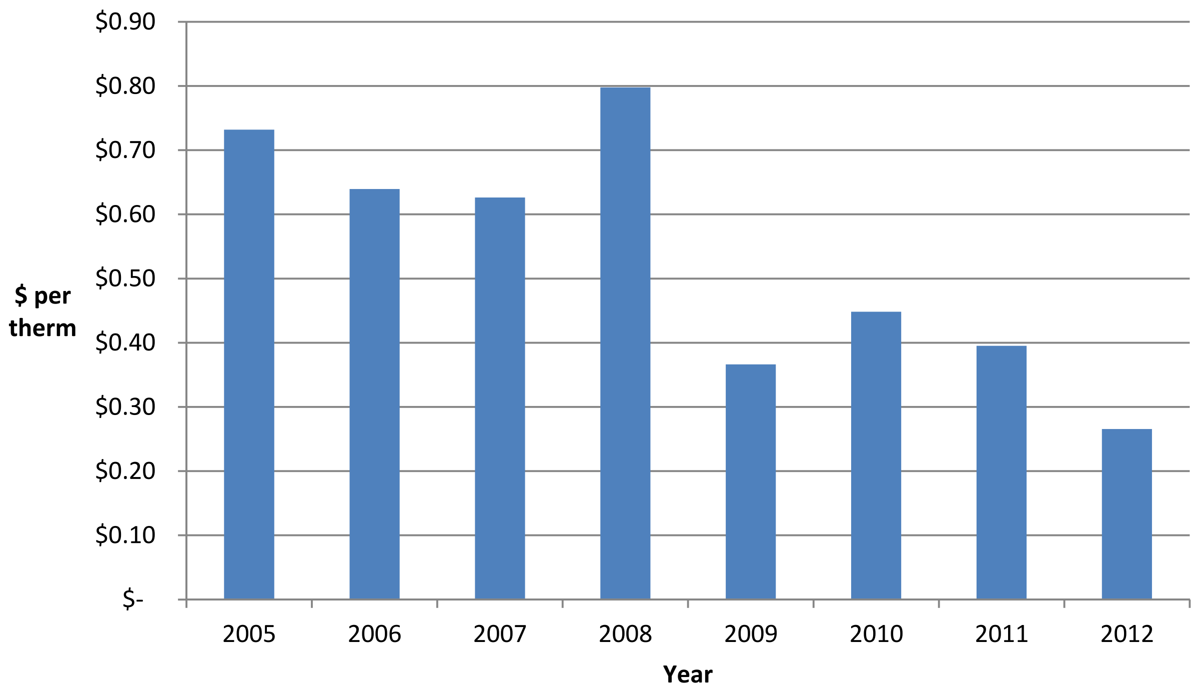
We do not include estimates of distribution costs in our avoided cost estimate because North Shore Gas does not avoid those costs when customers use energy more efficiently. It is essentially in no-growth mode. Its schedule for replacing and upgrading distribution mains and laterals depends on the age of the equipment, and not the volume of gas that flows through it.

North Shore Gas does avoid commodity costs when customers use gas more efficiently. The financial benefit of efficiency improvements relates directly to the level of natural gas prices. Those prices today are substantially lower than those seen in the mid to late years of the prior decade, which limits the scope and scale of energy efficiency resources. See Figure 1.

Figure 1

Average Annual Natural Gas Commodity Prices

Source: U.S. Energy Information Administration



[9] NYMEX is the acronym for the New York Mercantile Exchange, which serves as a trading platform for natural gas futures and options contracts. The 24-month strip price is the futures price for delivery of 10,000 MMBtu of natural gas at the Henry Hub in Erath Louisiana over an upcoming two-year period. A party that purchases this futures contract locks in a single price for natural gas over this two-year period. While forecasting natural gas prices is a daunting task, futures contract prices tend to be more accurate than most other methods.(Reischsfeld, 2011) That said, substantial uncertainty exists for any natural gas price forecast.

MONTE CARLO MODEL AND SCENARIO ANALYSIS

Any potential study relies on a large number of input variables. Our model has approximately 20,000 such inputs. It is difficult to quantify with a great deal of precision the numerical values for many of those variables. We reflect this inherent uncertainty in our analysis by using probability distributions for key input variables. Variables for which we apply this the probabilistic approach include incremental measure cost and the technical energy savings rate (i.e., how much gas the efficiency measure saves), among others.

We then employ Monte Carlo simulation, which randomly selects from the probability distributions a single value for each variable.[10] For a given run, the model then combines all of the values for the thousands of inputs in the analytical energy efficiency potential framework to develop a point estimate of achievable potential. The model then repeats this process many times (up to 4,000 times in some of our analyses), which allows us to develop a distribution of achievable efficiency outcomes. That is, the Monte Carlo approach allows the uncertainty associated with the input values to propagate through the model to provide an estimate of the uncertainty in the output result.

To further test the limits of our estimation process we also conducted scenario analysis in which we changed the values of certain other key model parameters not probabilistically, but rather explicitly. We refer to runs in which we changed variables in this manner as alternative scenarios. Variables subject to this scenario approach include the avoided cost, the degree to which North Shore Gas will focus on one sector versus another (e.g., business customers versus residential customers), the level of utility incentive payments and the degree to which customers are likely to participate in efficiency programs (achievability factor). For each of these alternative scenarios, we then ran the Monte Carlo model numerous times again to produce an output range rather than a single point estimate.

When determining the likely estimate of achievable energy efficiency potential, the alternative scenarios do not receive the same weight as the base case results. Rather those alternative scenarios tests the limits of the model, and help to determine the sensitivity of model results to explicit changes in key parameters. They are not necessarily reasonable scenarios as stand-alone items.

For example, in one scenario we assume that North Shore Gas pays 100 percent of the incremental cost of all cost-effective efficiency measures. Not surprisingly we find that if it did, it could achieve significantly more energy savings as compared to those we estimate for the base case. That is not to say, however, that such a full-cost incentive approach necessarily represents good public policy. Under this program design, the utility is essentially giving away efficiency for free, which is likely to raise concerns on the part of some parties, including the regulators.

When reporting results, we show the full distribution of Monte Carlo results only for our base case because we want to stress the fact that that analysis represents what we believe to be the most likely outcome. For alternative scenarios, rather than providing the entire distribution of Monte Carlo results, we generally report ranges. Unless specified otherwise, the low and high estimates of any achievable efficiency ranges we report here represent the 5th and 95th percentiles of the Monte Carlo model output. We also report this range for the base case, in addition to the full distribution.

[10] Not all variables vary independently of one another. For example, if random selection from the probability distribution suggests that the cost of a boiler improvement will be at the higher end of the range for retail shops, the model linkages ensure that the cost of the same improvement in small office spaces will also be at the high end. Establishing key linkages such as this is a basic principle of proper simulation modeling.

THE COST OF CONSERVED ENERGY

Energy efficiency measures typically involve an upfront payment and a stream of therm savings spread over the life of the measure. For example, it might cost $500 more to install a high-efficiency furnace, as compared to the cost of a standard efficiency model. The annual energy savings might be 130 therms per year. We expect the furnace to have a useful life of 20 years.

If we are to compare this or any energy efficiency measures to avoided gas supply costs, we need to express the measure costs on a cents per therm basis. We can use the cost of conserved energy approach for that purpose.

Looking at the raw data, we have a timing mismatch—the cost is a lump sum upfront payment and the savings occur over 20 years. We can convert the upfront cost to an annualized cost by using the annuity formula. This is the same approach one uses to determine payments for a home mortgage. For a given interest rate, using this formula we can find the annuity payment spread over the term of the loan that has the same present value as the amount of money provided by the lender.

For example, if one borrows $200,000 for a 30-year term at an interest rate of 5.0 percent, the monthly mortgage payment per the annuity formula is $1,073.64. One can use the Excel spreadsheet function PMT to do the math for you. What does this tell us? If we borrow $200,000, but pay it back in 360 monthly installments (30 years x 12 months), the lender will need to receive more than $200,000 in return. That is, we cannot simply divide $200,000 by 360 to calculate the monthly payment.

The mortgage payment we just calculated, if paid in full over the life of the loan, will provide the lender with a total of $386,510.40 ($1,073.64 per month x 360 months). Note that if the lender's opportunity cost of capital equals the mortgage rate, he or she is indifferent to either getting the loan paid off immediately, or collecting it over 30 years. That is what the annuity formula does for us. If we provide an interest rate, it calculates the levelized cash flow stream that has the same present value as the original lump sum.

We can apply this to our furnace example. Using the interest rate recommended by the Illinois Technical Reference Manual, which is 5.3 percent, we can convert the $500 upfront payment to a levelized annual payment (the formula can calculate monthly or annual payments). The figure is $41.15 per year. This tells at an interest rate of 5.3 percent, receiving payments of $41.15 in each of the next 20 years (which produces a total payment of $823) is equivalent to receiving $500 today.

We now have annual energy savings (130 therms) and an annual cost for the efficient furnace ($41.15), which allows us to calculate a cost of conserved energy for the measure, as follows:

$$\frac{\text{annuity cost}}{\text{annual energy savings}} = \frac{\$41.15}{130\text{ therms}} = \$0.32\text{ per therm}$$

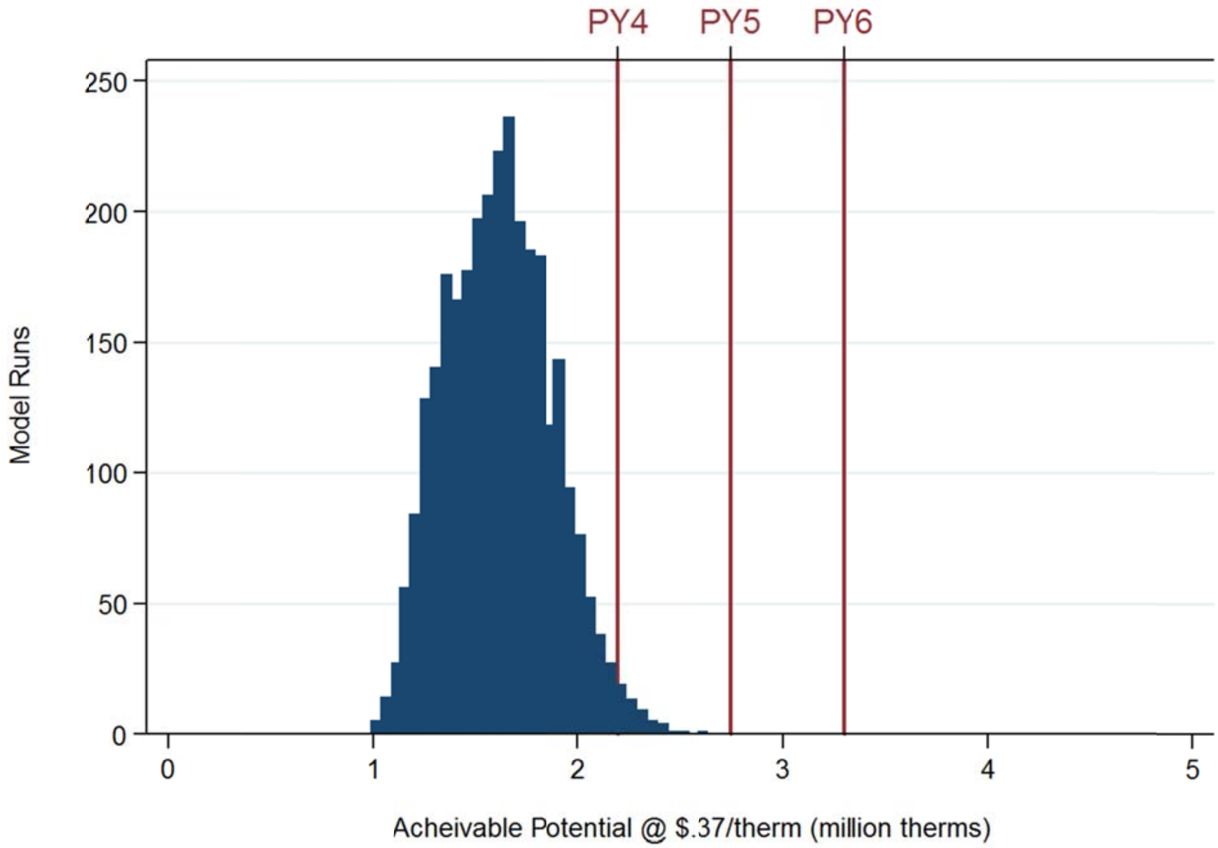
We can then compare this cost to the avoided cost of gas, which in our base case is $0.37 per therm. This suggests that the furnace upgrade is cost-effective because the incremental cost of the measure is less than the avoided cost (the per-therm dollar savings).

We calculate the cost of conserved energy for every measure. We rank the measures by that calculation. Once we select an avoided cost, any measure with a cost of conserved energy lower than that avoided cost passes the economic screen. Those with a cost of conserved energy in excess of the avoided cost fail the test. For the measures that pass the test, we count the total therm savings associated with that measure as economic potential. We apply achievability factors to convert those savings to achievable energy efficiency potential. We provide graphical results using this method later in the study.

ACHIEVABLE POTENTIAL—BASE CASE

We estimate in our base case that if the avoided natural gas cost remains near the current level, we expect that North Shore Gas could achieve 4.6 to 7.5 million therms per year (0.3 to 0.5 percent of utility sales) of energy efficiency savings. This is well below the statutory goals for all three program years. Figure 2 shows the full range of output results along with the statutory targets for programs years 4, 5 and 6.

Figure 2
North Shore Gas
Monte Carlo Model Results
Annual Achievable Energy Efficiency Potential



If there is one chart that presents the central core of our analysis it is Figure 2. Everything else is scenario analysis that reflects alternative, but less likely, futures.

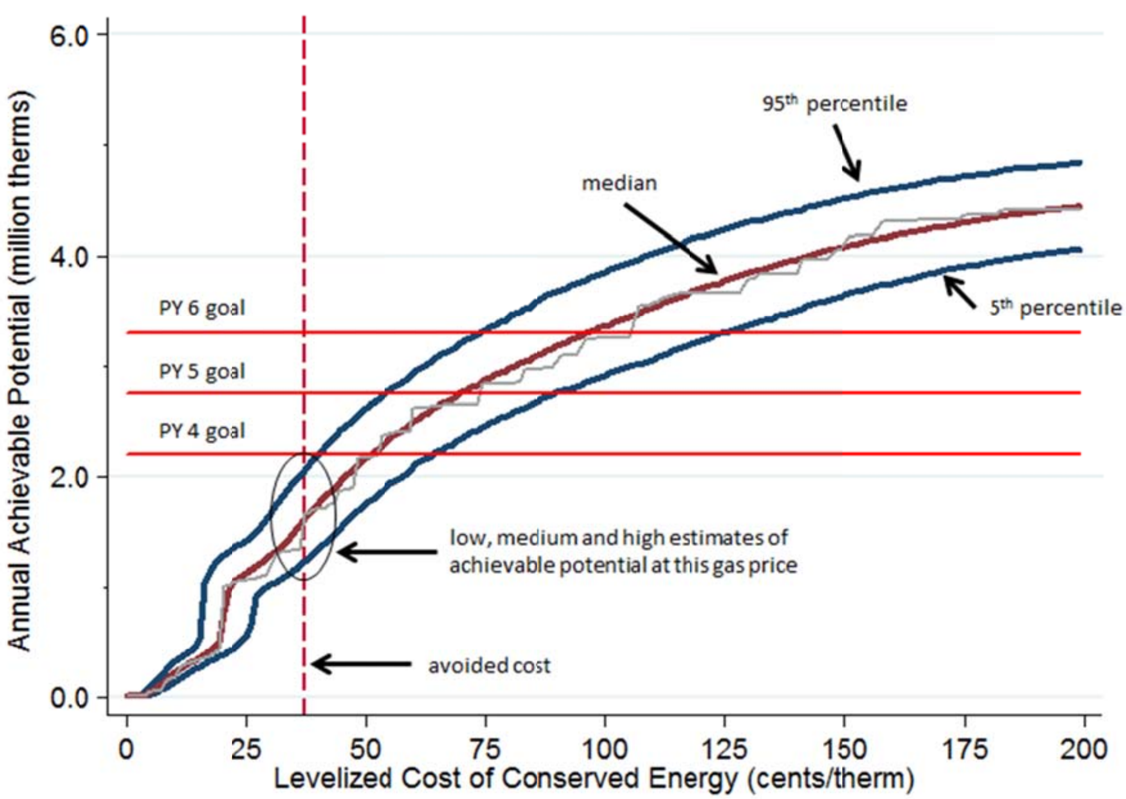
We should be explicit about a key assumption pervades this base case and the new few scenarios. We assume that the utility pays 50 percent of the incremental cost of measures. Unless noted otherwise, all conclusions we draw assume this incentive policy is in place.

Figure 2 presents achievability results at one avoided cost (i.e., one gas price) and one incentive policy. Achievability would increase if gas prices rose or if the utility paid a greater share of the incentive cost. We explore both those issues.

To conduct scenario analysis in which we change assumptions away from those used in the base case, a different chart comes into play. If we are going to vary the gas price, it is helpful to plot achievable potential against the cost of conserved energy. The cost of conserved energy and the avoided cost go hand in hand. For any given avoided cost, those measures that cost less than the avoided cost (i.e., those that have a cost of conserved energy lower than the avoided cost) are cost-effective and then can be promoted. Some customers will be persuaded to adopt those measures, thereby producing achieved potential.

Figure 3 provides estimates of achievable potential over a cost of conserved energy ranging for $0.00 to $2.00 per therm. We introduce this structure by showing the base case result.

Figure 3
North Shore Gas
Monte Carlo Model Results
Annual Achievable Potential vs. Avoided Cost
Base Case
(50% incentive policy)

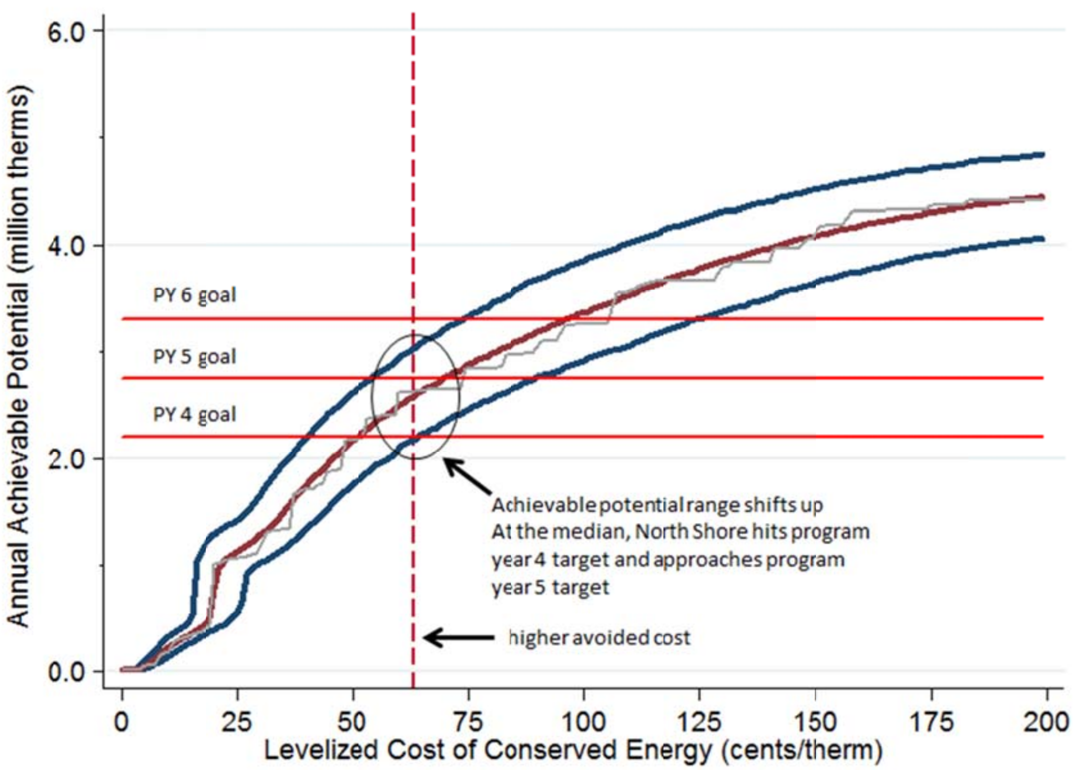


At our base avoided cost of $0.37 per therm, the range of achievable energy efficiency estimates does not reach the targets for any of the program years in question. At the 5th percentile (low estimate) of Monte Carlo outputs, the annual achievable potential is 1.2 million therms; at the median (medium estimate) is 1.6 million therms; and at the 95th percentile (high estimate) it is 2.1 million therms. The figure shows that the energy savings targets are 2.2 million, 2.8 million, and 3.3 million therms per year, respectively, for programs years 4, 5, and 6.

ACHIEVABLE POTENTIAL—HIGHER GAS PRICES

If we want to determine the achievable potential at higher gas prices, we simply move along the chart shown in Figure 3 to the point where the cost of conserved energy equals the avoided cost. Figure 4 shows this process using an avoided cost of $0.63 per therm, which is approximately the estimate North Shore Gas used when it prepared its plan for program years 1 through 3.

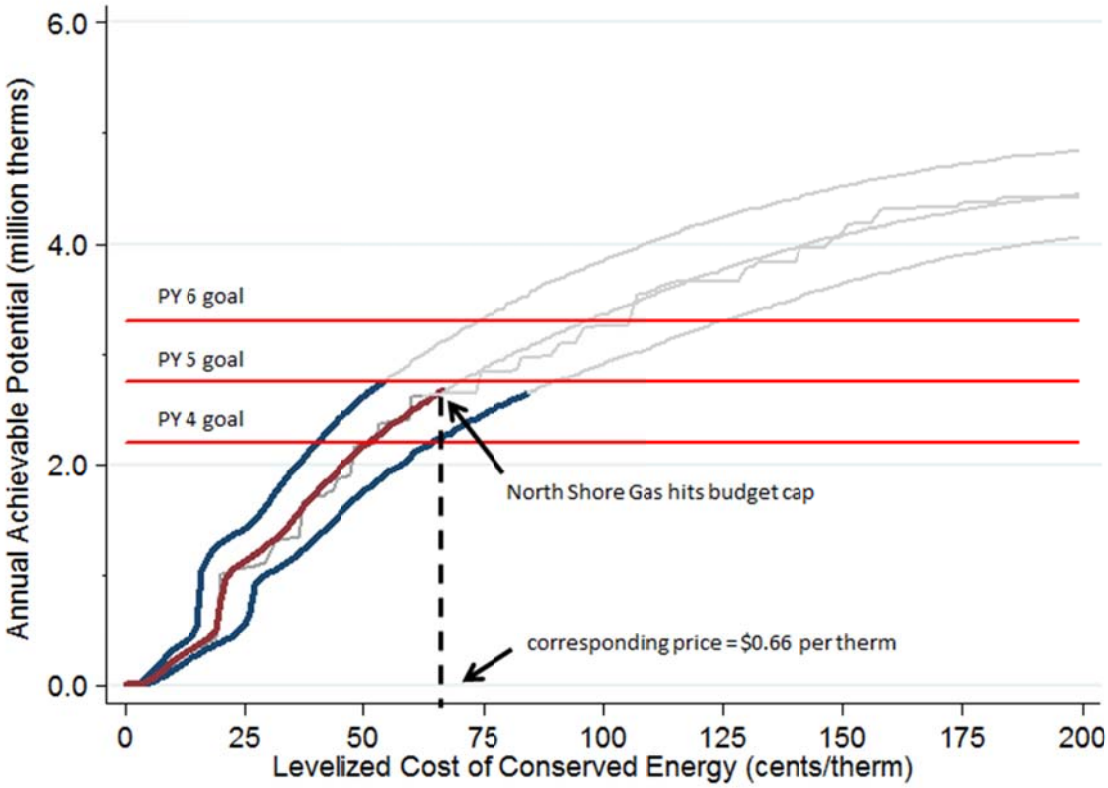
Figure 4
North Shore Gas
Monte Carlo Model Results
Annual Achievable Potential vs. Avoided Cost
Avoided Cost = $0.63 per therm
(50% incentive policy)



If the avoided cost reaches $0.63 per therm, we estimate that the range of annual achievable potential would then be 2.2 million to 3.0 million therms per year, and 2.6 million therms per year at the midpoint. We see North Shore Gas begins to hit the targets. If prices rose higher, say to about $1.00 per therm, North Shore Gas has a 50-50 chance of reaching the program year 6 target, as well.

But this analysis is a bit misleading. We have to consider the budget cap limitation. When we do we see that North Shore Gas cannot reach even the program year 5 target, no matter how high gas prices go, because it will hit its $5.3 million annual budget cap limitation. See Figure 5.

Figure 5
North Shore Gas
Monte Carlo Model Results
Annual Achievable Potential vs. Avoided Cost
Impact of the Budget Cap
(50% incentive policy)



Using the median estimate as our guide, if the utility pays 50 percent of the incremental cost of measures, it reaches its maximum achievable potential of 2.7 million therms per year when gas prices reach $0.66 per therm. This suggests that if North Shore Gas continues its 50 percent incentive policy, and if the budget cap remains at $5.3 million per year, North Shore Gas cannot reach the statutory targets for program years 5 and 6 no matter how high gas prices go.

POSSIBLE STRATEGIES TO INCREASE ACHIEVABLE POTENTIAL

While North Shore Gas cannot control gas prices, it does have control over other variables. We examined two possibilities in this regard to see whether North Shore Gas could increase achievability.

Greater Emphasis on the Commercial and Industrial Sector

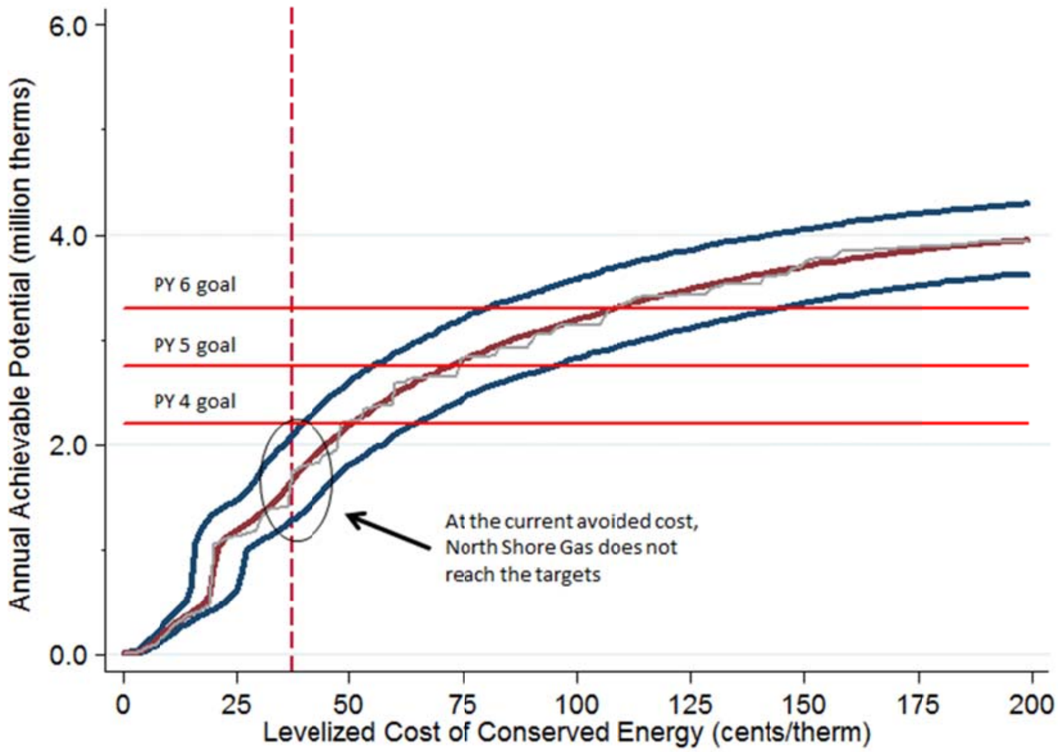
In our efficiency measure analysis, we found that there were proportionately more opportunities in the commercial and industrial sector than in the residential sector. Based on this finding, we explored the implications of North Shore Gas expending greater effort and resources to procuring efficiency in the former sector, and less effort and resources in the latter. We model this concept by changing the achievability factors as follows. See especially the shaded area, which highlights the significant changes in the achievability factors for the commercial and industrial customers, and especially for the industrial group.

Table 6
Achievability Factors by Segment
Base Case vs. Increased Commercial/Industrial Focus

Segment	End-of-Life Replacement		Retrofit	
	Base Case	Increased C&I Focus	Base Case	Increased C&I Focus
single-family non-low-income	27.0%	15.0%	0.9%	0.5%
single-family low-income	6.0%	6.0%	0.2%	0.2%
multi-family individually-metered non-low-income	15.0%	12.0%	0.5%	0.4%
multi-family individually-metered low-income	6.0%	6.0%	0.2%	0.2%
small multi-family master-metered non-low-income	15.0%	12.0%	0.5%	0.4%
small multi-family master-metered low-income	6.0%	6.0%	0.2%	0.2%
medium multi-family master-metered non-low-income	15.0%	12.0%	0.5%	0.4%
medium multi-family master-metered low-income	6.0%	6.0%	0.2%	0.2%
large multi-family master-metered non-low-income	15.0%	12.0%	0.5%	0.4%
large multi-family master-metered low-income	6.0%	6.0%	0.2%	0.2%
small and medium commercial	30.0%	37.5%	1.0%	1.3%
large commercial	30.0%	45.0%	1.0%	1.5%
industrial	30.0%	60.0%	1.0%	2.0%

This shift in focus increases achievable potential slightly. This may be due to the fact that while there appears to be proportionately more potential in the commercial and industrial sector, that sector is half the size of the residential sector. So under this approach North Shore Gas would be focusing more effort in a more economically attractive, but smaller sector. See Figure 6.

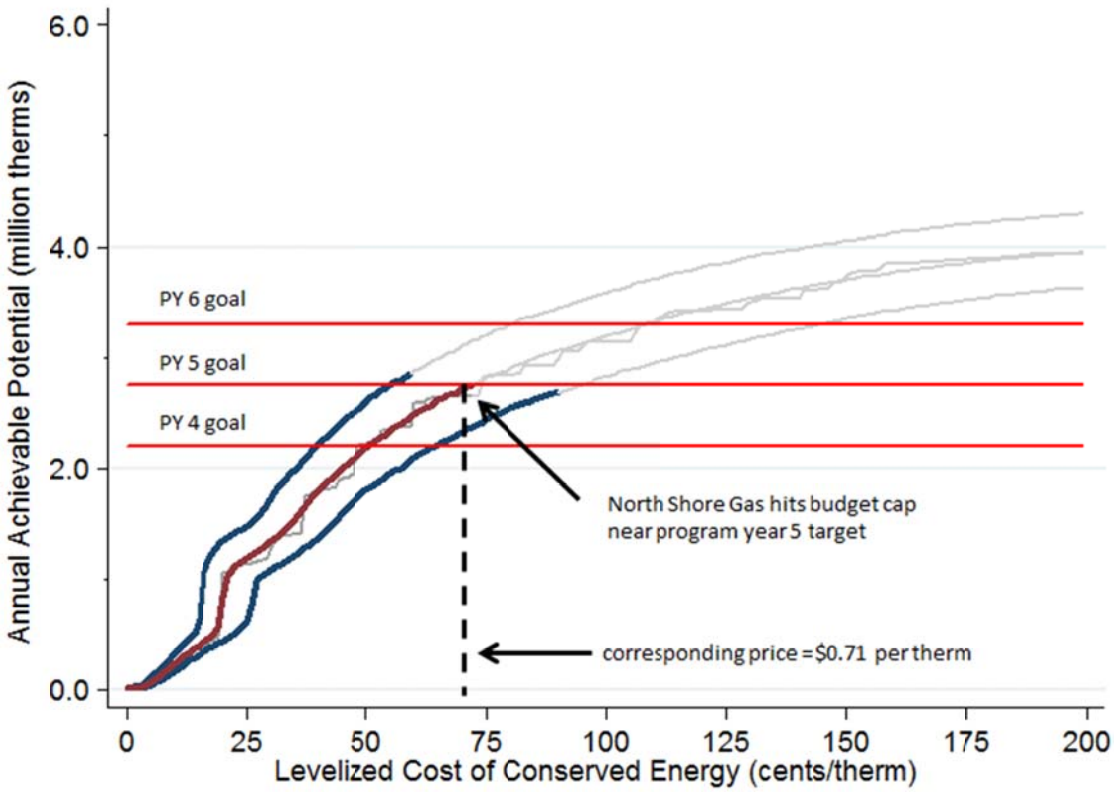
Figure 6
North Shore Gas
Monte Carlo Model Results
Annual Achievable Energy Efficiency Potential
Avoided Cost = $0.37 per Therm
Increased Focus on Commercial and Industrial Customers
(50% incentive policy)



Under this focused approach, if the avoided cost is $0.37 per therm and the utility pays 50 percent of the incremental cost of measures, the achievable potential range is 1.3 million to 2.1 million therms per year, which is almost identical to the base case range of 1.2 million to 2.1 million therms per year. This suggests that there is no a lot to be gained for North Shore Gas by shifting focus in this manner.

As Figure 7 shows, though, North Shore Gas under this scenario has a 50 percent chance of meeting the program year 5 target, as long as gas prices rise to $0.71 per therm. It cannot, however, reach the program year 6 target because it will run out of program funds before it does.

Figure 7
North Shore Gas
Monte Carlo Model Results
Annual Achievable Energy Efficiency Potential
Increased Focus on Commercial and Industrial Customers
Impact of Budget Cap
(50% incentive policy)



Higher Incentive Payments

The most direct way for North Shore Gas to achieve greater amounts of efficiency is to increase payments to customers who participate in efficiency programs. Whether it can do so and stay beneath the budget cap is the issue at hand.

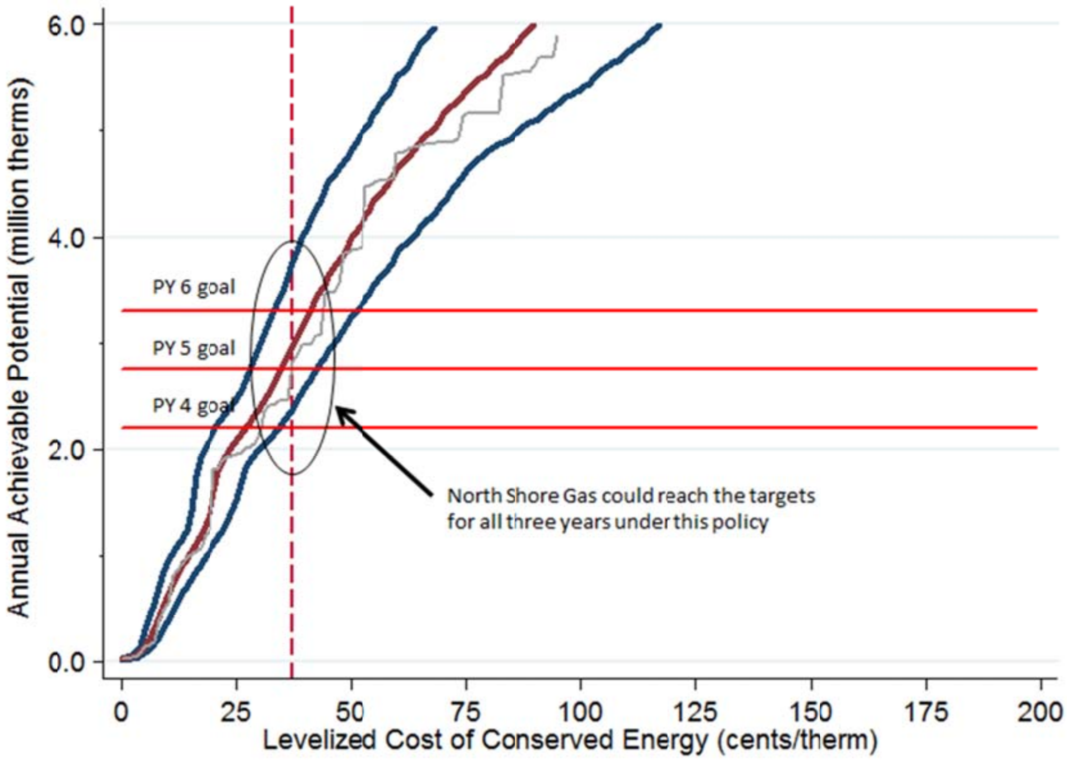
In the base case we assume that North Shore Gas pays 50 percent of the incremental cost of efficiency measures. Without prejudice as to the reasonableness of such a program design, to test whether a higher incentive payment policy could push the achievability potential estimate to the levels set forth in the statutes, in this scenario we increase the incentive payment to 100 percent of incremental cost and adjusted achievability factors up accordingly.

Table 7
Achievability Factors by Segment
Base Case vs. Higher Incentive Payments

Segment	End-of-Life Replacement		Retrofit	
	Base Case	Increased Incentives	Base Case	Increased Incentives
single-family non-low-income	27.0%	54.0%	0.9%	2.7%
single-family low-income	6.0%	12.0%	0.2%	0.6%
multi-family individually-metered non-low-income	15.0%	30.0%	0.5%	1.5%
multi-family individually-metered low-income	6.0%	12.0%	0.2%	0.6%
small multi-family master-metered non-low-income	15.0%	30.0%	0.5%	1.5%
small multi-family master-metered low-income	6.0%	12.0%	0.2%	0.6%
medium multi-family master-metered non-low-income	15.0%	30.0%	0.5%	1.5%
medium multi-family master-metered low-income	6.0%	12.0%	0.2%	0.6%
large multi-family master-metered non-low-income	15.0%	30.0%	0.5%	1.5%
large multi-family master-metered low-income	6.0%	12.0%	0.2%	0.6%
small and medium commercial	30.0%	60.0%	1.0%	3.0%
large commercial	30.0%	60.0%	1.0%	3.0%
industrial	30.0%	60.0%	1.0%	3.0%

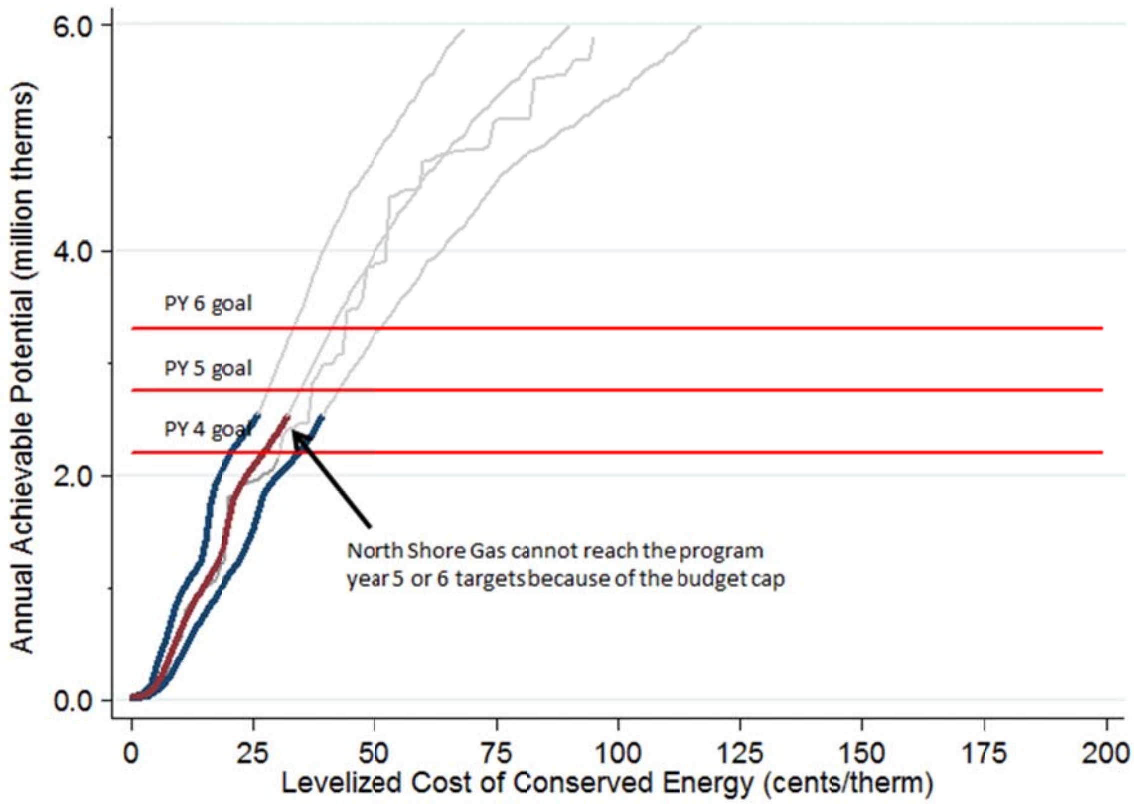
If North Shore Gas pays full incremental cost for all cost-effective measures, our analysis suggests that at first blush it appears that North Shore Gas can capture 2.3 to 3.8 million therms, which suggests that under this approach North Shore Gas could quite possibly meet the statutory target for all three program years. See Figure 8.

Figure 8
North Shore Gas
Monte Carlo Model Results
Annual Achievable Energy Efficiency Potential
Avoided Cost = $0.37 per Therm
(100% incentive policy)



But this achievable potential estimate is misleading because it fails to consider the budget cap, which looms large in this case. See Figure 9.

Figure 9
North Shore Gas
Monte Carlo Model Results
Annual Achievable Energy Efficiency Potential
Impact of Budget Cap
(100% incentive policy)



We see that North Shore Gas hits its budget limit between the targets for program year 4 and 5.

INCREASED INTEREST IN ENERGY EFFICIENCY

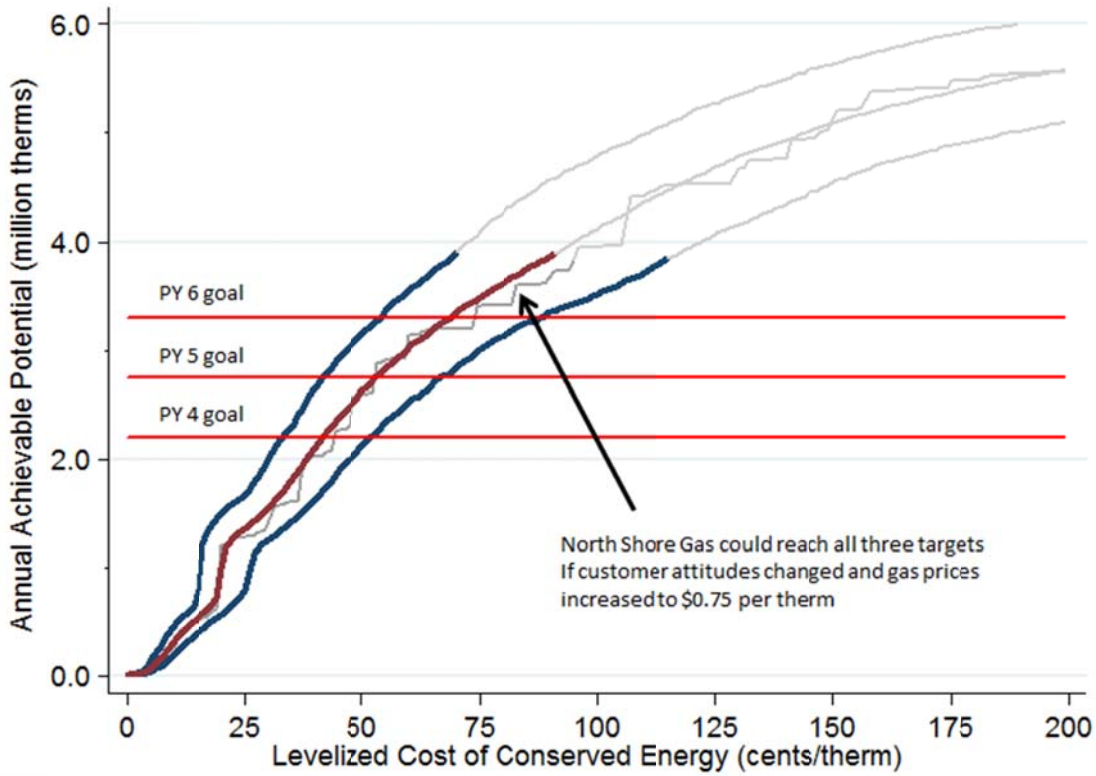
In order to test the robustness of our conclusions, we entertained a scenario in which customers manifested a significant increase in their interest in energy efficiency. Under this scenario we lowered the North Shore Gas incentive policy to 25 percent of incremental cost and increased the achievability factors. That is, North Shore Gas could not only pay less, it could achieve more than it did in the base case. This is an extremely optimistic scenario, and is more of a “what if” look at our model, rather than a realistic future. We are purposely trying to find a scenario where North Shore Gas can meet the targets for all three program years. We are not suggesting that such a scenario is likely.

Table 8
Achievability Factors by Segment
Base Case vs. Greater Customer Interest in Energy Efficiency

Segment	End-of-Life Replacement		Retrofit	
	Base Case	Increased Interest	Base Case	Increased Interest
single-family non-low-income	27.0%	36.0%	0.9%	1.4%
single-family low-income	6.0%	8.0%	0.2%	0.3%
multi-family individually-metered non-low-income	15.0%	20.0%	0.5%	0.8%
multi-family individually-metered low-income	6.0%	8.0%	0.2%	0.3%
small multi-family master-metered non-low-income	15.0%	20.0%	0.5%	0.8%
small multi-family master-metered low-income	6.0%	8.0%	0.2%	0.3%
medium multi-family master-metered non-low-income	15.0%	20.0%	0.5%	0.8%
medium multi-family master-metered low-income	6.0%	8.0%	0.2%	0.3%
large multi-family master-metered non-low-income	15.0%	20.0%	0.5%	0.8%
large multi-family master-metered low-income	6.0%	8.0%	0.2%	0.3%
small and medium commercial	30.0%	40.0%	1.0%	1.5%
large commercial	30.0%	40.0%	1.0%	1.5%
industrial	30.0%	40.0%	1.0%	1.5%

Having stepped through the process several times, in this case we proceed directly to the image of the achievable potential at the budget cap.

Figure 10
North Shore Gas
Monte Carlo Model Results
Annual Achievable Energy Efficiency Potential
Increased Customer Interest in Efficiency
Impact of Budget Cap
(25% incentive policy)



While this looks like a successful result, we must remember that this is a what if type scenario. That is, what would happen it customer attitudes about energy efficiency changed dramatically, and what if gas prices rose to $0.75 per therm? Then North Shore Gas would have a reasonable chance of reaching the statutory targets for all three years. But the gas price increase alone requires a 91 percent upward movement. And it is unclear why customer attitudes would change so fundamentally that they would participate more in North Shore Gas programs while receiving lower incentives

SCENARIO ANALYSIS CONCLUSION

Under current conditions, that is low gas prices and an incentive policy that sets rebates at 50 percent of incremental cost, North Shore Gas will not reach the program year targets. A combination of gas price increases, a shift in focus to the commercial and industrial sector and a change in incentive policy could let North Shore Gas meet the program year 4 target. Its ability to meet the program year 5 target is a bit more questionable and it appears to have little chance of meeting the program year 6 target.

ACHIEVABLE POTENTIAL—LOW-INCOME CUSTOMERS

In our base case, we estimate that the achievable potential for residential low income customers who participate in the North Shore Gas efficiency programs is 7,000 therms per year. In that case we assume that North Shore Gas would pay 50 percent of incremental cost, which is not typical of most low-income programs where full-cost incentives or direct installation of measures predominates. For this reason, in our study of the North Shore Gas programs we set the achievability factors for low-income homes at much lower than their non-low income counterparts (by either a factor of 4 for single-family homes, and a factor of 2 for multi-family residences).

RESIDENTIAL SECTOR

The following are the efficiency measures or concepts that offer the greatest potential.

NORTH SHORE GAS MEASURE	SAVINGS OPPORTUNITY (therms)	COST OF CONSERVED ENERGY ($ per therm)
Behavior programs—decile 1	580,448	0.20
Behavior programs—decile 2	314,108	0.37
Gas furnace efficiency upgrade—92%	96,435	0.31
Programmable thermostat	68,770	0.11
Low flow showerhead, direct install	44,210	0.08
Low flow aerators—faucet	28,636	0.17
Low flow showerhead, self-installed	23,184	0.09
Steam system pipe insulation	13,420	0.08
Gas boiler upgrade—95%	11,276	0.28
Gas boiler upgrade—90%	6,556	0.27
Hydronic system pipe insulation	6,169	0.16
Boiler—outdoor air reset/cutout controls	995	0.19
Recirculation—aquastat return temp controller	584	0.10
Steam trap—individual radiator maintenance/repair	275	0.34

We see that the behavioral program concept dominates the list. Targeted behavioral programs (i.e., home energy reports) appear to be a promising non-technological efficiency-inducing option in the residential sector. Our analysis suggests that if North Shore Gas implements such a program for the top two deciles of its customers (the 20 percent of its customers that use the most gas each year), it can garner much more efficiency savings than the combined impact associated with promoting all of the cost-effective technology options in that sector. Simply put, with current gas prices severely limiting technology-based efficiency opportunities, if North Shore Gas does not implement a behavioral program, there is only a minimal opportunity for efficiency savings in the residential sector.

Behavioral programs rely on social psychology (e.g., social norm concepts), not economic principles, to promote efficiency savings. Therefore, while lower gas prices can have a major deleterious effect on the economic attractiveness of energy efficient technologies, such price changes have little impact on behavioral programs. Those programs provide comparisons of gas usage (therms), not the dollar levels associated with that usage. Gas prices do not directly enter the mix here.

The targeted aspect of the program relates to the fact that larger volume customers who participate in home energy report studies not only save more gas in absolute terms, they do so in relative terms as well. (Davis, 2011) Based on our review of the research, we find suggest that the largest users (top ten percent) can save about 1.5 percent per year under such a program; the second decile can save 1.4 percent. In contrast, the last decile (bottom ten percent) can save only about 0.6 percent per year. This sort of targeting can lead to efficiency gains with the programs as only those who are likely to save substantial amounts of energy, and therefore who can be served cost-effectively, participate in this program. North Shore Gas can control who receives the reports. Customers in the targeted group who wish not to participate can opt out if they so desire.

COMMERCIAL AND INDUSTRIAL SECTOR

The following measures offer the most potential for savings in the commercial and industrial sector.

NORTH SHORE GAS MEASURE	SAVINGS OPPORTUNITY (therms)	COST OF CONSERVED ENERGY ($ per therm)
New construction programs	71,976	$0.30
Demand control ventilation	42,508	$0.22
Reduced temperature setpoints	25,108	$0.11
Programmable thermostat	23,937	$0.08
Steam trap maintenance program	21,971	$0.17
VAV system controls	20,191	$0.11
Retrocommisioning	15,158	$0.32
Heat recovery—refrigeration	15,114	$0.11
High efficiency storage tank water heaters	14,947	$0.22
High efficiency furnaces (<=300kBTU)	13,231	$0.17
Variable flow lab exhaust	12,669	$0.37
Boiler reset controls	9,773	$0.07
High efficiency boilers HVAC (condensing)	7,868	$0.26
High efficiency boilers DHW (condensing)	7,551	$0.06
Insulate HVAC pipes/lines	5,847	$0.17

We see that new construction leads the pack in this sector. It does not dominate the savings potential, however, as the behavioral program did in the residential sector.

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