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Peoples Gas Light & Coke Energy Efficiency Potential Study

Program Years 7, 8 and 9

March 2016

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CHAPTER 1: OVERVIEW AND RESULTS SUMMARY

Purpose of the Report

In 2013 the Energy Center of Wisconsin (Seventhwave's predecessor) completed the first energy efficiency potential study for Peoples Gas Light & Coke (Peoples Gas).[1] It covered years 4, 5 and 6 of the company's program planning and implementation cycle. This report updates that analysis, covering program years 7, 8 and 9.

Types of Energy Efficiency Potential Estimates

There are three major types of energy efficiency potential estimates, as described by the U.S. Environmental Protection Agency.[2]

- *Technical potential*: the maximum amount of energy use that could be eliminated by applying the most efficient available technology, regardless of cost-effectiveness and regardless of customer willingness to adopt the technology.

- *Economic potential*: the portion of the technical potential savings that is economically cost-effective, with no regard paid to consumer willingness to adopt the technology.

- *Achievable potential*: the portion of the economic potential savings not currently adopted in actual markets but that would be adopted in a given year as a result of energy efficiency programs.

Of the three, the achievable potential estimate is the only one that considers the practical realities of actual utility markets and it is the primary focus of this report. We discuss the other two potential concepts briefly later in the report.

Low Gas Prices Continue to Limit Energy Efficiency Potential

Our study determines on an item-by-item basis which option is less expensive: (1) saving gas by improving efficiency, or (2) purchasing gas from suppliers. We make these comparison with a large database of energy efficiency measures, one that spans all of Peoples Gas's customer sectors (residential, commercial and industrial) and includes all of its segments within those sectors (e.g., single-family vs multi-family in the residential sector, or office space vs. hospitals in the commercial sector).[3]

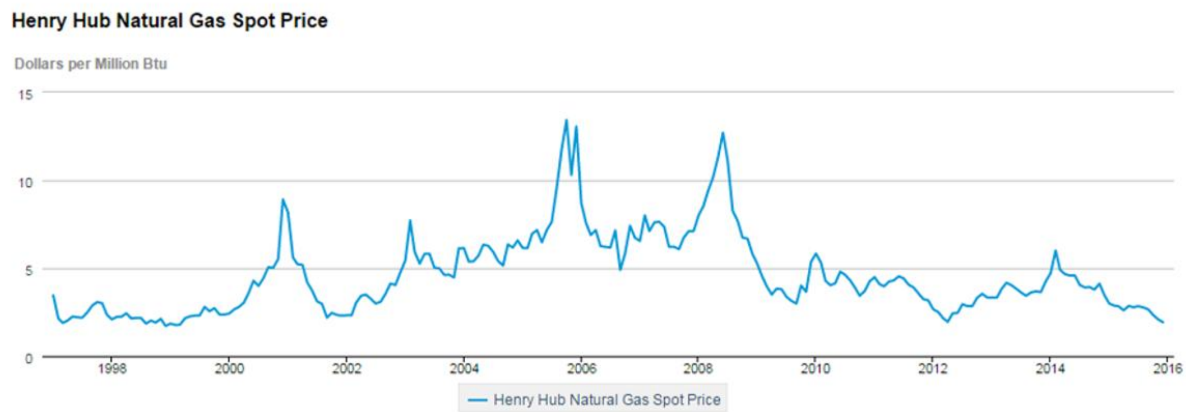
In the 2013 study we found that the low level of natural gas prices was a factor in preventing Peoples Gas from achieving the Illinois Legislature's energy saving goals established in 220 ILCS 5/8-104. Natural gas prices today remain below historical averages, at approximately half the levels seen when the Legislature established those goals in 2008. See Figure 1.

With today's low gas prices some energy efficiency measures that had been cost-effective in the past are no longer economical. A particular case in point is revealing. In our base case run high-efficiency furnaces used in single family homes have an effective cost (cost of energy saved) of $0.48 per therm, on

[1] Energy Center of Wisconsin, *Peoples Gas Light and Coke Company Energy Efficiency Potential Study: Program Years 4, 5 and 6*, May 2013.
[2] EPA (U.S. Environmental Protection Agency). 2007. *Guide for Conducting Energy Efficiency Potential Studies*. Washington, DC: EPA.
[3] For this analysis we exclude the results for low-income customers and public buildings because the Illinois Department of Commerce and Economic Opportunity (DCEO) is responsible for the energy efficiency programs serving those customers.

average.[4] When natural gas prices were $0.80 per therm, as they were circa 2006-2008, the reduction in gas costs associated with installing a high-efficiency furnace instead of a standard unit more than offset the incremental cost of moving to the high-efficiency model.[5]

Fig. 1 Natural Gas Prices at the Wellhead



Source: U.S. Energy Information Administration

With today's low gas prices some energy efficiency measures that had been cost-effective in the past are no longer economic. A particular case in point is revealing. In our base case run high-efficiency furnaces used in single family homes have an effective cost (cost of energy saved) of $0.48 per therm, on average.[6] When natural gas prices were $0.80 per therm, as they were circa 2006-2008, the reduction in gas costs associated with installing a high-efficiency furnace instead of a standard unit more than offset the incremental cost of moving to the high-efficiency model.[7]

But the economics of high-efficiency furnaces look much different today. Peoples Gas can currently purchase gas at a cost of only $0.44 per therm, which is less than the $0.48 per therm cost of the upgrade to the high-efficiency model. As such, it is less expensive for Peoples Gas customers as a whole if the utility purchases the additional gas necessary to heat a home with the standard furnace than it is to incur the cost associated with the upgrade to the more efficient model.[8]

This may be a surprising result for those with knowledge of the long history of utility-sponsored energy efficiency programs. Heating load accounts for about 75 percent of Peoples Gas residential natural gas consumption, with a large portion of that gas consumed in furnaces. For many years high-efficiency furnaces formed the backbone of gas utility efficiency programs, especially in cold-weather climates. Yet, because of the improvement in the efficiency of the standard model, and due to today's relatively low gas prices, currently that standard model is the more economical choice.

This situation ripples through all sectors and segments, noticeably limiting the potential for technology-based energy efficiency savings. If natural gas prices were to rise substantially, the economics would change and energy efficiency potential would increase, but there is no compelling evidence that gas prices are headed higher anytime soon.[9]

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[4] This is the levelized cost of the measure (an annuity payment) based on its expected life, divided by annual therms saved by the measure.
[5] Benefit-cost ratio = $0.80 / $0.48 = 1.67
[6] This is the levelized cost of the measure (an annuity payment) based on its expected life, divided by annual therms saved by the measure.
[7] Benefit-cost ratio = $0.80 / $0.48 = 1.67
[8] Benefit/cost ratio = $0.44 / $0.48 = 0.92
[9] See U.S. Energy Information Administration, *Short-Term Energy Outlook*, March 2016.

Behavioral Programs Offer Energy Savings Opportunities

As lower natural gas prices restrict the amount of energy savings potentially available from technology-based improvements, behavioral programs have the ability to pick up some of the energy-savings slack. Those programs focus on changing customers' actions regarding energy use (e.g., cutting shower times in half) rather than promoting technological improvements (e.g., installing a more efficient water heater).

Home energy reports fall into the behavioral category, although there can often be some ancillary associated effect on the technology-based program participation rate.[10] The reports provide customers with information about their current natural gas use relative to benchmarks, such as: (1) their historical consumption and (2) the use of similarly situated customers. They also include tips about actions customers can take to reduce gas use (e.g., washing clothes in cold water).

Many factors drive customer decisions about energy use, with economics being but one. While some customers save gas ultimately to save money, other customers may want to reduce consumption for environmental reasons (e.g., to reduce CO_2 emissions). Still other customers may simply want to use less gas than their neighbors do.[11] The latter two motivations relate to the consumption of gas per se, and not necessarily to the cost of gas. With efficiency potential from technology-based programs waning, we expect that behavioral programs will play a more noticeable role in helping reduce natural gas use precisely because results from those reports are less sensitive to gas price levels. This is precisely what our analysis suggests.

Home energy reports account for 62 percent of the potential savings in Peoples Gas's residential sector. Evaluation reports for Peoples Gas's existing home energy report program confirm the magnitude of the savings potential.[12] Interestingly, it is difficult for evaluators to discern precisely what customers are doing to reduce gas use in response to the information provided in the reports. Nevertheless, billing analysis reveals quite clearly that the reports are an effective means of lowering customers' gas use.

Base Case Achievable Potential Estimates are Lower Than the Statutory Goals

While the home energy reports will likely continue to produce cost-effective energy savings for Peoples Gas, those savings cannot totally offset the dampening effect of low natural gas prices on the savings expected from technology-based programs. Our base case analysis[13] shows that given current conditions Peoples Gas could capture the energy savings shown in Table 1. Those estimates lie noticeably below the statutory goals.[14]

Incorporating Uncertainty Does Not Change the General Conclusions

Determining energy efficiency potential requires that we estimate appropriate input values for hundreds of individual items, including the incremental cost of each measure, the energy savings potential of the measure, the portion of the customer base that will be in the market for that measure each year, the portion of the customer base that will install the measure without utility incentive payments, among other items. All of those input estimates for a particular measure (e.g., boiler tune ups) also can vary by sector (e.g., residential versus commercial) as well as by segment (e.g., single family versus large multi-family or office space vs. hospitals).

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[10] Behavioral programs often spur some customers to make technology-based efficiency improvements, either through utility program offerings or on the customer's own volition.

[11] P. Wesley Schultz, et al., "The Constructive, Destructive and Restructive Power of Social Norms," *Psychological Science*, 2007.

[12] Navigant Consulting, *Home Energy Reports Program GPY3 Evaluation Report*, October 3, 2014.

[13] These are the results based on the mid-point estimates for all input measures.

[14] The savings estimates are lower for years 8 and 9 than they are for year 7 because there is a one-time savings decay associated with home energy reports, as suggested in the Illinois Technical Reference Manual. See the body of the report for details.

We cannot know with certainty the exact value of each of these inputs. Since the aggregate energy efficiency potential is the sum of all of the inputs, that overall estimate is therefore also uncertain. To reflect this fact, instead of relying solely on single point estimates for the inputs of each measure we conducted a Monte Carlo simulation analysis. Under that approach estimates for the input variables vary randomly from iteration to iteration within a predetermined range.

Table 1
Peoples Gas
Efficiency Targets and Base Case Achievable Potential

Program Year	Time Period	Statutory Efficiency Target (% of sales)[15]	Statutory Efficiency Target (millions of therms)[16]	**Base Case Achievable Efficiency Potential (millions of therms)**
7	June 2017-May 2018	1.4%	19.0	**7.7**
8	June 2018-May 2019	1.5%	20.3	**6.7**
9	June 2019-May 2020	1.5%	20.3	**6.7**

For example, our analysis suggests that the average cost of sealing a home for air leaks in the Peoples Gas service area is $400, but in any iteration in our model it could vary from $240 to $560, based on the uncertainty range we associate with that estimate. An individual simulation run contains a particular value within that range, as determined by a random number generator.[17]

We apply this approach to every key input assumptions for all measures in a simulation run. We then repeat that process 9,999 times to produce a range of aggregate achievable energy efficiency savings. Table 2 presents the 95 percent prediction interval[18] for the aggregate energy savings based on those 10,000 simulation runs.

Table 2
Peoples Gas
Efficiency Targets and Upper and Lower Limits on Achievable Potential
(Monte Carlo Results)

Program Year	Time Period	Statutory Efficiency Target (% of sales)	Statutory Efficiency Target (millions of therms)	**Range of Achievable Efficiency Potential (millions of therms)**
7	June 2017-May 2018	1.4%	19.0	**6.1 to 9.2**
8	June 2018-May 2019	1.5%	20.3	**5.1 to 8.2**
9	June 2019-May 2020	1.5%	20.3	**5.1 to 8.2**

The Monte Carlo results reveal that even if we focus exclusively on the upper bound estimate (which is not the expected forecast, but rather one biased to the high side), Peoples Gas's potential savings figures still lie below the statutory goals.

[15] 220 ILCS 5/8-104.
[16] Information provided by Peoples Gas. Does not include revenues from customers served under DCEO's energy efficiency obligations.
[17] We assumed a uniform probability distribution for the range of values.
[18] The chance of the actual achievable potential estimate being outside this range is 5 percent.

The Budget Cap is Binding Only if Gas Prices Increase Noticeably

Illinois statutes limit Peoples Gas spending on efficiency programs over program years 7 through 9 to about $18 million per year.[19] Our analysis suggests that Peoples Gas can achieve the energy efficiency targets in Table 1 without exceeding that budget limit.

If gas prices were to rise, energy efficiency potential would increase because the economic benefits of saving energy would also increase. But greater participation in efficiency programs would also eventually consume the remaining program budget. Our analysis shows that if gas prices rise to $0.69 per therm Peoples Gas would increase its total achievable potential for program year 7 from the mid-point estimate of 7.7 million therms under current gas prices to 9.8 million therms per year under that higher price. But at that point it would reach its budget cap. It would then still be short of the 19 to 20 million therm annual statutory goals.

[19] This does not include dollars allocated for the DCEO programs.

CHAPTER 2: DESCRIPTION OF PEOPLES GAS

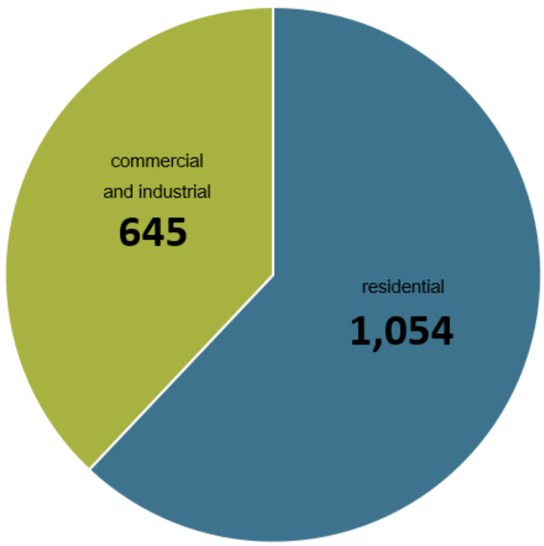
General Characteristics

Peoples Gas serves over 800,000 residential, commercial and industrial customers in the Chicago area. It sells about 1.7 billion therms of natural gas per year, with 62 percent flowing to residential customers. See Figure 2.

Fig. 2 Peoples Gas Sales Mix

Sales to Residential Customers Account for More Than Half of Total Sales

(millions of therms)



Residential Customers

Figure 3 describes natural gas use by residential customers that Peoples Gas serves. The left side of the figure shows gas consumption by customer segment and the right side consumption by end use.

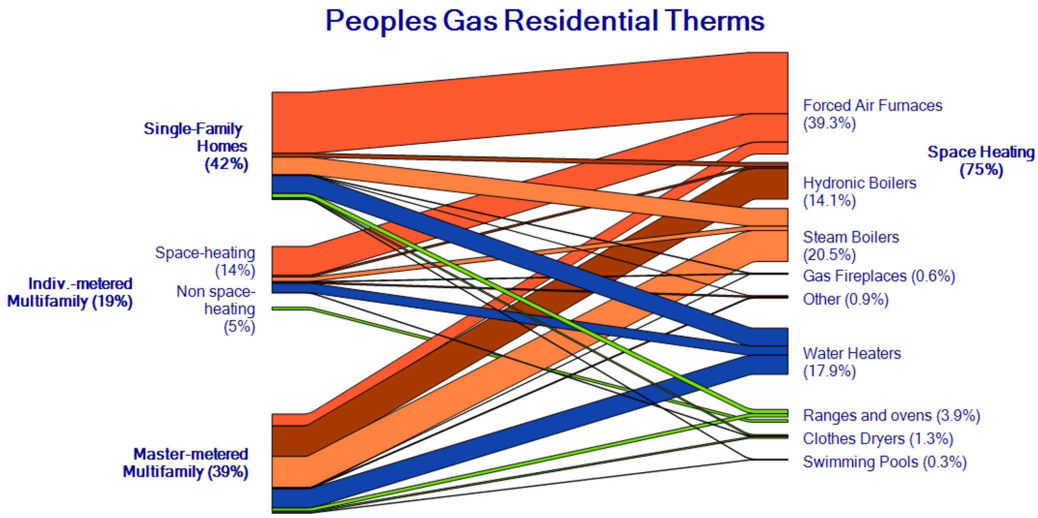
The figure shows that customers living in multifamily residences consume more gas in total than those in single family structures, which reflects the dense urban Chicago area that Peoples Gas serves. About 40 percent of the load flows to buildings with master meters. In that case, the principal target audience for energy efficiency programs is not the residents of the building, but the owner or manager.[20]

Space heating accounts for three-quarters of gas use in this sector. Adding water heating increases that figure to 93 percent. This suggests that the majority of energy savings opportunities are likely to lie in those two end use applications.

A detailed overview of end use consumption data for the residential sector can be found in Appendix A.

[20] While individual residents can make some efficiency improvements (e.g., installing low-flow showerheads), they typically cannot make building shell improvements or change out major equipment, such as boilers.

Figure 3: Peoples Gas Residential Customer Type and End Use Distribution



Commercial and Industrial Customers

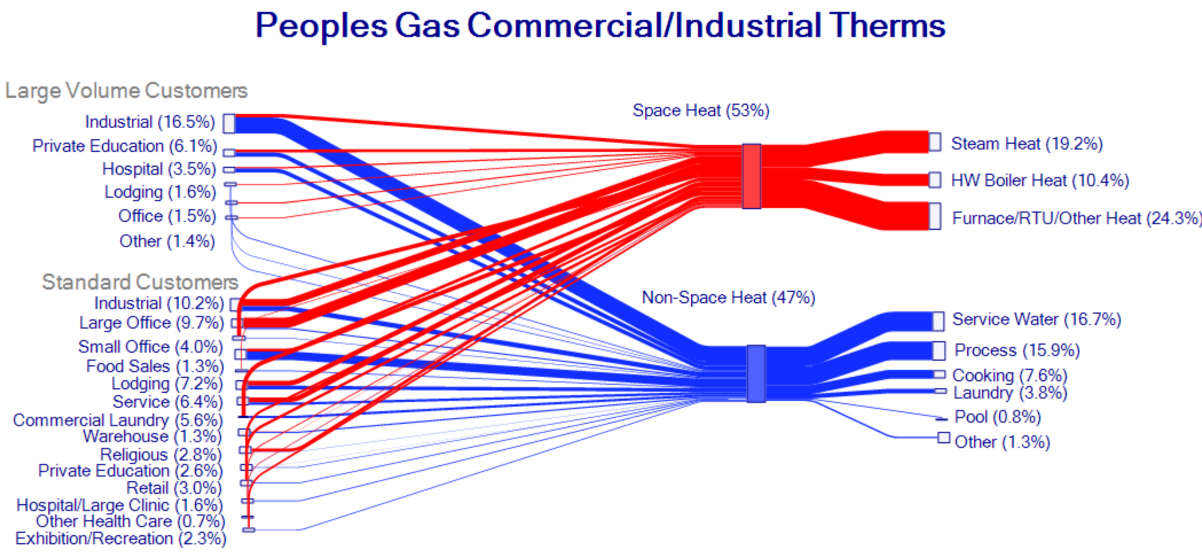
Figure 4 describes natural gas use by the commercial and industrial customers that Peoples Gas serves. As before, the left side of the figure shows gas consumption by customer segment and the right side consumption by end use.

Here we see a more diverse and heterogeneous environment vis-à-vis that observed in the residential sector. While there are certainly differences in total consumption between a large single family home and a small apartment, the latter is often a scaled-down version of the former in terms of natural gas use. That is not necessarily true in the commercial and industrial sector. A small office building is not simply a shrunken version of a large hospital.

With respect to end use consumption, again we see that space heating is the most significant item, but it is not as dominant as it is in the residential sector. Also, entirely new end uses emerge upon inspection of this sector, such as gas used in process loads. This suggests that there will be a wider range of commercial and industrial energy saving opportunities, and that programs designed to capture those savings will need to be more complex.

A detailed overview of end use consumption data for the commercial and industrial sectors can be found in Appendix B.

Figure 4: Peoples Gas Commercial and Industrial Customer Type and End Use Distribution



CHAPTER 3: DATA COLLECTION AND SUPPORTING ANALYSIS

Primary Data Collection for the 2013 Potential Study

In the prior potential study we gathered a substantial amount of primary data. We used both surveys and on-site inspections to help us understand and characterize the Peoples Gas service area. We used that data as a guide in building our energy efficiency potential model in the 2016 study.

2013 Residential Customers

We conducted telephone surveys for 1,400 of Peoples Gas residential customers using a sampling design stratified by customer gas usage, distributed across the sector segments. We followed up on the survey with 67 site visits to a subset of customers who completed the telephone survey. These visits 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 in some cases perform a blower door test. We interviewed residents to gather additional information about behavioral aspects of energy use.

2013 Commercial and Industrial Customers

We used a similar combination of surveys and site visits to gather primary data for this sector. It was important to split the customers into large and small in terms of volumes of sales because large customers often approach energy-related decision making in a different manner than do the smaller firms even in the same subsector. For example, large hospitals often have an energy manager while small clinics generally do not. We completed 440 telephone surveys in the commercial and industrial sector spread across the various customer segments. We also conducted 30 site visits to gather additional general information about this diverse sector.

Primary Data Collection for the 2016 Potential Study

The data collection conducted in 2013 provided a useful foundation upon which to build this study. We needed updated information in this case, but we didn't need to start from scratch.

Given that we had a substantial amount of data for Peoples Gas customers, and given that the data was gathered only three years ago, rather than conduct another massive round of surveys and site visits, we were able to update our information through the use of a smaller survey sample. We determined that we did not need any new site visits.

We conducted 705 telephone surveys in the residential sector. In the commercial and industrial sector we conducted 374 surveys.[21] The residential and commercial/industrial survey instruments are attached as Appendices D and E, respectively.

Illinois Technical Reference Manual

Much of the data we need to analyze energy efficiency measures—the incremental cost, useful life and expected annual savings—can be found in the *Illinois Technical Reference Manual*. Rather than just blindly accepting every estimate, however, we checked the data against our independent data. In nearly all cases the information in the manual seems to be on track, which reflects the considerable effort that has gone into assembling the data.

One exception that seems worthy of further review, however, is the cost of high-efficiency furnaces, a technology we discussed in the Overview section. The estimate of the incremental cost of the furnace

[21] At the outset of this study Peoples Gas informed us that it might be responsible for the energy efficiency programs that DCEO now providers. To allow for that potentiality, we conducted an additional 84 surveys of public buildings.

contained in the manual seems to be on the high side based on our review of recent data. In this study we used the information in the manual.

If that cost were lower, high-efficiency furnaces then might be cost-effective. If we did use a lower incremental cost, one that led to a conclusion that high-efficiency furnaces are cost-effective, the contribution to achievable potential would be 257,000 therms per year.

Other Studies

We used other studies from Illinois and other cold-weather climates to guide our analysis. Selected examples include:

- Evaluation Reports
    - Navigant Consulting, *Joint Utility RCx EPY6 GPY3 Report*, March 18, 2015.
    - Navigant Consulting, *Commercial & Industrial (C&I) Custom Rebate & Gas Optimization Services Programs GPY3 Evaluation Report*, January 12, 2015.
    - Navigant Consulting, *Home Energy Reports Program GPY3 Evaluation Report*, October 3, 2014.
    - Navigant Consulting, *GPY3 Evaluation Report for TRM-Based Programs*, January 2, 2015.
- Other Potential Studies
    - Max Neubauer, *Cracking the TEAPOT: Technical, Economic, and Achievable Energy Efficiency Potential Studies*, American Council for an Energy-Efficient Economy, August 2014.
    - Andrey Gribovich and Stefano Galiasso, *Illinois Public Sector and Low-Income Housing Energy Efficiency Potential Study*, Energy Resources Center, August 22, 2013.
    - GDS Associates, *Michigan Electric and Natural Gas Energy Efficiency Potential Study*, November 5, 2013.
    - Optimal Energy, *Potential for Natural Gas Fuel Efficiency Savings in Vermont*, February 10, 2015.
    - The Cadmus Group, *Assessment of Energy Capacity and Energy Savings in Iowa*, February 28, 2012.

Billing Analysis—All Sectors

Peoples 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 years 2013 through the first half of 2015 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 discussed earlier.

CHAPTER 4: TECHNICAL AND ECONOMIC POTENTIAL

Technical Potential

The Concept

Technical potential provides a theoretical outer bound estimate of energy efficiency potential. Rather than reflecting any practical aspects of real markets, a technical potential is akin to the results one obtains in a frictionless surface experiment in physics. Technical potential assumes that the most efficient technology always displaces less-efficient versions.

This assumes rapid turnover of even fairly new equipment. As a case in point, if a commercial customer installed an efficient water heater last year and a university lab develops a slightly more efficient water heater design, the technical potential estimate assumes that the customer will immediately scrap the former and install the later, even if the new equipment costs $7,000, for example.

Estimate

We estimate that the technical potential savings for Peoples Gas is about 40 percent, which would suggest that within a year Peoples Gas would be only a little more than half of the gas it sells today.

Drawbacks

Technical potential estimates are of at best limited value, at best, in a practical setting because they flow from assumptions that are far removed from reality. It is interesting to note that over half of the energy efficiency potential studies that the American Council for an Energy-Efficient Economy (ACEEE) reviewed in a recent meta-analysis did not provide a technical potential estimate.[22]

Economic Potential

The Concept

This energy efficiency potential estimate improves upon the technical potential estimate by incorporating economic considerations. It eliminates from consideration any measures that are not cost-effective, i.e., that effectively cost more to meet energy services needs than to do so by purchasing gas supplies.

Estimate

We estimate that the economic potential savings for Peoples Gas is about 25 percent. This suggests that Peoples Gas would immediately see its gas sales cut by about one quarter.

Drawbacks

Moving from technical potential to economic potential steps us a bit closer to reality, but the gap between that estimate and the actual situation is still quite wide. The notion that perfect markets guide consumers to make all economic investments in terms of energy use (or other resources) is an abstract theoretical concept.[23] Analysis of real, imperfect markets tells a different tale. Numerous studies have identified the frictions in real markets—market barriers—that prevent the economy from delivering immediately all of the cost-effective energy resources.[24]

The Cost of Energy Saved

To its credit, the economic potential estimate brings into focus the notion of cost-effectiveness, which is important. To develop this estimate we need to determine whether the benefits of reduced energy use

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[22] Max Neubauer, *Cracking the TEAPOT: Technical, Economic and Achievable Energy Efficiency Potential Studies*, American Council for an Energy-Efficient Economy, August 2014.
[23] Hal Varian, *Intermediate Microeconomics*, W.W. Norton & Co., 2014.
[24] See, for example, David Austin, *Addressing Market Barriers to Energy Efficiency in Buildings*, U.S. Congressional Budget Office, 2012.

exceed the cost of making the energy efficiency investment. To do that we need the following items for each measure:

1. The incremental cost of the measure
2. The estimated life of the measure
3. The annual energy savings
4. The discount rate (to convert future cash flows to their associated present values)
5. The avoided cost of gas

We will step through the process with a specific measure—steam pipe insulation for a particular single family home. The data for that measure are:

1.	The incremental cost of the measure	**$75**
2.	The estimated life of the measure	**15 years**
3.	The annual energy savings `	**100 therms**
4.	The discount rate[25]	**5.3%**
5.	The avoided cost of gas[26]	**$0.44 per therm**

Using this data we convert the upfront cost to a levelized annuity payment. We need to do that because the gas cost savings will occur over the life of the measure, so we need to express the cost over the same period. This is similar to the process used to convert the upfront cost of a home purchase to a monthly mortgage payment. In this case, we calculate an annual payment.

The payment can be determined using the PMT function in Excel. In this case the annualized equivalent of an upfront cost of $75 spread over 15 years at a 5.3 percent discount rate is $7.37 per year.

We then use that figure to determine the cost of energy saved, as follows:

$$\text{cost of energy saved} = \frac{\text{annual cost}}{\text{annual therm savings}}$$

In this situation:

$$\text{cost of energy saved} = \frac{\$7.37}{100\text{ therms}} = \$0.07\text{ per therm}$$

This tells us that instead of purchasing gas at $0.44 per therm it would be much less expensive for Peoples Gas if it could wrap steam pipes, which would cost it the equivalent of less than ten cents per therm. We conduct this sort of analysis for all measures in the database. If the cost of energy saved for a measure is less than $0.44 it is included in the economic potential; if it exceeds $0.44 per therm it is excluded.

<u>Total Resource Cost Test</u>

This analysis reveals that we are using the Total Resource Cost test, which determines cost-effectiveness without regard to which party bears which portion of the cost and how the benefit stream might be

[25] This is the same discount rate we used in the 2013 study. In discussions with Franklin Energy (Peoples Gas's program implementer) we verified that 5.3% is close to the utility's after-tax weighted cost of capital, which is a frequently-used reference point for a discount rate in potential studies.

[26] This is the avoided cost used by other Illinois gas utilities in recent analysis. It is close to current gas price levels.

allocated among them. This is the most frequently used benefit-cost framework in potential studies,[27] and is the standard approach in Illinois.

[27] Max Neubauer, *Cracking the TEAPOT: Technical, Economic, and Achievable Energy Efficiency Potential Studies*, American Council for an Energy-Efficient Economy, August 2014.

CHAPTER 5: ACHIEVABLE POTENTIAL

The Concept

When reviewing the definitions of energy efficiency potential note that in only the case of achievable potential does the final estimate have a time dimension (savings per year), which is a critical distinction. While economic potential uses the life of the measure to estimate the savings, once we know the result under that definition of achievability we assume that cost-effective resources are implemented immediately. The technical potential estimate, too, assumes immediate action on the part of all customers for all measures. As discussed, this is an extremely unrealistic assumption. Achievable potential is about the savings the utility can capture in a given year, which recognizes market realities.

Types of Energy Efficiency Opportunities

The analysis of achievable energy efficiency potential requires close attention to the specific nature of energy saving opportunities. We describe four types.

Replace on Burnout

With no efficiency programs in place, markets might drive us close to the economic potential estimate over the long run, but in real markets the pace is likely to be quite slow, perhaps taking several decades to achieve that result. Many natural gas appliances have long lives, and customers do not tend to replace equipment until it wears out. In such cases, Peoples Gas then has to wait for equipment failure before it has the opportunity to make an efficiency improvement. We refer to this as "replace on burnout."

To put this in context, a hypothetical example may be illustrative. Since water heaters have useful lives of approximately 20 years, only 5 percent ($1/20^{th}$) of the commercial water heating equipment might be available for an efficiency upgrade each year. But as we shall see, even that estimate is a bit high in terms of load that is available for efficiency improvements.

We know that some customers already have the most efficient appliance installed and when that equipment fails they will replace it with the most efficient model whether or not Peoples Gas has an efficiency program in place. There are no efficiency gains there. Another group of customers did not install the most efficient unit in the past, but they plan on doing so going forward with or without a utility incentive payment. There is an efficiency gain in that case, but it occurs naturally and not because of the utility program.

Assume that the consumption of natural gas for the water heating end use of these two groups of customers represents one-quarter of the total commercial water heating load. That means that the remaining commercial water heating end use load EU_{water} that in a given year could be upgraded to the more efficient water heater is given by:

$$EU_{water} = TURN \times (1 - NAT)$$

Here TURN is the annual appliance turnover (5 percent in this case) and NAT is the naturally occurring efficiency upgrades (25 percent in this case), so the portion of the commercial water heating end use load that could be upgraded is:

$$EU_{water} = 0.05 \times (1 - 0.25) = 0.038 \text{ or } 3.8\%$$

But to derive achievable potential there are more adjustments. The customers that use this 3.8 percent of the commercial water heating load are not the energy efficiency pioneers. These are the slow adopters.

Even if Peoples Gas will pay for 50 percent of the incremental cost of the equipment, our research shows that only about 30 percent of these customers will participate in the program.[28] This reduces the total end use in play for this measure to 1.1 percent of the load.[29]

But that isn't the energy efficiency savings, it's simply the load to which the efficiency would apply in this year. If that energy savings rate for the water heater efficiency upgrade is 20 percent, the efficiency program will ultimately deliver an energy savings of about 0.2 percent of the commercial water heating load in a given year.[30]

$$1.1\% \text{ of load making efficiency improvement x } 20\% \text{ savings rate} = 0.2\% \text{ total energy savings}$$

The economic potential estimate would be much higher because it would not recognize the slow turnover rate (turnover would be assumed to be 100 percent). It would assume that all customers that were not planning on installing the high-efficiency model would do so. So the water heating load in play would not be 3.8 percent as we would reasonably expect, but rather:

$$EU_{water} = 1 \times (1 - 0.25) = 0.75 \text{ or } 75.0\%$$

Instead of only 30 percent of the customers making the efficiency upgrade, all customers would do so—and Peoples Gas wouldn't even have to run a program to capture that savings. In fact, there would be no benefit at all from such a program as there would being no cost-effective resources that the market didn't capture.

Over time (about 20 years), the turnover issue will resolve itself as all water heaters will eventually burnout. But even then, since not all customers will install the most cost-effective water heater, the real market will never capture the full energy efficiency potential. Utility energy efficiency programs can help by capturing some, but not all, of that efficiency opportunity. Therefore, absent some unusual energy efficiency program design (e.g., the utility pays 100 percent or more of the incremental cost of the measure) achievable potential never fully captures economic potential, even over the long run.

Retrofit

Some efficiency improvements do not depend on equipment failure and therefore for those measures there is no natural impetus to take action in this regard. A water heater that fails must be replaced at that point; air leaks in a home never have to be sealed. The customer could seal them to reduce gas use, but there is no urgency.

We refer to all actions of this kind as "retrofit." The achievable potential estimate must reflect this fact as well—while it might be economical to take retrofit actions, that doesn't mean that such activities will naturally occur at a high rate, if at all. The economic potential calculation assumes that all cost-effective air sealing will occur within one program year. Under more realistic assumptions, we estimate that through its efficiency programs Peoples Gas could capture only 1 to 3 percent of such retrofit opportunities each year.[31]

[28] Our program participation rates are derived from reviews of other studies, many which include quantitative analysis based on payback rates and technology diffusion studies. We consider those analyses, as well as real options analysis (see Kihm and Cowan, *Uncertainty, Real Options, and Industrial Efficiency Analysis*, 2009 Summer Study on Energy Efficiency in Industry, American Council for an Energy-Efficient Economy) in developing our estimates using our judgment.
[29] 0.038 x 0.300 = 0.011
[30] 0.011 x 0.200 = 0.002
[31] The availability of retrofit opportunities varies by customer sector and segment.

New Construction

Building to beyond efficiency code can offer cost-effective savings to customers. Note that there is no turnover issue here—a building is in the new category only once, upon its initial construction. Therefore the entire load associated with all new buildings could be available for efficiency improvements, at least in theory. But many buildings are constructed just to meet the code and therefore the achievable potential is lower than the economic potential estimates would suggest.

Direct Install

The remaining category involves direct installation of energy efficiency measures. In the Peoples Gas multifamily program, for example, program staff will rely upon the building manager to install low-flow shower heads in all of the residential units in the building. The ability of Peoples Gas to achieve these savings then depends on the willingness of the building manager to participate in the program. Some do; others do not. The economic potential estimate assumes that all building managers will participate in the program in the year in question.

Aggregate Achievable Potential Estimates by Sector

Considering all of these market realities, we estimate that the achievable energy efficiency potential for Peoples Gas in program year 7 is 4.6 million therms in the residential sector (0.6 percent of residential sales) and 3.1 million therms in the commercial and industrial sector (0.5 percent of commercial and industrial sales), producing the aggregate 7.7 million therm figure (0.5 percent of total sales) shown in the Overview section.

CHAPTER 6: TOP EFFICIENCY MEASURES BY SECTOR

Tables 3 and 4 lists the individual measures that offer the greatest energy efficiency potential by sector, respectively. The home energy reports are listed by decile, which is explained in the next section.

Table 3 Top Residential Measures

Description of Measure	therms savings	% of total	cumulative % of total	cost of energy saved
Home energy reports - decile 1	1,510,500	32%	32%	$ 0.13
Home energy reports - decile 2	954,004	21%	53%	$ 0.21
Air sealing	283,587	6%	59%	$ 0.35
Smart thermostat - ROB contractor install	249,846	5%	64%	$ 0.41
Home energy reports - decile 3	242,511	5%	70%	$ 0.27
Steam system pipe insulation	202,386	4%	74%	$ 0.07
Home energy reports - decile 4	187,967	4%	78%	$ 0.35
Clothes Washer Recycling	173,832	4%	82%	$ 0.20
Programmable thermostat	138,417	3%	85%	$ 0.22
Condensing Storage water heater	105,271	2%	87%	$ 0.24
Gas boiler upgrade - 95%	89,796	2%	89%	$ 0.30
Multifamily Direct Install	74,221	2%	91%	$ 0.35
Low flow showerhead, direct install	69,230	1%	92%	$ 0.11
Low flow showerhead, self-installed	67,295	1%	94%	$ 0.17
Gas boiler upgrade - 90%	55,879	1%	95%	$ 0.32

Table 4 Top Commercial and Industrial Measures

Description of Measure	therms savings	% of total	cumulative % of total	cost of energy saved
New Construction Programs	528,182	17%	17%	$ 0.35
Variable Flow Kitchen Exhaust	235,023	8%	25%	$ 0.02
Demand Control Ventilation	217,042	7%	32%	$ 0.10
Chemical Sanitizing (Low Temp) Dishwashin	117,391	4%	36%	$ 0.09
HE Rooftop Units	116,266	4%	39%	$ 0.27
Steam Trap Maintenance Program	101,785	3%	43%	$ 0.10
HE Dishwashers	101,086	3%	46%	$ 0.08
HE Storage Tank Water Heaters	92,387	3%	49%	$ 0.24
CAV to VAV retrofit	92,051	3%	52%	$ 0.22
HE Furnaces (<=300kBTU)	87,253	3%	55%	$ 0.12
VAV system controls	78,636	3%	57%	$ 0.19
HE Boilers (Condensing)	65,330	2%	59%	$ 0.30
Retrocommisioning	63,706	2%	61%	$ 0.44
HE Boilers (Condensing)	58,709	2%	63%	$ 0.10
Heat Recovery - Refrigeration	55,925	2%	65%	$ 0.44

Note that home energy reports account for over half the savings in the residential sector. Note also that the top 15 measures in the residential sector account for almost all of the savings.

In contrast, the top 15 measures in the commercial sector account for less than two-thirds of the savings. This reflects the fact that the commercial and industrial sector is more heterogeneous than the residential sector. That reflects the fact that in the more-diverse commercial and industrial sector energy efficiency opportunities are spread across a wider number of measures. New construction offers noticeable opportunities in this sector.

A detailed list of all measures, both cost-effective and not cost-effective, for all sectors can be found in Appendix C.

CHAPTER 7: HOME ENERGY REPORTS

We estimate the cost-effectiveness and energy efficiency potential of the home energy reports in two ways. First we use the method applied in the 2013 study (no persistence of savings) and then use the method now embodied in the *Illinois Technical Reference Manual* (decaying persistence).

No Savings Persistence

Estimating the energy savings from Home Energy Reports requires a structural approach. The evidence suggests that consumers who use more gas, when provided with home energy reports, save not only more gas than lower-use customers in an absolute sense, but also in percentage terms. We estimate that the customers that lie in the 1st decile (the 10 percent of customers who use the most gas) will save 26 therms per year when provided with home energy reports. This amounts to 1.03 percent of their total usage. In contrast the customers in the 5th decile will save 8 therms, which amounts to 0.63 percent of their total usage. The cost of sending a home energy report does not depend on customer usage—the annual cost of sending reports to any Peoples Gas customer is $5.75 per year.

If report-related savings do not persist from year to year, calculating the cost of energy saved is straightforward. There is an annual cost for the reports and an annual amount of energy saved. If the reports stop, the customer's usage reverts to the historic behaviors. (This assumption seems unreasonable, which led to the update to the *Illinois Technical Reference Manual*.)

Under the no-persistence assumption the cost energy saved for the 1st decile is:

$$\textbf{1st decile} \quad \text{cost of energy saved} = \frac{\$5.75}{26\ \text{therms}} = \$0.22\ \text{per therm}$$

This cost is half the cost of purchasing gas supplies. The cost of energy saved for the 5th decile is:

$$\textbf{5th decile} \quad \text{cost of energy saved} = \frac{\$5.75}{8\ \text{therms}} = \$0.76\ \text{per therm}$$

This is much more expensive than the cost of purchasing gas supplies. It would be cost-effective for Peoples Gas to send home energy reports to the 1st decile, but not to the 5th decile. Our complete analysis reveals that it is cost-effective for Peoples Gas to send home energy reports to the 1st and 2nd deciles only.

With Savings Persistence

The preceding discussion sets the stage for a more-complex one. The Illinois Stakeholder Advisory Group has recently made some changes in the recommended analysis of home energy report as set forth in the *Illinois Technical Reference Manual*, which we adopted in this analysis. The major change is that analysis of home energy reports requires the assumption that energy savings persist for several years after the reports stop, albeit at a decaying rate.

This converts the one-year analysis discussed above to a five-year horizon. The first difference we notice in moving to the situation with persistent savings is that those savings increase. Instead of 26 therms, we expect the customers in the first decile to effectively save 44 therms in total.[32] The cost of energy saved for that decile is now even lower.

$$\textbf{1st decile} \quad \text{cost of energy saved} = \frac{\$5.75}{44\ \text{therms}} = \$0.13\ \text{per therm}$$

[32] This is the discounted therm balance over the 5-year period.

This cost is now about a quarter of the cost of purchasing gas supplies. The cost of energy saved for the 5th decile is improved, but still not quite at the level of cost-effectiveness (the $0.44 per therm target):

$$\textbf{5th decile} \quad \text{cost of energy saved} = \frac{\$5.75}{13\ \text{therms}} = \$0.46\ \text{per therm}$$

Our full analysis shows that under the persistent savings assumption, for program year 7 sending gas to the first four deciles is now cost-effective, instead of only to the first two deciles as we found in the no-persistence analysis.

Reports in Subsequent Years

The decaying level of energy savings that manifest in the persistent-savings case adds another level of complexity. Since the impact of the reports received in the first year carry over to some extent to the second year, if Peoples Gas sends out a report in the second year it cannot expect to produce the same level of savings as that generated by the reports in the first year. Rather, the second year reports just make up for the savings that would have been lost as the effect of the first year reports decayed over time. The reduced aggregate savings from the home energy reports from program year 7 to program years 8 and 9 shown in the Overview section is due to this effect.

This requires a separate analysis of the cost of energy saved for the years after the first year (program year 7). Our analysis shows that while it is cost-effective to send reports to the first four deciles in the first year, it is cost-effective to send them only to the first two deciles in the second and third years. Peoples Gas should then wait until the fourth year, at which point savings from the reports sent in the first would have decayed almost to zero, before again sending the reports to the third and fourth deciles.

This leads to the following conclusions based on the analysis of cost of energy saved under persistent savings.

- 1st decile — send reports in program year 7 and **every year** thereafter
- 2nd decile — send reports in program year 7 and **every year** thereafter
- 3rd decile — send reports in program year 7 and **every three years** thereafter
- 4th decile — send reports in program year 7 and **every three years** thereafter
- 5th decile — do not send reports in any year
- 6th decile — do not send reports in any year
- 7th decile — do not send reports in any year
- 8th decile — do not send reports in any year
- 9th decile — do not send reports in any year
- 10th decile — do not send reports in any year

Rather than using a three-year cycle as suggested above, we assumed that every year Peoples Gas sends reports to a separate one-third of the customers in deciles three and four. Over a three year period every customer in these deciles would receive one year of reports.[33]

[33] For evaluation purposes Peoples Gas needs to hold out a small group of customers from the entire report cycle to maintain a control group for comparison to the customers who receive the reports.

CHAPTER 8: MONTE CARLO SIMULATIONS

Incorporating Uncertainty

As noted in the Overview section of this report, the estimated values of the inputs are uncertain. To address this issue we employed a Monte Carlo simulation technique.[34] We can use our steam pipe wrap example to demonstrate the concept.

Instead of simply using the mid-point estimates for the cost of the measure and the annual gas savings, we use a number randomly selected from with the following ranges, based on our analysis of the potential uncertainty.

- Upfront cost (base $75) **$45 to $105**
- Annual energy savings (base 100 therms) **60 to 140 therms**

The life of the measure, the discount rate and the avoided cost of gas are held constant.

In the base case scenario we found that the cost of energy saved for steam pipe wrap to be $0.09 per therm. Note below how that estimate varies from iteration to iteration under the Monte Carlo approach.

Iteration 1

- Upfront cost **$92**
- Annual energy savings **57 therms**
- Cost of energy saved **$0.16 per therm**

Iteration 2

- Upfront cost **$102**
- Annual energy savings **76 therms**
- Cost of energy saved **$0.13 per therm**

Iteration 3

- Upfront cost **$59**
- Annual energy savings **82 therms**
- Cost of energy saved **$0.07 per therm**

In this simple example we see that the conclusion that steam pipe wrap is cost-effective appears to be a robust one. In none of these cases does the cost of energy saved approach the $0.44 per therm avoided cost.

In other cases, however, the random variation in the input parameters will cause the measure to vary around that avoided cost. This means that in some scenarios those measures will be included in the achievable energy efficiency estimates and in others they will not.

Uncertainty Factors in the Simulation

The preceding discussion provides a simplified example of the simulation approach we used. The actual simulation model applied uncertainty factors to the following input variables for each efficiency measure.

[34] For a detailed explanation of the Monte Carlo method in Stata (the program we used), see David M. Drukker, "Monte Carlo simulations using Stata," http://blog.stata.com/2015/10/06/monte-carlo-simulations-using-stata/

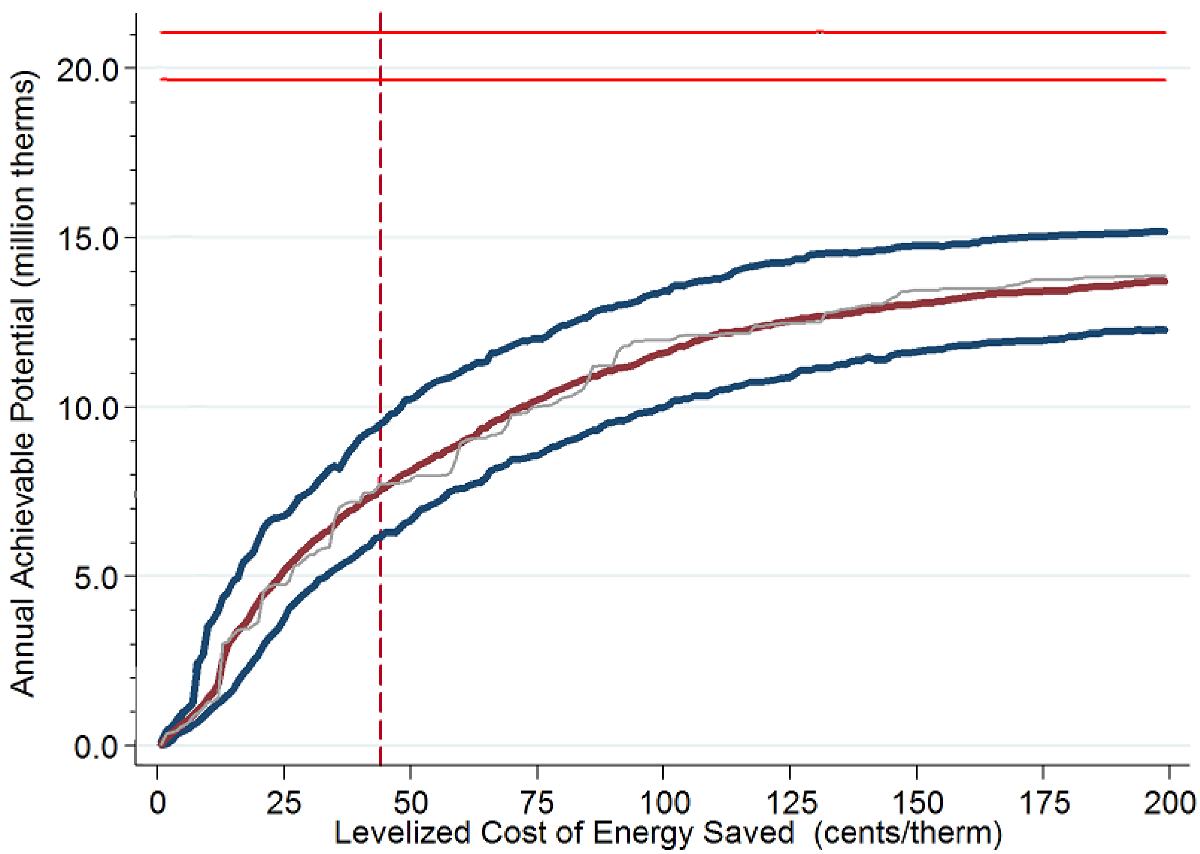
- The energy savings rate
- The energy efficiency achievability percentage [35]
- The incremental cost
- The net-to-gross ratio[36]

We applied ranges of varying degrees ranging from low uncertainty (+/- 20%) to high uncertainty (+/- 60%) depending on the nature of the variable and the confidence we have in the data we gathered or estimated for each variable.

The 95 Percent Prediction Interval for Achievable Energy Efficiency Potential

Figure 5 shows the Monte Carlo estimates of the achievable energy efficiency. We are 95 percent confident that the true figure lies between the blue upper and lower bounds shown on the chart. The brown line represents the median. The light gray line shows the base case result with no uncertainty. The two red horizontal lines represent the program year 7 and program year 8 & 9 statutory targets.

Figure 5 Monte Carlo Results



The dashed vertical line at 44 cents per therm provides the cost-effectiveness cut-off point. The accumulated energy efficiency total to the left of the line is comprised entirely of measures that are cost-

[35] This is the percentage of the load that would not have made the efficiency improvement that is spurred by the program to do so.

[36] This measure determines the extent to which free riders (those who would have made the efficiency improvement without the program) participate in the program. The lower the number, the more incentive payments Peoples Gas makes to free riders.

effective vis-à-vis current gas supply costs. The additional energy savings potential to the right of that line flows from energy efficiency measures that are not currently cost-effective at that price.

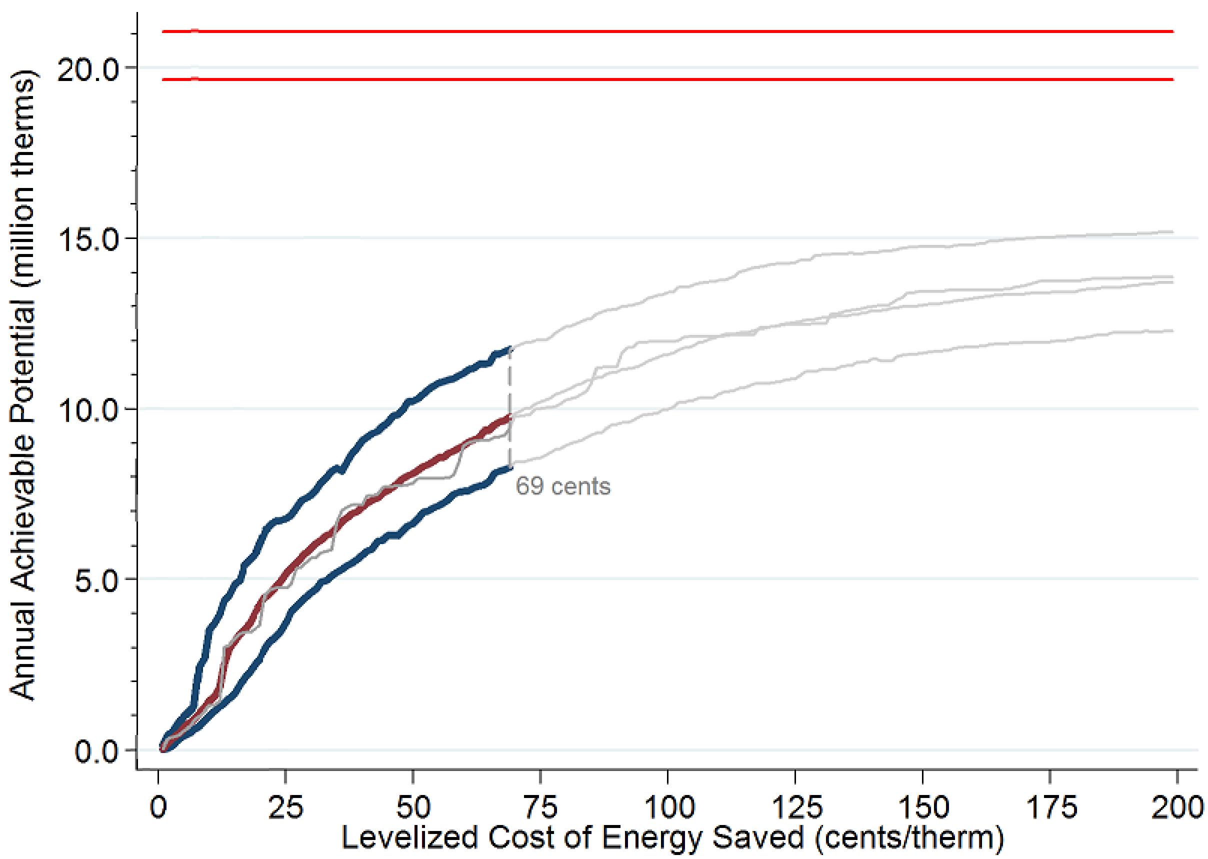
If gas prices were to rise, the vertical line would move to the right. Then the accumulated energy efficiency potential to the left of that line, which would then be a higher amount relative to that which is achievable under the lower price, would again be comprised solely of cost-effective measures. Any additional energy efficiency potential to the right of the line would not be cost-effective. We see that as gas prices rise, it becomes more expensive to purchase supplies and more energy efficiency measures become cost-effective.

CHAPTER 9: THE BUDGET CAP

Illinois statutes limit energy efficiency spending by Peoples Gas to 2.0 percent of its revenues. As discussed in the Overview section, this amounts to about $18 million per year for the utility. Under current conditions Peoples Gas can capture the achievable energy efficiency potential discussed earlier without exceeding this budget.

We conducted an analysis to see how high natural gas prices would need to rise for Peoples Gas to reach that threshold. As gas prices rise more measures become cost-effective, and more customers participate in energy efficiency programs. This depletes the Peoples Gas efficiency budget. We see that this would likely occur if gas prices reached 69 cents per therm.

Figure 6 Gas Price Threshold at Which Peoples Gas Depletes Its Program Budget



CHAPTER 10: KEY CONCLUSIONS

The major takeaways from this potential study are:

- Achievable energy efficiency opportunities for Peoples Gas lie in the range of 6.1 to 9.2 million therms for program year 7, and 5.1 and 8.2 million therms per year for program year 8 and for program year 9.
- Higher gas prices would increase energy efficiency potential, but in capturing those opportunities Peoples Gas would expend its full program budget before approaching the statutory goals.
- Home energy reports account for more than half the energy efficiency opportunities in the residential sector.
- New construction offers the greatest energy saving opportunities in the commercial and industrial sector.

APPENDIX A: RESIDENTIAL END USE MATRIX

Utility	Segment	% rental premises	% rental therms	mean housing units per premise	Total therms	Total premises	Space heat therms	Non space-heat therms	space heating -steam therms	space heating -steam premises
PGL	single family - non low-income (NON)	15%	13%	1.0	347,220,360	268,040	268,200,501	79,019,859	55,394,661	42,901
PGL	single family - low-income (LI)	32%	29%	1.0	91,244,550	64,510	71,701,124	19,543,426	16,625,775	12,390
PGL	Indiv. metered multi-family (NON)	66%	62%	1.0	129,823,850	192,100	98,782,745	31,041,105	8,012,462	14,392
PGL	Indiv. metered multi-family (LI)	81%	81%	1.0	70,089,690	91,530	50,996,573	19,093,117	9,996,353	12,133
PGL	Master metered small (NON)			3.5	85,395,240	45,100	65,809,176	19,586,064	28,982,102	12,996
PGL	Master metered small (LI)			3.3	33,959,090	17,330	27,205,500	6,753,590	10,861,168	4,295
PGL	Master metered medium (NON)			15.2	78,454,720	6,930	62,167,182	16,287,538	44,884,961	4,982
PGL	Master metered medium (LI)			18.1	32,200,890	2,510	23,559,188	8,641,702	17,503,836	1,865
PGL	Master metered large (NON)			88.6	139,763,120	1,580	97,888,275	41,874,845	18,522,208	633
PGL	Master metered large (LI)			67.4	34,321,650	570	28,257,752	6,063,898	5,941,747	256
PGL	Master metered non-heat (NON)			1.0	8,906,140	69,880				
PGL	Master metered non-heat (LI)			1.0	3,463,500	24,550				
PGL	TOTAL				1,054,842,800	784,630	794,568,015	247,905,145	216,725,273	106,843

Utility	Segment	space heating -hydronic therms	space heating -hydronic premises	space heating - furnace therms	space heating - furnace premises	space heating - fireplace therms	space heating - fireplace premises	space heating - other therms	space heating - other premises	water heating therms	water heating premises	cooking therms	cooking premises
PGL	single family - non low-income (NON)	12,237,107	10,707	198,599,319	211,752	1,969,876	37,526	0	0	58,526,114	254,638	13,750,546	249,277
PGL	single family - low-income (LI)	3,672,489	3,092	50,618,103	41,286	213,794	3,226	569,941	1,290	14,715,954	59,349	3,723,794	62,575
PGL	Indiv. metered multi-family (NON)	4,227,094	10,581	81,517,150	153,680	2,272,015	42,262	2,753,958	3,842	23,476,466	172,890	6,260,391	192,100
PGL	Indiv. metered multi-family (LI)	3,156,539	8,919	35,420,320	59,495	269,349	4,577	2,154,636	2,746	14,369,387	79,631	3,963,969	91,530
PGL	Master metered small (NON)	15,288,885	9,554	20,829,857	21,197	229,731	1,804	478,605	451	15,543,947	40,590	2,884,957	39,237
PGL	Master metered small (LI)	5,728,730	3,157	9,848,250	8,838	350,321	2,426	417,564	347	5,320,826	15,770	976,687	15,077
PGL	Master metered medium (NON)	12,578,085	1,255	3,832,680	416	235,649	347	635,716	69	13,303,873	6,445	1,896,277	4,019
PGL	Master metered medium (LI)	4,907,111	470	960,137	100	16,002	25	174,570	25	7,131,163	2,309	850,566	1,205
PGL	Master metered large (NON)	65,816,900	663	11,325,711	174	322,592	47	1,943,554	32	31,912,661	1,533	6,315,484	1,011
PGL	Master metered large (LI)	21,102,983	268	1,193,403	23	0	0	0	0	4,853,119	553	826,847	314
PGL	Master metered non-heat (NON)												
PGL	Master metered non-heat (LI)												
PGL	TOTAL	148,715,923	48,666	414,144,930	496,961	5,879,329	92,240	9,128,544	8,802	189,153,512	633,708	41,449,518	656,345

Utility	Segment	clothes dryer therms	clothes dryer premises	swimming pool therms	swimming pool premises	space heating -steam incidence	space heating -steam avg. use	space heating - hydronic incidence	space heating - hydronic avg. use	space heating - furnace incidence	space heating - furnace avg. use	space heating - fireplace incidence	space heating - fireplace avg. use
PGL	single family - non low-income (NON)	4,866,918	211,752	1,876,000	2,680	16%	1,291	4%	1,143	79%	938	14%	52
PGL	single family - low-income (LI)	1,103,699	44,512	0	0	19%	1,342	5%	1,188	64%	1,226	5%	66
PGL	Indiv. metered multi-family (NON)	1,304,248	96,050	0	0	7%	557	6%	399	80%	530	22%	54
PGL	Indiv. metered multi-family (LI)	759,764	42,104	0	0	13%	824	10%	354	65%	595	5%	59
PGL	Master metered small (NON)	1,157,161	30,217	0	0	29%	2,230	21%	1,600	47%	983	4%	127
PGL	Master metered small (LI)	456,057	13,517	0	0	25%	2,529	18%	1,815	51%	1,114	14%	144
PGL	Master metered medium (NON)	1,087,240	5,267	0	0	72%	9,009	18%	10,022	6%	9,213	5%	679
PGL	Master metered medium (LI)	372,122	1,205	286,907	25	74%	9,385	19%	10,441	4%	9,601	1%	640
PGL	Master metered large (NON)	2,598,656	1,248	1,048,586	190	40%	29,261	42%	99,271	11%	65,090	3%	6,864
PGL	Master metered large (LI)	385,335	439	0	46	45%	23,210	47%	78,742	4%	51,887	0%	0
PGL	Master metered non-heat (NON)												
PGL	Master metered non-heat (LI)												
PGL	TOTAL	14,091,200	446,311	3,211,493	2,941								

Utility	Segment	space heating - other incidence	space heating - other avg. use	water heating incidence	water heating avg. use	cooking incidence	cooking avg. use	clothes dryer incidence	clothes dryer avg. use	swimming pool incidence	swimming pool avg. use
PGL	single family - non low-income (NON)	0%	0	95%	230	93%	55	79%	23	1.00%	700
PGL	single family - low-income (LI)	2%	442	92%	248	97%	60	69%	25	0%	0
PGL	Indiv. metered multi-family (NON)	2%	717	90%	136	100%	33	50%	14	0%	0
PGL	Indiv. metered multi-family (LI)	3%	785	87%	180	100%	43	46%	18	0%	0
PGL	Master metered small (NON)	1%	1,061	90%	383	87%	74	67%	38	0%	0
PGL	Master metered small (LI)	2%	1,203	91%	337	87%	65	78%	34	0%	0
PGL	Master metered medium (NON)	1%	9,213	93%	2,064	58%	472	76%	206	0%	0
PGL	Master metered medium (LI)	1%	6,983	92%	3,088	48%	706	48%	309	1%	11,476
PGL	Master metered large (NON)	2%	60,736	97%	20,823	64%	6,247	79%	2,082	12%	5,519
PGL	Master metered large (LI)	0%	0	97%	8,778	55%	2,633	77%	878	8%	0
PGL	Master metered non-heat (NON)										
PGL	Master metered non-heat (LI)										
PGL	TOTAL										

APPENDIX B: COMMERCIAL AND INDUSTRIAL END USE MATRIX

Utility	Segment	Total gas consumption (therms)	Number of premises	Average consumption per premise (therms)	Space Heating Gas Consumption therms)	Non-Space Heating Gas Consumption (therms)	Share of Gas Use by End Use Space heating	Service Hot Water	Comm. kitchen	Comm. Laundry	Swimming pool
PGL	Small Office	20,198,537	8,987	2,248	17,810,278	2,388,260	88%	7%	1%	1%	0%
PGL	Large Office	48,720,857	320	152,253	43,618,115	5,102,742	90%	6%	1%	1%	0%
PGL	Warehouse	29,578,431	2,527	11,705	24,703,338	4,875,093	84%	15%	0%	0%	0%
PGL	Food Sales	6,653,608	1,719	3,871	3,007,731	3,645,877	45%	11%	44%	0%	0%
PGL	Food Service	49,135,813	5,878	8,359	12,944,426	36,191,387	26%	29%	44%	0%	0%
PGL	Retail	15,053,433	5,064	2,973	11,516,967	3,536,466	77%	9%	9%	0%	0%
PGL	Education	13,058,242	1,257	10,393	10,175,972	2,882,270	78%	13%	2%	2%	2%
PGL	Religious	13,985,900	2,896	4,829	12,962,913	1,022,988	93%	3%	4%	0%	0%
PGL	Exhibition/Recreation	11,672,898	2,015	5,793	8,097,888	3,575,011	69%	12%	18%	0%	6%
PGL	Other Health Care	3,551,602	993	3,577	3,011,394	540,209	85%	12%	2%	2%	0%
PGL	Hospital/Large Clinic	7,899,403	60	131,657	4,141,477	3,757,926	52%	29%	5%	10%	0%
PGL	Service	28,037,936	4,919	5,700	17,933,765	10,104,172	64%	18%	0%	11%	0%
PGL	Commercial Laundry	6,440,691	177	36,388	964,671	5,476,020	15%	0%	0%	85%	0%
PGL	Lodging	36,171,516	1,293	27,975	20,758,555	15,412,961	57%	23%	6%	9%	4%
PGL	Industrial	51,489,705	2,701	19,067	30,755,002	20,734,703	60%	4%	0%	0%	0%
PGL	Large volume, other	7,239,731	10	723,973	4,030,448	3,209,283	56%	22%	4%	2%	2%
PGL	Large volume, office	7,414,182	11	674,017	5,164,046	2,250,136	70%	18%	3%	0%	0%
PGL	Large volume, hospital	22,938,180	18	1,274,343	6,123,036	16,815,144	27%	51%	7%	15%	0%
PGL	Large volume, hotel	7,845,786	9	871,754	4,165,555	3,680,231	53%	26%	7%	9%	5%
PGL	Large volume, private educ	30,492,282	7	4,356,040	12,488,064	18,004,218	41%	41%	9%	6%	3%
PGL	Large volume, industrial	83,284,820	62	1,343,304	15,669,192	67,615,628	19%	8%	0%	0%	0%

				Share of Space Heating by Primary Space Heating Type					Share of Premises by Primary Heating System Type				
Utility	Segment	Process	other	Steam	Hydronic	Furnace	Rooftop unit	Other	Steam	Hydronic	Furnace	Rooftop unit	Other
PGL	Small Office	0%	3%	19%	16%	31%	15%	18%	5%	2%	66%	14%	13%
PGL	Large Office	0%	3%	77%	17%	1%	0%	5%	67%	22%	1%	0%	10%
PGL	Warehouse	0%	2%	9%	3%	36%	38%	14%	6%	4%	20%	33%	36%
PGL	Food Sales	0%	0%	7%	32%	2%	59%	0%	4%	66%	4%	26%	0%
PGL	Food Service	0%	0%	0%	25%	28%	47%	0%	1%	22%	52%	25%	0%
PGL	Retail	0%	5%	13%	0%	38%	46%	3%	4%	0%	68%	27%	1%
PGL	Education	0%	2%	44%	24%	6%	26%	0%	16%	2%	37%	44%	0%
PGL	Religious	0%	0%	20%	21%	33%	15%	11%	3%	12%	68%	12%	6%
PGL	Exhibition/Recreation	0%	0%	23%	11%	24%	33%	9%	1%	3%	47%	46%	3%
PGL	Other Health Care	0%	0%	0%	44%	36%	19%	0%	0%	18%	69%	13%	0%
PGL	Hospital/Large Clinic	0%	5%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%
PGL	Service	0%	7%	8%	6%	46%	28%	12%	0%	4%	47%	35%	14%
PGL	Commercial Laundry	0%	0%	0%	0%	30%	48%	22%	0%	0%	68%	25%	8%
PGL	Lodging	0%	0%	35%	55%	10%	0%	0%	2%	11%	85%	0%	2%
PGL	Industrial	36%	0%	15%	9%	31%	32%	13%	6%	1%	53%	33%	7%
PGL	Large volume, other	0%	13%	70%	20%	0%	10%	0%	60%	30%	0%	10%	0%
PGL	Large volume, office	0%	9%	70%	20%	0%	10%	0%	60%	30%	0%	10%	0%
PGL	Large volume, hospital	0%	0%	70%	20%	0%	10%	0%	60%	30%	0%	10%	0%
PGL	Large volume, hotel	0%	0%	70%	20%	0%	10%	0%	60%	30%	0%	10%	0%
PGL	Large volume, private educ	0%	0%	70%	20%	0%	10%	0%	60%	30%	0%	10%	0%
PGL	Large volume, industrial	73%	0%	70%	20%	0%	10%	0%	60%	30%	0%	10%	0%

APPENDIX C: MEASURE RESULTS

Sector	Measure code	Measure Type	Measure Description	Applicable therms	Energy Efficiency Saturation	Savings Rate	Measure Life	Cost OF Energy Saved	Achievable Factor	Achievable Potential
R	R-EN-AI-001	Retrofit	Attic / ceiling insulation, open attic, uninsulated	526,619,546	0.71	0.14	25	0.79	0.01	138,058
R	R-EN-AI-002	Retrofit	Attic / ceiling insulation, open attic, R-11 or less existing	526,619,546	0.83	0.08	25	1.33	0.01	45,740
R	R-EN-AI-003	Retrofit	Attic / ceiling insulation, open attic, R-12 - R-19 existing	526,619,546	0.59	0.02	25	3.55	0.01	28,164
R	R-EN-AI-004	Retrofit	Attic / ceiling insulation, open attic, R-20 - R-30 existing	526,619,546	0.90	0.02	25	5.14	0.01	7,656
R	R-EN-AI-005	Retrofit	Attic / ceiling insulation, open attic, R-31+ existing	526,619,546	0.86	0.01	25	13.33	0.01	3,931
R	R-EN-AI-006	Retrofit	Attic / ceiling insulation, floored attic	44,368,355	0.25	0.01	25	3.61	0.01	4,184
R	R-EN-AI-007	Retrofit	Attic / ceiling insulation, cathedral ceiling	167,897,644	0.59	0.02	25	2.10	0.01	10,957
R	R-EN-AI-008	Retrofit	Attic / ceiling insulation, kneewall	62,073,155	0.00	0.03	25	2.35	0.01	20,474
R	R-EN-AS-001	Retrofit	Air sealing	494,959,603	0.05	0.10	15	0.57	0.01	409,028
R	R-EN-FD-001	Retrofit	Int Foundation wall insulation, basement	391,717,562	0.26	0.20	25	0.60	0.01	555,180
R	R-EN-FD-002	Retrofit	Int Foundation wall insulation, crawlspace	37,548,070	0.00	0.09	25	0.68	0.01	33,720
R	R-EN-FD-003	Retrofit	Ext foundation insulation	150,833,140	0.05	0.40	25	0.91	0.01	546,402
R	R-EN-FD-004	Retrofit	Slab edge insulation	24,254,066	0.00	0.03	25	2.26	0.01	5,902
R	R-EN-FD-005	Retrofit	Rim joist insulation	350,496,461	0.01	0.04	20	1.32	0.01	136,853
R	R-EN-FE-001	ROB	Windows – on replacement: higher performance	587,079,045	0.25	0.09	35	0.85	0.30	194,296
R	R-EN-FE-003	Retrofit	Windows – Add storm windows to single pane windows	463,876,012	0.68	0.02	30	3.34	0.01	16,688
R	R-EN-FL-001	Retrofit	Floor insulation	156,366,595	0.62	0.02	25	0.43	0.01	9,679
R	R-EN-WI-001	Retrofit	Wall cavity insulation, exterior blow	225,441,761	0.71	0.12	25	1.71	0.01	72,891
R	R-EN-WI-002	Retrofit	Wall cavity insulation, interior blow	270,512,180	0.69	0.15	25	2.40	0.01	118,818
R	R-EN-WI-003	Retrofit	Walls ext rigid board insulation	192,937,271	0.12	0.07	25	1.32	0.01	126,296
R	R-SH-AL-001	Retrofit	Programmable thermostat	442,150,507	0.37	0.05	5	0.24	0.01	145,989

Sector	Measure code	Measure Type	Measure Description	Applicable therms	Energy Efficiency Saturation	Savings Rate	Measure Life	Cost OF Energy Saved	Achievable Factor	Achievable Potential
R	R-SH-AL-002	Retrofit	Space heating submetering	93,683,870	0.05	0.10	20	2.43	0.01	89,000
R	R-SH-AL-003	NC	New Construction	7,806,573	0.05	0.10	25	0.73	0.20	148,325
R	R-SH-AL-004	Retrofit	Home energy reports - decile 1	152,575,800	0.00	0.01	5	0.13	0.90	1,510,500
R	R-SH-AL-005	Retrofit	Home energy reports - decile 2	106,000,388	0.00	0.01	5	0.21	0.90	954,004
R	R-SH-AL-006	Retrofit	Home energy reports - decile 3	89,819,094	0.00	0.00	5	0.27	0.90	242,511
R	R-SH-AL-007	Retrofit	Home energy reports - decile 4	78,319,803	0.00	0.00	5	0.35	0.90	187,967
R	R-SH-AL-014	Retrofit	Smart thermostat - self-install	442,150,507	0.06	0.07	7	0.91	0.01	263,551
R	R-SH-AL-015	DI	Smart thermostat - direct-install	442,150,507	0.06	0.07	7	0.91	0.01	263,551
R	R-SH-AL-016	DI	Multifamily Direct Install	433,436,930	0.51	0.04	10	0.35	0.01	74,221
R	R-SH-AL-017	ROB	Smart thermostat - ROB contractor install	442,150,507	0.06	0.07	22	0.64	0.30	359,388
R	R-SH-BL-002	ROB	Gas boiler upgrade - 90%	110,148,071	0.26	0.08	25	0.55	0.30	77,922
R	R-SH-BL-003	ROB	Gas boiler upgrade - 95%	110,148,071	0.23	0.12	25	0.51	0.30	125,753
R	R-SH-BL-004	Retrofit	Boiler - outdoor air reset/cutout controls	93,683,870	0.65	0.08	20	0.28	0.01	21,677
R	R-SH-BL-005	Retrofit	Boiler tune-up	265,944,465	0.43	0.02	3	2.19	0.01	18,434
R	R-SH-BL-007	Retrofit	Steam to HW conversion	31,159,279	0.00	0.25	50	0.77	0.01	77,898
R	R-SH-BL-008	Retrofit	Steam Package A - single-pipe upgrades	73,911,417	0.15	0.10	6	1.49	0.01	64,081
R	R-SH-BL-009	Retrofit	Steam trap - individual radiator maintenance / repair	18,477,854	0.00	0.13	6	0.26	0.01	23,750
R	R-SH-BL-011	Retrofit	Hydronic system pipe insulation	99,133,264	0.23	0.03	15	0.33	0.02	17,002
R	R-SH-BL-012	Retrofit	Steam system pipe insulation	140,216,755	0.23	0.11	15	0.07	0.02	202,386
R	R-SH-BL-014	Retrofit	Boiler vent Damper	198,473,179	0.28	0.08	15	0.58	0.01	107,194
R	R-SH-FU-001	ROB	Gas furnace efficiency upgrade - 92%	140,013,000	0.24	0.12	20	0.88	0.30	193,171
R	R-SH-FU-002	Retrofit	Duct sealing /insulation		0.50	0.05	20	0.48	0.01	

Sector	Measure code	Measure Type	Measure Description	Applicable therms	Energy Efficiency Saturation	Savings Rate	Measure Life	Cost OF Energy Saved	Achievable Factor	Achievable Potential
				62,025,038						15,506
R	R-WH-AP-001	ROB	EStar - Clothes washer - (gas WH & gas dryer)	529,763,524	0.45	0.01	14	0.67	0.30	39,503
R	R-WH-AP-002	ROB	EStar - Clothes washer - (gas WH but not gas dryer)	211,440,376	0.45	0.00	14	1.17	0.30	11,241
R	R-WH-AP-003	ROB	EStar Most Efficient - Clothes washer - (gas WH & gas dryer)	529,763,524	0.45	0.01	14	1.32	0.30	64,521
R	R-WH-AP-004	ROB	EStar Most Efficient - Clothes washer - (gas WH, not gas dryer)	211,440,376	0.45	0.01	14	2.11	0.30	20,051
R	R-WH-AP-005	ROB	Dishwasher replacement	47,665,261	0.49	0.00	13	18.67	0.30	918
R	R-WH-AP-006	Retrofit	Kitchen range - replace ranges with pilot lights	33,334,190	0.74	0.40	20	2.38	0.01	32,007
R	R-WH-AP-009	ROB	Estar Clothes Dryer	546,317,410	0.15	0.00	14	3.21	0.30	30,590
R	R-WH-AP-010	Retrofit	Ozone Clothes Washing	741,203,900	0.05	0.01	15	3.69	0.01	50,386
R	R-WH-AP-011	ROB	Clothes Washer Recycling	741,203,900	0.05	0.01	3.7	0.66	0.30	357,610
R	R-WH-EU-001	Retrofit	Low flow aerators - faucet	142,763,062	0.60	0.07	9	0.37	0.01	29,175
R	R-WH-EU-002	Retrofit	Low flow showerhead, self-installed	142,763,062	0.00	0.09	10	0.17	0.01	67,295
R	R-WH-EU-003	Retrofit	Low flow showerhead, direct install	142,763,062	0.54	0.17	10	0.11	0.01	69,230
R	R-WH-SP-001	Retrofit	Swimming pools –covers	2,685,623	0.01	0.28	6	0.43	0.01	6,836
R	R-WH-WH-001	ROB	High Efficiency Water Heater (power venting)	93,385,738	0.15	0.13	13	1.57	0.30	242,958
R	R-WH-WH-002	ROB	Condensing Storage water heater	120,866,938	0.05	0.35	13	0.86	0.30	875,090
R	R-WH-WH-003	ROB	Whole house tankless water heater	93,385,738	0.08	0.41	13	0.95	0.30	807,196
R	R-WH-WH-004	Retrofit	Water heater pipe insulation	142,763,062	0.25	0.03	15	0.25	0.02	46,566
R	R-WH-WH-005	Retrofit	Hot water temp setting change	142,763,062	0.59	0.03	2	0.45	0.01	9,207
R	R-WH-WH-006	Retrofit	Drainwater heat recovery	46,110,447	0.00	0.17	20	2.47	0.01	79,353
R	R-WH-WH-007	Retrofit	Indirect WH -pipe insulation retrofit	24,446,732	0.38	0.08	15	0.08	0.01	8,246
R	R-WH-WH-010	Retrofit	Recirculation - aquastat return temp controller	47,470,347	0.50	0.14	20	0.45	0.01	15,386

Sector	Measure code	Measure Type	Measure Description	Applicable therms	Energy Efficiency Saturation	Savings Rate	Measure Life	Cost OF Energy Saved	Achievable Factor	Achievable Potential
R	R-WH-WH-011	Retrofit	High efficiency dedicated WH boiler	20,896,042	0.08	0.11	15	0.95	0.01	21,846
C	C-CK-001	ROB	HE Broilers	3,806,413	0.40	0.25	12	0.15	0.30	14,274
C	C-CK-002	ROB	HE Convection Ovens (rack oven, conveyor)	7,612,826	0.40	0.29	12	0.02	0.30	33,213
C	C-CK-003	ROB	HE Fryers	7,232,184	0.40	0.31	15	0.23	0.30	26,925
C	C-CK-004	ROB	HE Griddles	3,045,130	0.40	0.12	12	0.05	0.30	5,604
C	C-CK-006	ROB	Infrared Charbroiler	3,806,413	0.10	0.45	12	0.38	0.30	38,540
C	C-CK-007	ROB	Infrared Rotisserie Oven	1,522,565	0.10	0.50	12	0.56	0.30	17,129
C	C-CK-008	ROB	Infrared Salamander Broiler	761,283	0.10	0.50	12	0.48	0.30	8,564
C	C-CK-009	ROB	Infrared Upright Broiler	761,283	0.10	0.50	10	0.71	0.30	10,277
C	C-CK-010	ROB	Pasta Cooker	1,141,924	0.10	0.20	12	0.20	0.30	5,139
C	C-CK-011	ROB	Bottom-Finned Stock Pot	1,141,924	0.10	0.33	3	0.26	0.30	34,258
C	C-CK-012	ROB	Commercial Steam Cooker	3,425,772	0.10	0.53	12	0.15	0.30	40,852
C	C-DHW-001	ROB	HE Storage Tank Water Heaters	41,809,923	0.15	0.13	15	0.25	0.30	93,945
C	C-DHW-002	Retrofit	Reduced Temperature Setpoints	83,474,637	0.70	0.08	10	0.10	0.01	19,852
C	C-DHW-003	ROB	Tankless Water Heaters	26,590,769	0.03	0.15	20	1.68	0.30	58,207
C	C-DHW-004	Retrofit	Faucet Aerators	13,442,176	0.40	0.32	9	0.34	0.01	26,111
C	C-DHW-005	Retrofit	Low Flow Pre-Rinse Nozzles	6,298,113	0.45	0.44	5	0.33	0.01	15,314
C	C-DHW-006	Retrofit	Low Flow Showerhead	12,884,225	0.15	0.44	10	0.04	0.01	47,990
C	C-DHW-007	Retrofit	Drain Water Recovery	19,915,211	0.01	0.15	30	0.73	0.01	24,830
C	C-DHW-008	Retrofit	Heat Recovery - Chiller	27,610,811	0.05	0.47	15	0.74	0.01	119,366
C	C-DHW-009	Retrofit	Heat Recovery - Refrigeration	31,451,805	0.05	0.24	15	0.44	0.01	55,925
C	C-DHW-010	Retrofit	Insulating Blankets		0.70	0.04	5	1.30	0.01	

Sector	Measure code	Measure Type	Measure Description	Applicable therms	Energy Efficiency Saturation	Savings Rate	Measure Life	Cost OF Energy Saved	Achievable Factor	Achievable Potential
				25,769,723						3,092
C	C-DHW-011	Retrofit	Pipe Insulation	16,694,927	0.60	0.05	15	0.95	0.01	3,480
C	C-DHW-012	Retrofit	Timer on Recirculation Pump	65,061,696	0.40	0.03	10	0.59	0.01	11,375
C	C-DHW-013	Retrofit	Ultrasonic Faucet Control	50,723,379	0.33	0.04	10	0.30	0.01	13,388
C	C-DHW-014	Retrofit	Heat Trap	83,474,637	0.10	0.01	10	0.59	0.01	7,513
C	C-DHW-017	Retrofit	Combination Water Heater/Boiler	52,108,256	0.15	0.15	13	0.82	0.01	66,438
C	C-DHW-019	ROB	HE Boilers (Condensing)	27,504,215	0.30	0.16	13	0.10	0.30	69,416
C	C-DHW-CK-001	ROB	HE Dishwashers	18,115,860	0.10	0.31	15	0.08	0.30	101,086
C	C-DHW-CK-002	ROB	Chemical Sanitizing (Low Temp) Dishwashing (ES)	18,115,860	0.10	0.36	15	0.09	0.30	117,391
C	C-DHW-CL-001	ROB	HE Clothes Washers	6,396,001	0.20	0.28	14	0.24	0.30	30,784
C	C-DHW-CL-002	Retrofit	Ozone Commercial Laundry System (Gas HW)	6,396,001	0.30	0.20	10	0.26	0.01	8,954
C	C-DHW-CL-003	Retrofit	Wastewater Reclamation	13,409,273	0.15	0.35	15	0.66	0.01	39,893
C	C-NC-001	NC	New Construction Programs	15,024,492	0.01	0.18	15	0.35	0.30	528,182
C	C-PL-001	Retrofit	HE Gas Pool Water Heater	3,973,223	0.50	0.16	15	0.59	0.01	3,137
C	C-PL-002	Retrofit	Pool DHW heat recovery	3,973,223	0.50	0.80	15	0.76	0.01	15,893
C	C-PL-003	Retrofit	Pool/Spa Covers	3,973,223	0.25	0.42	6	0.15	0.01	12,647
C	C-PL-006	ROB	HE Gas Pool Water Heater	3,973,223	0.50	0.16	15	0.36	0.30	6,274
C	C-PR-HT-001	Retrofit	Heat Recovery - Combustion Air Preheating	7,951,530	0.50	0.20	10	0.16	0.01	7,952
C	C-PR-HT-002	Retrofit	Heat Recovery - Load Preheating	6,361,224	0.50	0.13	10	0.18	0.01	4,135
C	C-PR-HT-003	Retrofit	Heat Recovery - External Processes	6,361,224	0.50	0.13	10	0.19	0.01	4,135
C	C-PR-HT-004	Retrofit	Air Seal Furnaces	9,939,412	0.50	0.10	3	0.17	0.01	4,970
C	C-PR-HT-005	Retrofit	Furnace Insulation	9,939,412	0.50	0.04	5	0.18	0.01	1,988

Sector	Measure code	Measure Type	Measure Description	Applicable therms	Energy Efficiency Saturation	Savings Rate	Measure Life	Cost OF Energy Saved	Achievable Factor	Achievable Potential
C	C-PR-HT-006	Retrofit	Lower Flammable Limit Monitoring Equipment	3,975,765	0.75	0.09	10	0.05	0.01	905
C	C-PR-HT-007	Retrofit	Tune Burner Air to Fuel Ratios	29,818,237	0.75	0.01	3	0.14	0.01	969
C	C-PR-HT-008	Retrofit	O2-enriched Combustion	9,939,412	0.50	0.25	3	0.14	0.01	12,424
C	C-PR-HT-009	Retrofit	Clean/Repair Heat Transfer Surfaces	9,939,412	0.50	0.05	3	0.14	0.01	2,485
C	C-PR-HT-010	Retrofit	Process Heat Custom Efficiency Measure	3,975,765	0.00	0.10	10	0.44	0.01	3,976
C	C-PR-ST-002	Retrofit	Boiler Tune-Ups	39,757,649	0.75	0.01	3	0.52	0.01	1,292
C	C-PR-ST-003	Retrofit	Insulate Pipes/Lines	39,757,649	0.60	0.04	15	0.29	0.01	6,278
C	C-PR-ST-004	Retrofit	Steam Trap Maintenance Program	39,757,649	0.10	0.14	6	0.10	0.01	50,095
C	C-PR-ST-005	Retrofit	O2-Trim	39,757,649	0.10	0.01	18	1.50	0.01	3,113
C	C-PR-ST-006	ROB	HE Boilers	39,757,649	0.70	0.13	20	0.01	0.30	23,855
C	C-PR-ST-007	Retrofit	Boiler Blowdown Heat Exchanger	39,757,649	0.10	0.01	15	0.04	0.01	5,086
C	C-PR-ST-008	Retrofit	Boiler - Steam System Isolation	39,757,649	0.80	0.03	3	0.28	0.01	2,385
C	C-PR-ST-009	Retrofit	Process Heating Stack Economizer	19,878,824	0.10	0.04	15	0.05	0.01	6,432
C	C-PR-ST-013	Retrofit	Boiler Burner Upgrades	29,818,237	0.50	0.01	21	0.16	0.01	2,087
C	C-SH-FA-001	Retrofit	Retrocommisioning	32,177,079	0.05	0.08	5	0.44	0.01	24,455
C	C-SH-FU-012	ROB	HE Furnaces (<=300kBTU)	51,099,345	0.28	0.13	16.5	0.12	0.30	87,253
C	C-SH-FU-013	Retrofit	Small Business Furnace Tune-Up	51,099,345	0.00	0.02	2	1.51	0.01	9,198
C	C-SH-FU-016	Retrofit	Shut Off Damper for Space Heating Boilers or Furnaces	31,264,811	0.50	0.01	18	0.49	0.01	1,563
C	C-SH-GE-002	Retrofit	Mechanically Operated Makeup Air Dampers	91,270,368	0.70	0.07	15	0.51	0.01	16,956
C	C-SH-GE-003	Retrofit	Demand Control Ventilation	100,595,566	0.05	0.27	10	0.10	0.01	217,042
C	C-SH-GE-004	Retrofit	Destratification fans	64,985,092	0.10	0.03	20	0.43	0.01	17,546
C	C-SH-GE-005	Retrofit	Duct Sealing		0.50	0.07	20	0.22	0.01	

Sector	Measure code	Measure Type	Measure Description	Applicable therms	Energy Efficiency Saturation	Savings Rate	Measure Life	Cost OF Energy Saved	Achievable Factor	Achievable Potential
				24,169,892						8,459
C	C-SH-GE-007	Retrofit	Programmable Thermostat	97,782,136	0.40	0.05	4	0.14	0.01	28,958
C	C-SH-GE-008	Retrofit	Reduced Temperature Setpoints	52,998,595	0.30	0.05	2	3.38	0.01	16,567
C	C-SH-GE-009	Retrofit	Variable Flow Kitchen Exhaust	44,436,300	0.10	0.67	15	0.02	0.01	268,791
C	C-SH-GE-010	Retrofit	Variable Flow Lab Exhaust	10,861,853	0.10	0.50	15	0.37	0.01	48,878
C	C-SH-GE-011	Retrofit	VAV system controls	77,093,966	0.15	0.12	20	0.19	0.01	78,636
C	C-SH-GE-012	Retrofit	CAV to VAV retrofit	59,924,793	0.36	0.32	15	0.22	0.01	92,051
C	C-SH-GE-013	Retrofit	Improved Roof/Ceiling Insulation	270,042,829	0.35	0.07	20	7.73	0.01	94,919
C	C-SH-GE-014	Retrofit	Direct-fired Make-Up Air Units	79,227,644	0.33	0.12	20	0.94	0.01	63,699
C	C-SH-GE-015	Retrofit	Electric Ignition	148,523,420	0.75	0.00	15	1.09	0.01	1,187
C	C-SH-GE-016	Retrofit	Heat Recovery - Air to Air	79,760,643	0.10	0.14	15	0.86	0.01	81,422
C	C-SH-GE-017	Retrofit	Heat Recovery - Chiller/Refrigeration	86,737,311	0.16	0.06	20	0.37	0.01	39,809
C	C-SH-GE-019	Retrofit	Radiant Tube Heaters	11,952,023	0.10	0.20	12	0.43	0.01	21,514
C	C-SH-GE-021	Retrofit	Air Sealing	216,034,263	0.33	0.10	15	7.18	0.01	140,950
C	C-SH-GE-022	Retrofit	Dock door seals	89,061,297	0.20	0.05	10	0.30	0.01	28,435
C	C-SH-GE-023	Retrofit	HE Windows	270,042,829	0.50	0.02	30	1.67	0.01	20,578
C	C-SH-GE-024	Retrofit	CO / Nox garage controls	130,280,122	0.10	0.01	5	0.26	0.01	13,191
C	C-SH-GE-028	Retrofit	Spray or blown-in wall insulation (retro)	229,536,404	0.20	0.02	20	5.36	0.01	36,726
C	C-SH-GE-030	Retrofit	Vestibules	187,506,009	0.95	0.02	20	0.62	0.01	847
C	C-SH-GE-031	ROB	Condensing Unit Heater	11,952,023	0.15	0.16	12	0.29	0.30	40,102
C	C-SH-GE-034	ROB	HE Rooftop Units	52,848,235	0.00	0.11	15	0.27	0.30	116,266
C	C-SH-GE-035	Retrofit	Smart Thermostat	84,797,752	0.10	0.07	4	0.27	0.01	47,880

Sector	Measure code	Measure Type	Measure Description	Applicable therms	Energy Efficiency Saturation	Savings Rate	Measure Life	Cost OF Energy Saved	Achievable Factor	Achievable Potential
C	C-SH-GE-099	Retrofit	Commercial Space Heating Custom Measures	11,036,040	0.00	0.04	15	0.44	0.01	4,510
C	C-SH-HW-001	Retrofit	Retrocommisioning	40,557,176	0.05	0.08	5	0.44	0.01	30,823
C	C-SH-HW-002	Retrofit	Boiler Tune-Ups	51,884,842	0.15	0.02	3	0.75	0.01	7,938
C	C-SH-HW-003	Retrofit	Boiler Reset Controls	51,884,842	0.30	0.08	20	0.05	0.01	29,056
C	C-SH-HW-004	Retrofit	Insulate Pipes/Lines	51,884,842	0.30	0.04	15	0.29	0.01	14,337
C	C-SH-HW-005	ROB	HE Boilers (Condensing)	38,913,632	0.20	0.16	20	0.32	0.30	73,731
C	C-SH-HW-006	ROB	HE Boilers (Non-Condensing)	12,971,211	0.30	0.06	20	0.43	0.30	8,012
C	C-SH-HW-008	Retrofit	Heating Stack Economizer	26,765,451	0.11	0.03	15	0.86	0.01	6,826
C	C-SH-HW-013	Retrofit	Boiler Burner Upgrades	38,913,632	0.50	0.01	21	0.28	0.01	2,724
C	C-SH-HW-014	Retrofit	Linkageless Boiler Controls for Space Heating	38,913,632	0.50	0.04	16	0.41	0.01	7,394
C	C-SH-HW-015	Retrofit	Oxygen Trim Controls for Space Heating Boilers	38,913,632	0.50	0.01	18	7.74	0.01	1,693
C	C-SH-HW-016	Retrofit	Shut Off Damper Space Heating Boilers or Furnaces	38,913,632	0.50	0.01	18	0.43	0.01	1,946
C	C-SH-ST-001	Retrofit	Retrocommisioning	83,823,398	0.05	0.08	5	0.44	0.01	63,706
C	C-SH-ST-002	Retrofit	Boiler Tune-Ups	96,261,162	0.22	0.02	3	0.83	0.01	13,515
C	C-SH-ST-003	Retrofit	Boiler Reset Controls	96,261,162	0.36	0.08	20	0.06	0.01	47,844
C	C-SH-ST-004	Retrofit	Insulate Pipes/Lines	96,261,162	0.40	0.04	15	0.29	0.01	22,799
C	C-SH-ST-005	Retrofit	Steam Trap Maintenance Program	80,781,750	0.10	0.14	6	0.10	0.01	101,785
C	C-SH-ST-006	ROB	HE Boilers	67,510,707	0.70	0.08	20	0.13	0.30	25,019
C	C-SH-ST-007	Retrofit	Boiler - Steam to Hot Water Conversion	96,050,053	0.00	0.18	20	0.84	0.01	141,288
C	C-SH-ST-008	Retrofit	Boiler Blowdown Heat Exchanger	68,688,343	0.11	0.01	15	0.04	0.01	8,596
C	C-SH-ST-009	Retrofit	Heating Stack Economizer	64,977,958	0.11	0.04	15	0.18	0.01	20,617
C	C-SH-ST-010	Retrofit	Boiler - Automatic Chemical feed		0.25	0.02	12	0.17	0.01	

Sector	Measure code	Measure Type	Measure Description	Applicable therms	Energy Efficiency Saturation	Savings Rate	Measure Life	Cost OF Energy Saved	Achievable Factor	Achievable Potential
				82,957,738						12,444
C	C-SH-ST-013	Retrofit	Boiler Burner Upgrades	70,912,570	0.50	0.01	21	0.28	0.01	4,964
C	C-SH-ST-014	Retrofit	Linkageless Boiler Controls for Space Heating	70,912,570	0.50	0.04	16	0.42	0.01	13,473
C	C-SH-ST-015	Retrofit	Oxygen Trim Controls for Space Heating Boilers	70,912,570	0.50	0.01	18	7.91	0.01	3,085
C	C-SH-ST-016	Retrofit	Shut Off Damper for Space Heating Boilers or Furnaces	70,912,570	0.50	0.01	18	0.44	0.01	3,546

APPENDIX D: RESIDENTIAL TELEPHONE SURVEY

Peoples Gas / North Shore Gas Potential Study
Residential Survey
for Seventhwave
(removed)

APPENDIX E: COMMERCIAL AND INDUSTRIAL TELEPHONE SURVEY

Peoples Gas / North Shore Gas Potential Study
C&I
for Seventhwave
(removed)