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Peoples Gas Light and Coke Company Wasted Energy Study

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EXECUTIVE SUMMARY

In its order in Docket 13-0550 the Illinois Commerce Commission ordered the Peoples Gas Light and Coke Company to study the potential to reduce wasted energy use.[1] In response, Peoples Gas retained the Energy Center of Wisconsin to study this issue.

We address energy savings that can be garnered by changing consumer behavior. Examples include setting back thermostats when space is unoccupied and washing clothes in cold water instead of hot or warm. We analyze the potential to reduce energy waste from two perspectives: (1) before any other energy efficiency actions are taken; and (2) after all technically feasible energy efficiency opportunities are captured. The savings available in the former case are greater than those available in the latter case because installing the other energy efficiency measures first reduces base energy use to which energy savings rates are applied. Table 1 reports the annual savings for the waste-reducing behavioral actions we investigated.

Table 1
Upper-Bound Estimates of Annual
Energy Waste Reduction Opportunities

Waste-Reducing Energy-Saving Behavior	Savings Before Technology Measures Installed (million therms)	Savings After Technology Measures Installed (million therms)
Residential Sector		
Set back thermostat[2]	16.1	9.9
Wash clothes in cold water	6.5	4.8
Reduce water heater temperature	1.4	1.0
Maintain heating system	0.9	0.5
Subtotal	**24.9**	**16.2**
Commercial Sector		
Set back thermostat	6.4	3.3
Maintain heating system	0.8	0.4
Subtotal	**7.2**	**3.7**
Grand total	**31.1**	**19.9**

These estimates represent upper bounds for two reasons. First, they are the possible savings from particular behavioral actions that could be achieved if all persons not currently practicing those behaviors were to adopt them. It is almost certain that some customers would not change behavior in this way. Second, these estimates also do not reflect economic considerations. For example, heating system maintenance may require hiring a professional, which may further limit the likelihood that the reported savings will be achieved. Achievable savings levels would be noticeably lower than those reported here.

[1] Order, Docket 13-0550: Petition Pursuant to Section 8-104 of the Public Utilities Act to Submit an Energy Efficiency Plan, Illinois Commerce Commission, May 20, 2014, p. 8.
[2] Assumes that customers setting back install smart thermostats. If they instead install standard programmable thermostats, or use a manual approach, the savings would be 40 percent less than those shown in the table.

CHAPTER 1: BACKGROUND

PEOPLES GAS 2013 ENERGY EFFICIENCY POTENTIAL STUDY

In developing estimates of the potential to eliminate energy waste, we rely heavily on the work we conducted in preparing the energy efficiency potential study for Peoples Gas. The primary data we collected reflects the characteristics of the utility under review, and is therefore likely to be more accurate than information gleaned from other studies. In the potential study we completed 2,096 residential and 796 commercial phone surveys in the Peoples Gas and North Shore service areas. We also completed 114 residential and 60 commercial site visits in the utilities' service areas. We combined the information from the surveys and site visits with billing information from Peoples Gas's billing system to fully characterize energy consumption by end use. In this study we supplemented that analysis with field research that we conducted in other Midwest states. We filled remaining gaps with information from the technical literature.

UPPER-BOUND VERSUS ACHIEVABLE ESTIMATES

We examined the potential to reduce energy waste on the part of individually-metered customers, which includes all single-family customers and a portion of multi-family customers. To put the energy waste reduction estimates we report here in perspective, the achievable energy efficiency potential for the entire Peoples Gas system in the 2013 study was 6 million therms per year. This current study shows that if we could reduce wasted energy to the full extent, the savings would greatly exceed the 2013 achievable potential estimate, suggesting that it is unlikely that our wasted energy opportunities estimates can be achieved in full. Nevertheless, that is not our intent. Rather, our goal is to develop an upper bound estimate of that savings potential. Practical considerations mean that Peoples Gas could achieve but a fraction of those savings. That is not to say that there are no opportunities to reduce energy waste.

INTERACTIONS BETWEEN TECHNOLOGICAL AND BEHAVIORAL ENERGY EFFICIENCY OPPORTUNITIES

Energy efficiency measures and waste-reducing behavior change actions have interactive effects. Each measure or action taken reduces the base amount of energy savings available for the next measure or action. For example, installing five energy efficiency measures that each reduce space heating energy use by 10 percent would not reduce total heating use by 50 percent, but rather by 41 percent.[3] The following tables show the difference in savings estimate from behavior change activity that results from changing the order in which the actions are taken.

[3] The mathematical formula is: base usage after all measures are installed = $(1\text{-savings rate})^{\text{years}} = (1-0.10)^5 = 0.59$, or 59 percent of the original use, which is a 41 percent reduction.

Table 2
Interactive Effects of
Energy Savings Actions or Measures
Behavior Change First

Energy Saving Action or Measure	Savings Rate	Base Use (therms)	Energy Savings (therms)	Adjusted Base Use (therms)
Behavior Change	10%	1,000	100	900
Technology A	10%	900	90	810
Technology B	10%	810	81	729
Technology C	10%	729	73	656
Technology D	10%	656	66	590

Table 3
Interactive Effects of
Energy Savings Actions or Measures
Behavior Change Last

Energy Saving Action or Measure	Savings Rate	Base Use (therms)	Energy Savings (therms)	Adjusted Base Use (therms)
Technology A	10%	1,000	100	900
Technology B	10%	900	90	810
Technology C	10%	810	81	729
Technology D	10%	729	73	656
Behavior Change	10%	656	66	590

To address this sequencing issue we estimate energy savings from two perspectives. First we estimate the savings from waste-reducing behavior changes assuming that no technological energy saving measures were implemented. Then we estimate the savings from the behavior changes assuming that all the available energy saving technologies, regardless of cost-effectiveness, have been implemented. The difference in estimates is significant, with the after-technologies estimate generally being about 40 to 60 percent lower than the before-technologies estimate.

CHAPTER 2: OPPORTUNITIES TO REDUCE ENERGY WASTE IN THE RESIDENTIAL SECTOR

NATURAL GAS END USE IN THE RESIDENTIAL SECTOR

In the Peoples Gas service area, space heating accounts for 75 percent of total natural gas consumption in the residential sector. Water heating accounts for 20 percent of total consumption. The two end uses therefore account for nearly all the gas consumption in that sector. We focus on actions that could reduce energy waste for these two end uses.

RESIDENTIAL SPACE HEATING

Thermostat Setback

If customers heat living space to levels that meet their comfort needs or health requirements, they are not wasting energy, even if the temperature setting may seem high to others. On the other hand, if customers would be just as comfortable, if not more comfortable, at lower temperature settings, they are wasting energy by heating space to higher temperatures. If they never change the thermostat setting and heat space to same temperature regardless of whether there is anyone in the space, again they are wasting energy during the periods when the space is unoccupied. Furthermore, sleep experts suggest that a cooler room (one lower in temperature than that used during waking hours) improves the quality of sleep.[4] Therefore, customers not setting back temperature during sleeping hours are likely wasting energy, as well.

The U.S. Department of Energy recommends a base temperature of 68 degrees when consumers are using space and a 10-15 degree setback when space is unoccupied or when sleeping.[5] We view the DOE recommended setback temperatures as outer bounds and would expect to observe less extreme behavior in practice.

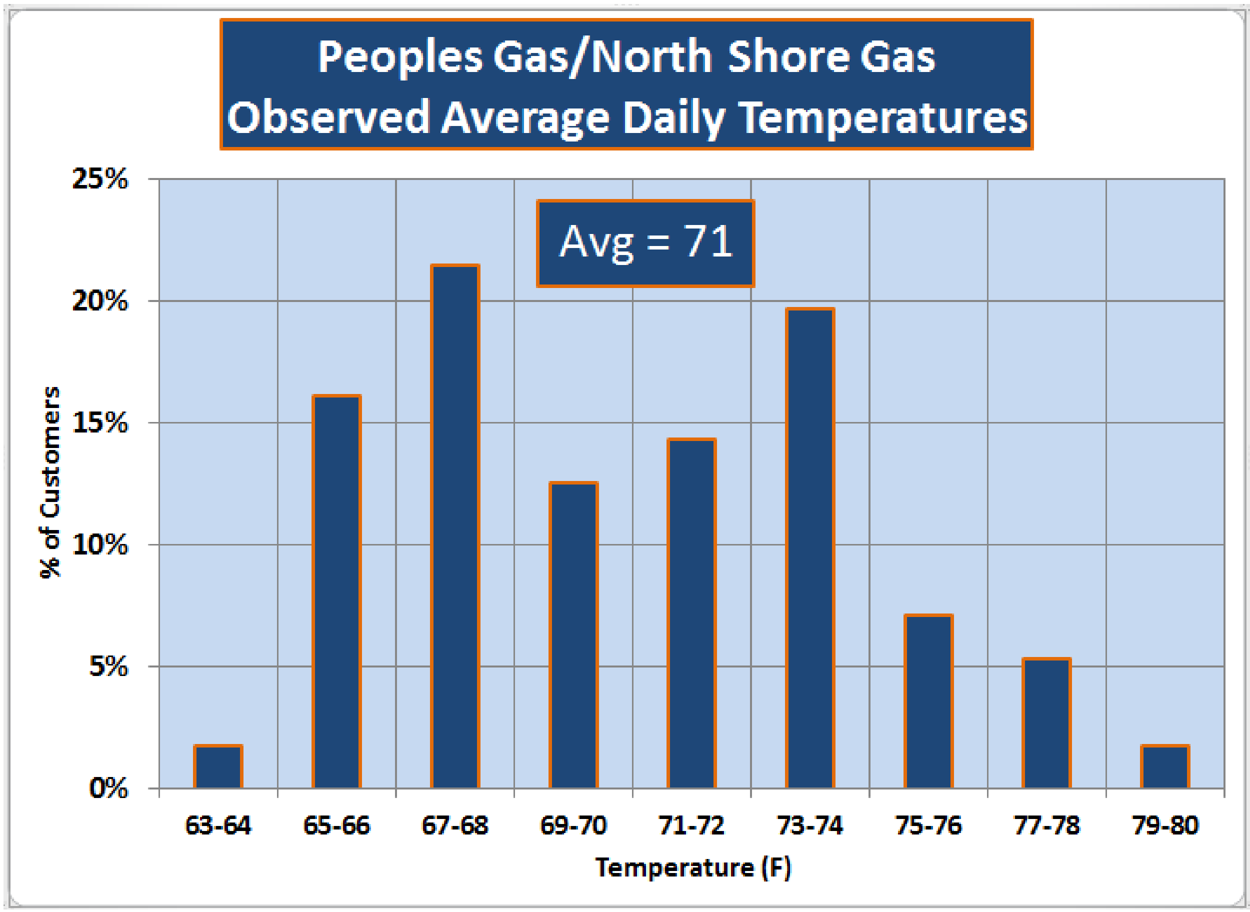
The most accurate means of measuring the extent that Peoples Gas customers not now setting back their thermostats would be willing to do so would be a carefully designed before-after experiment with treatment and control groups. Conducting such primary data collection is beyond the scope of this analysis.

Absent such a controlled experiment, we relied on the data we collected in the residential site visits conducted for the potential study. We recorded hourly indoor temperatures (ambient temperatures, not thermostat settings) for 56 residential customers in the Peoples Gas/North Shore Gas service areas. The average daily temperature varies considerably over the sample residences, ranging from about 63 degrees at the low end and about 80 degrees at the high end. See Fig. 1. The average daily temperature across all residences in the sample is 71 degrees.

[4] National Sleep Foundation, http://sleepfoundation.org/bedroom/touch.php

[5] The DOE analysis states that consumers save one percent per degree set back for every eight hours of setback. Reducing average daily temperature by one degree is equivalent to a one-degree setback for 24 hours, or a 3 percent energy savings. See http://energy.gov/energysaver/articles/thermostats

Figure 1

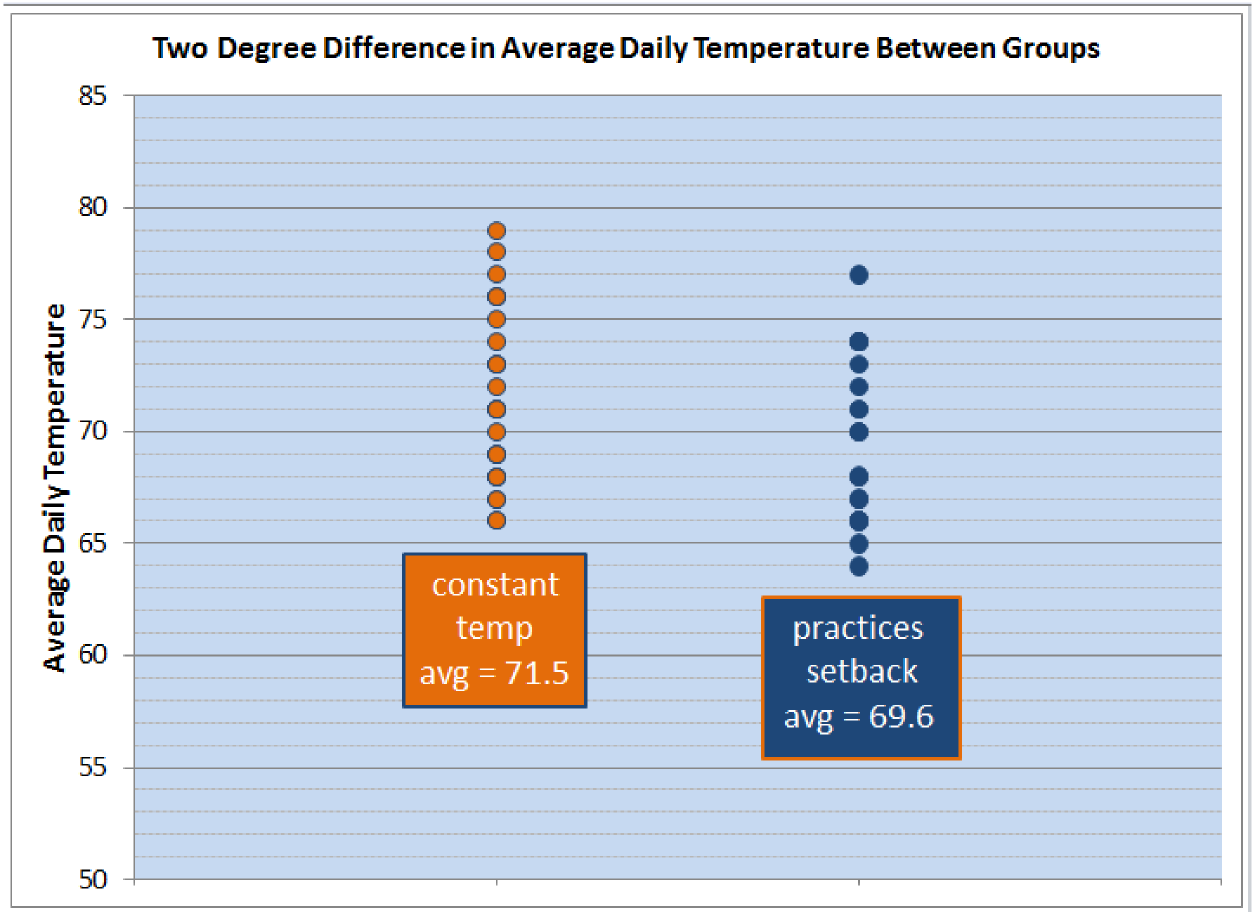


A closer look at the hourly temperature data observed for each residence reveals that about half of the customers heat their residences to a constant temperature throughout the day. The remaining customers manifest a variety of setback behaviors as revealed by the deviations in hourly temperatures recorded by the loggers.

In the next stage of the analysis we separated customer data into two groups, those who set back the thermostat (temperatures varied over the day) and those who do not (constant temperatures). While the average daily temperature for the first group is slightly lower than the average for the second, there is wide dispersion within each group. See Fig. 2. Put another, the fact that a customer sets back the thermostat does not mean that the average daily temperature is higher than average. Conversely, a residence for which there was not thermostat set back could manifest a lower-than-average daily temperature.

On average, however, those setting back thermostats have average daily temperatures that are about two degrees lower than those who do not. Statistical analysis of these data reveals that the presence of setback behavior is a statistically significant predictor of the average daily temperature, but it nevertheless explains only six percent of the variation in that figure. This suggests that there are a lot of other factors that determine the average daily temperature.

Figure 2



As a first cut, we assume that those other factors are approximately constant between groups. If that is true, then the two-degree difference in average temperatures observed for the setting-back and not-setting-back groups is a reasonable estimate of the magnitude of setback we would obtain if those not setting back did adopt setback behavior.

To fully understand this issue, is important to distinguish between the reduction in average daily temperature (measured in degrees) and the extent of the setback (also measured in degrees). Reducing the constant base temperature setting for a home is one way to lower average daily temperature; using varying temperature settings throughout the day is another. The following table shows that consumers can achieve the same reduction in average daily temperature in a variety of ways.

Table 4
Different Means of Achieving a Two-Degree Reduction
in Average Daily Temperature

Hour of the Day	Current Setting		Adjust Base Temp Setting	Set Back Night Temp	Set Back at Night and When Away
1	71		69	65	68
2	71		69	65	68
3	71		69	65	68
4	71		69	65	68
5	71		69	65	68
6	71		69	71	71
7	71		69	71	71
8	71		69	71	71
9	71		69	71	68
10	71		69	71	68
11	71		69	71	68
12	71		69	71	68
13	71		69	71	68
14	71		69	71	68
15	71		69	71	68
16	71		69	71	68
17	71		69	71	68
18	71		69	71	71
19	71		69	71	71
20	71		69	71	71
21	71		69	71	71
22	71		69	65	71
23	71		69	65	68
24	71		69	65	68
Avg	71		69	69	69

Knowing the change in average daily temperature from introducing setback behavior allows us to estimate the energy savings. The DOE estimates that residential customers who reduce average daily temperature by one degree will on average reduce energy consumption by three percent.[6] The two-degree reduction in average temperature we observed in the data would therefore produce energy savings of six percent.

[6] The DOE analysis states that consumers save one percent per degree set back for every eight hours of setback. Reducing average daily temperature by one degree is equivalent to a one-degree setback for 24 hours, or a 3 percent energy savings. See http://energy.gov/energysaver/articles/thermostats

Recall, though, that the two-degree temperature reduction estimate was a first-cut estimate based on the site visit data. We test our result against the information in the Illinois Technical Reference Manual and find that it is consistent with that resource. The TRM suggests that customers installing a programmable thermostat will experience a six percent reduction in energy use, which is equivalent to a two-degree reduction in average daily temperature, precisely matching our estimate.[7]

We also examined the savings that could be garnered if customers installed state-of-the-art smart thermostats, which research suggests can save more energy than either standard programmable thermostats or manual setback behavior. Smart thermostats typically allow customers remote access through the Internet, and some automatically adjust settings based on historical patterns or occupancy. This increased flexibility and capability generally allows customers greater control—and produces greater energy saving—than that associated with either manual or standard programmable thermostat control.

In a field experiment in Massachusetts customers who were given a smart thermostat reduced energy consumption by about 10 percent,[8] which is equivalent to a 3.3 degree reduction in average daily temperature.[9] We prepared a separate analysis assuming that customers currently not setting back installed a smart thermostat and used it to control indoor temperatures. For that scenario we assumed a 10 percent energy savings.[10]

The Peoples Gas potential study reveals that single-family homes consume about 261 million therms per year to heat living space, while individually-metered customers in multi-family residences consume 109 million therms per year for that purpose. The residential survey results reveal that 65 percent of single-family residences and 37 percent of multi-family residences are already practicing thermostat setback behavior, which we assume eliminates them as candidates for further setback behavior. Removing that space heating load from the total leaves 92 million and 69 million therms of space heating load in the single-family and multi-family segments, respectively, that could save energy by implementing setback practices. Applying the six percent savings rate discussed above produces total therm savings of about 10 million therms per year.

Table 5
Savings From Thermostat Setback
Programmable Thermostat or Manual Setback
(millions)

Segment	Available Space Heating Load	Savings Factor	Annual Savings
Single-Family	92	6%	5.5
Multi-family	69	6%	4.1
Total	**161**		**9.6**

If we assume that the customers use a smart thermostat, which we assume will save 10 percent, the savings estimate increases to about 16 million therms per year.

[7] Illinois Energy Efficiency Stakeholder Advisory Group, 2014. *Illinois Statewide Technical Reference Manual for Energy Efficiency: Version 3.0*.
[8] The Cadmus Group, Inc., 2012. *Wi-Fi Programmable Controllable Thermostat Pilot Program Evaluation: Part of the Massachusetts 2011 Residential Retrofit and Low Income Program Area Evaluation*.
[9] 3.3° average daily temperature reduction x 3% energy savings/degree temperature reduction = 10% energy savings.
[10] That savings estimate is likely an outer bound. During the field study the thermostat was installed by a professional and the customers were provided with instructions as to how to use it. This increases the likelihood that customers will use the device in an optimal manner to meet their space heating needs.

Table 6
Savings From Thermostat Setback
Smart Thermostat
(millions)

Segment	Available Space Heating Load	Savings Factor	Annual Savings
Single-Family	92	10%	9.2
Multi-family	69	10%	6.9
Total	**161**		**16.1**

The preceding analysis assumes that no other energy efficiency actions are taken prior to implementing the setback behavior. The potential study estimates that if all technically feasible energy efficiency measures were implemented prior to implementing the setback behavior, the available space heating loads would decline to 54 million and 45 million terms, respectively, for the single-family and multi-family segments. The following tables show that this reduces the savings from thermostat setback to about 6 to 10 million therms per year, depending on the means employed to achieve the temperature setbacks.

Table 7
Savings From Thermostat Setback
Programmable Thermostat or Manual Setback
After Technology Measures Installed
(millions)

Segment	Available Space Heating Load	Savings Factor	Annual Savings
Single-Family	54	6%	3.2
Multi-family	45	6%	2.7
Total	**99**		**5.9**

Table 8
Savings From Thermostat Setback
Smart Thermostat
After Technology Measures Installed
(millions)

Segment	Available Space Heating Load	Savings Factor	Annual Savings
Single-Family	54	10%	5.4
Multi-family	45	10%	4.5
Total	**99**		**9.9**

Heating System Maintenance

Gas furnaces
In the Peoples Gas service area there are 183 thousand single-family households and 174 thousand multi-family households with furnaces, which consume a total of 183 million and 92 million therms per year in each segment, respectively. Research suggests that energy savings will occur from increased frequency of filter changes only if the filter is currently being changed less often than annually. A field study we conducted in Minnesota revealed that 95 percent of customers change their filters at least annually. This allows us to estimate the furnace space heating load that would be subject to savings from more frequent filter changes.

Table 9
Portion of Furnace Load Subject to Savings From
Increased Frequency of Filter Changes
(therms-millions)

Segment	Furnace Consumption	Percent of Customers Not Setting Back	Adjusted Consumption
Single-family	183	5%	9.1
Multi-family	92	5%	4.6
Total	**275**		**13.7**

Energy Center analysis suggests that the annual energy savings from an increased frequency of filter change for those who currently do not change filters at least once per year is 2 percent. We use this savings rate to estimate aggregate savings.

Table 10
Savings From Increased Frequency of
Furnace Filter Changes
(therms-millions)

Segment	Furnace Consumption	Savings Factor	Adjusted Consumption
Single-family	9.1	2%	0.18
Multi-family	4.6	2%	0.09
Total	**13.7**		**0.27**

If energy-saving technologies are installed prior to the change in furnace filter replacement frequency, the single-family figure declines to 0.11 million therms, and the multi-family figure declines to 0.06 million therms, producing a total therm savings of 0.17 million therms.

Boiler maintenance
In the Peoples Gas service area there are 58 thousand single-family households and 26 thousand individually-metered multi-family residences with boilers.[11] These boilers consume a total of 90 million therms per year.

Table 11
Annual Therm Usage by Boiler Type
(therms-millions)

Segment	Steam Boilers	Hydronic Boilers	Total
Single-family	53	24	77
Multi-family	7	6	13
Total	**60**	**30**	**90**

Results from the Energy Center's survey of Minnesota homeowners reveals that about 70 percent are performing regular maintenance on their heating systems, leaving 30 percent of customers who could

[11] Energy Center of Wisconsin, 2013. *Peoples Gas Light and Coke Company Energy Efficiency Potential Study: Program Years 4, 5 and 6*.

adopt new maintenance practices.[12] This reduces the total therms available for boiler maintenance activity to 27 million therms.

Table 12
Annual Therm Usage by Boiler Type
For Customers Not Maintaining Boilers
(therms-millions)

Segment	Steam Boilers	Hydronic Boilers	Total
Single-family	16	7	23
Multi-family	2	2	4
Total	**18**	**9**	**27**

Using the TRM's calculation of 2 percent savings achieved from a boiler tune-up,[13] we estimate that 30 percent of residential customers are not performing regular maintenance and could achieve an annual total savings of 0.53 million therms, as shown in the following table.

Table 13
Annual Therm Savings by Boiler Type
(therms-millions)

Segment	Steam Boilers	Hydronic Boilers	Total
Single-family	0.32	0.14	0.46
Multi-family	0.04	0.03	0.07
Total	**0.36**	**0.17**	**0.53**

If customers install available technology measures before they implement a more-frequent furnace filter change, the savings decline as follows:

Table 14
Annual Therm Savings by Boiler Type
After Technology Measures Installed
(therms-millions)

Segment	Steam Boilers	Hydronic Boilers	Total
Single-family	0.19	0.08	0.27
Multi-family	0.03	0.02	0.05
Total	**0.22**	**0.10**	**0.32**

Heating System Maintenance: Combined Savings

Combining the furnace filter and boiler maintenance estimates produces the following savings estimates for heating system maintenance.

[12] Energy Center of Wisconsin, 2014. *Initial Results from a Study of Quality Installation / Quality Maintenance in Minnesota Homes.*

[13] Illinois Energy Efficiency Stakeholder Advisory Group, 2014. *Illinois Statewide Technical Reference Manual for Energy Efficiency: Version 3.0*.

Table 15
Annual Therm Savings From Heating System Maintenance
(therms-millions)

Segment	Furnace Filters	Boiler Maintenance	Total annual savings (therms)
Single-family	0.18	0.46	0.64
Multi-family	0.09	0.07	0.16
Total	**0.27**	**0.53**	**0.90**

If all technological efficiency-saving measures are installed first, the total savings estimate declines from 0.90 million therms per year to 0.54 million therms per year.

Table 16
Annual Therm Savings From Heating System Maintenance
After Technology Measures Installed
(therms-millions)

Segment	Furnace Filters	Boiler Maintenance	Total annual savings (therms)
Single-family	0.11	0.29	0.40
Multi-family	0.06	0.05	0.11
Total	**0.17**	**0.34**	**0.54**

RESIDENTIAL WATER HEATING

Clothes Washer Temperature Setting

In most cases, washing in cold water cleans clothes just as well as washing them in hot or warm water.[14] Cold water washing also tends to be less damaging to clothing, which extends its useful life.[15] Therefore, customers who wash clothes in hot or warm water because they believe it generally provides benefits relative to washing in cold water would be wasting energy.

EPA data suggest that the typical household washes 400 loads per year, or 7.6 loads per week.[16] In 2000 the Energy Center prepared a characterization study for Wisconsin that reports that the typical household washes 7.2 loads per week.[17] A 2010 study conducted by the Cadmus Group found that households wash 5.0 loads of laundry per week.[18] The ComEd baseline end-use saturation and penetration study reports that its customers wash on average 5.8 loads per week.[19] Leaning more heavily on the local data, we use an estimate of 6.0 loads washed per week, or 312 loads per household per year.

[14] Center for Energy & Environment, *MN Energy Challenge*, www.mnenergychallenge.org/Actions/Wash--em-Cold.aspx
[15] Martin and Rosenthal, "Cold-Water Detergents Get a Cold Shoulder," September 16, 2011, *The New York Times*, www.nytimes.com/2011/09/17/business/cold-water-detergents-get-a-chilly-reception.html?pagewanted=all
[16] U.S. Environmental Protection Agency, Green Building: Laundry Room & Basement, www.epa.gov/greenhomes/Basement.htm
[17] Energy Center of Wisconsin, 2000. *Energy and Housing in Wisconsin: A Study of Single-Family Owner-Occupied Homes*.
[18] David Korn and Scott Dimetrosky, 2010. "Do the Savings Come Out in the Wash? A Large Scale Study of In-Situ Residential Laundry Systems," *Proceedings of the ACEEE Summer Study on Energy Efficiency in Buildings*.
[19] Opinion Dynamics Corporation, 2013. *ComEd Residential Saturation/End-Use, Market Penetration & Behavioral Study*.

Washing in cold water is gaining momentum, but most consumers still wash primarily with either hot or warm water.[20] The Energy Center characterization study reports that about 30 percent of loads were washed using cold water.[21] For the remaining loads, 58 percent washed in warm and 12 percent washed in hot. Data from Grand Valley State University reveals that on a national basis 37 percent of loads use cold water, with warm and hot water washing accounting for 49 percent and 14 percent of loads, respectively.[22] The ComEd baseline end-use saturation and penetration study reports that 41 percent of loads are washed in cold, 40 percent in warm and 19 percent in hot.[23] In this study we rely on the local data from ComEd, assuming that 40 percent of laundry loads in the Peoples Gas territory are washed in cold water, 40 percent in warm water and 20 percent in hot water.

The Peoples Gas potential study analysis reveals that there are 229 thousand single-family households, and 180 thousand individually-metered multi-family residences with gas water heaters. The survey data supporting the study suggests that 5 percent of single-family residences and 25 percent of multi-family residences do not have a clothes washer. This reduces the effective number of households potentially subject to laundry water temperature change behavior to 217 thousand single-family homes and 135 thousand multi-family residences.

Applying the 312 loads per household per year estimate to these effective household figures produces estimates of 68 million loads of laundry per year in the single-family segment and 42 million loads per year in the multi-family segment. We allocate these loads among the cold-warm-hot categories using the percentages identified earlier, producing the results found in the following table:

Table 17
Laundry Loads Per Year by Washing Temperature
(millions)

Segment	Cold (40%)	Warm (40%)	Hot (20%)
Single-Family	27	27	14
Multi-family	17	17	8
Total	**44**	**44**	**22**

Per the Peoples Gas natural gas appliance calculator, washing clothes in hot water consumes 0.147 therms per load; washing in warm consumes 0.074 therms per load.[24] Switching to from hot to cold or warm to cold washer temperature settings would therefore save those amounts, respectively, for each load switched. There are no savings for loads currently washed in cold water as there would be no change in behavior in that situation. The system-wide annual therms savings associated with switching all loads washed in either hot or warm to washing in cold is about 6 to 7 million therms per year, as shown in the following table.

[20] "Campaign Makes Progress Toward P&G's Commitment to Convert 70% of Wash Loads to Cold by 2020," Procter & Gamble News Release, April 2, 2012.
[21] Energy Center of Wisconsin, 2000. *Energy and Housing in Wisconsin: A Study of Single-Family Owner-Occupied Homes*.
[22] Grand Valley State University. *Green Laundry Statistics*, www.gvsu.edu/housing/students/green-laundry-statistics-59.htm
[23] Opinion Dynamics, 2013. *ComEd Residential Saturation/End-Use, Market Penetration & Behavioral Study*.
[24] Natural Gas Appliance Calculator, www.peoplesgasdelivery.com/home/gas_calculator.aspx

Table 18
Annual Therm Savings From Switching to Cold Water Washing
(millions)

Segment	Currently Washed in Cold (40%)	Currently Washed in Warm (40%)	Currently Washed in Hot (20%)	Total
Single-Family	0.0	2.0	2.0	4.0
Multi-family	0.0	1.2	1.2	2.5
Total	**0.0**	**3.2**	**3.2**	**6.5**

These estimates reflect the energy savings that could be available if no other efficiency actions are taken. If instead we assume that all possible technological efficiency measures were implemented prior to the change in laundry water temperature setting, the base savings would be 21 percent lower for the single-family segment and 34 percent lower for the multi-family segment. Under this scenario the estimated system-wide annual therm savings from changing laundry water temperature would be about 5 million therms per year in total, as shown in the following table.

Table 19
Annual Therm Savings From Switching to Cold Water Washing
After Technology Measures Installed
(millions)

Segment	Currently Washed in Cold (40%)	Currently Washed in Warm (40%)	Currently Washed in Hot (20%)	Total
Single-Family	0.0	1.6	1.6	3.2
Multi-family	0.0	0.8	0.8	1.6
Total	**0.0**	**2.4**	**2.4**	**4.8**

Water Heater Temperature Setpoint Reduction

According to the U.S. Department of Energy, water heating is the second largest home energy expense, typically accounting for about 18 percent of a utility bill after heating and cooling.[25] To save energy and ensure both comfort and safety, it is recommended to set the water heater temperature to 120 degrees Fahrenheit. This temperature setting also helps to slow mineral buildup and corrosion in the water heater and pipes and reduce standby losses (heat from the water heater escaping into the surrounding area).[26]

As stated earlier, there are 229 thousand single-family households and 180 thousand individually-metered multi-family residences with gas water heaters.[27] An analysis of site visit data in the People's Gas potential study reveals that 36 percent of customers are setting their water heater temperature to the ideal temperature of 120 degrees, and 64 percent are setting their water heaters to a temperature within a 13 degree range of that ideal setting. Using the TRM's calculation of 6.4 therms per 15 degrees (or 0.43 therms per degree)[28] coupled with our analysis of actual water heater settings, we estimate 5.6 therms per 13 degree setback for an annual total savings of 1.5 million therms.

[25] U.S. Department of Energy, *Tips: Water Heating*, http://energy.gov/energysaver/articles/tips-water-heating
[26] U.S. Department of Energy, *Savings Project: Lower Water Heating Temperature*, http://energy.gov/energysaver/projects/savings-project-lower-water-heating-temperature
[27] Energy Center of Wisconsin, 2013. *Peoples Gas Light and Coke Company Energy Efficiency Potential Study: Program Years 4, 5 and 6*.
[28] Illinois Energy Efficiency Stakeholder Advisory Group, 2014. *Illinois Statewide Technical Reference Manual for Energy Efficiency: Version 3.0*.

Table 20
Annual Therm Savings From Setting Water Heater to 120° F

Segment	Number of homes setting above 120° F	Annual savings per home (therms)	Total annual savings (million therms)
Single-family	146,279	5.6	0.8
Multi-family	115,418	5.6	0.6
Total	**261,697**		**1.4**

These estimates reflect the energy savings that could be available if no other efficiency actions are taken. Assuming that all possible technological efficiency measures were implemented prior to setting the water heater temperature to 120 degrees, the base savings would be 21 percent lower for the single-family segment and 34 percent lower for the multi-family segment. Under this scenario the estimated system-wide total annual savings from setting back the water heater temperature would be about 1.0 million therms, as shown in the following table.

Table 21
Annual Therm Savings From Setting Water Heater to 120° F
After Technology Measures Installed

Segment	Number of homes setting above 120° F	Annual savings per home (therms)	Total annual savings (million therms)
Single-family	146,279	4.4	0.6
Multi-family	115,418	3.7	0.4
Total	**261,697**		**1.0**

CHAPTER 3: OPPORTUNITIES TO REDUCE ENERGY WASTE IN THE COMMERCIAL SECTOR

NATURAL GAS END USE IN THE COMMERCIAL SECTOR

In the commercial sector, space heating accounts for about half of total natural gas consumption. While this is still a substantial amount of load, note that it is proportionately less than observed in the residential sector.

COMMERCIAL SPACE HEATING

Thermostat Setback

The analysis of potential savings from residential thermostat setback practice is a fairly straightforward task. The largely homogeneous nature of that class justifies the consistent use of well-documented assumptions regarding typical energy use and savings potential. The same cannot be said of the potential for thermostat-related savings in the commercial sector.

The commercial sector manifests considerable heterogeneity, including entities ranging in size from those smaller than a typical residence (e.g., a barber shop) to those that use many millions of therms each year (e.g., a major hospital). Furthermore, practices regarding thermostat settings vary considerably, even within the same commercial subsector.

One more complicating factor is that we do not have data logger measurements for indoor temperatures for commercial customers, as we did in the residential sector. We do, however, have reported temperature settings for morning, afternoon, evening and night for 44 commercial establishments for which we conducted site visits. The data is illuminating, although practices vary widely.

Table 22 shows the hours of operation and reported temperature settings for a fast-food restaurant. We see that even though the restaurant is not open at night during the week or on the weekend, the business does not set back its thermostat during those times. A fast-food restaurant could set back its thermostat during those periods without loss of comfort because there would typically be no one on site.

Table 22
Hours of Operation and Thermostat Settings
for a Fast-Food Restaurant

	Open for Business?	**Thermostat Setting**
Weekdays		
Morning	Yes	72°
Afternoon	Yes	72°
Evening	Yes	72°
Night	No	72°
Weekend		
Morning	Yes	72°
Afternoon	Yes	72°
Evening	Yes	72°
Night	No	72°

In contrast, Table 23 provides the same information for a commercial laundry facility. Note that it is open fewer hours than the fast-food restaurant and it practices setback behavior, dialing back during all periods that the business is not open. There is no setback potential for this customer.

Table 23
Hours of Operation and Thermostat Settings
for a Commercial Laundry

	Open for Business?	Thermostat Setting
	Weekdays	
Morning	Yes	70°
Afternoon	Yes	70°
Evening	No	55°
Night	No	55°
	Weekend	
Morning	No	55°
Afternoon	No	55°
Evening	No	55°
Night	No	55°

We begin this analysis by examining space heating use by subsector. To estimate the savings potential from thermostat setback in the commercial sector we consulted with Energy Center building engineers to assess the likelihood that commercial customers within each subsector are setting back their thermostat. Based on those discussions we eliminated hospitals from the analysis because they are always open, and would therefore have no opportunity to set back thermostats. We also eliminated warehouses because they typically set temperatures at low levels at all times. We did not consider industrial customers in this analysis.

Table 24 shows space heating use by sub-sector for the Peoples Gas service area.

Table 24
Commercial Sector
Space Heating Load
by Subsector
(therms-millions)

Subsector	Space Heating Load
Small office	14.0
Large office	9.0
Food service	11.0
Private education	14.4
Religious	2.7
Other health care	31.2
Service	2.8
Lodging	13.4
Retail	21.6
Food sales	22.1
Total	**142.2**

Per discussions with our building energy engineers, many commercial firms, especially those with energy management systems, already practice thermostat setback. Table 25 shows the remaining load that could be subject to setback.

Table 25
Load Not Yet Subject to Setback
Space Heating Load by Subsector
(therms-millions)

Subsector	Space Heating Load
Small office	4.2
Large office	2.7
Food service	3.3
Private education	4.3
Religious	0.8
Other health care	9.4
Service	1.4
Lodging	10.7
Retail	17.3
Food sales	19.9
Total	**74.0**

To ascertain the likely savings from thermostat setback in the commercial sector, we used our energy modeling software[29] to examine the potential savings for a variety of building types over a range of temperature setbacks. The average savings from thermostat setback for all scenarios analyzed is 8.7 percent per year, which lies within the 6-10 percent savings range we used in the residential sector. Applying this savings rate to the available therms yields annual savings of 6.4 million therms for commercial setback. If technology measures were implemented first, these savings would drop to 3.3 million therms per year.

Heating System Maintenance

We focus on boiler maintenance in this analysis. The Peoples Gas potential study survey data reveals that 53 percent of businesses surveyed are not performing regular boiler tune-ups.[30] We adjust boiler space heating use by segment to identify the portion of the load that could be subject to boiler maintenance practice.

[29] This model is used to help design buildings as part of ComEd's commercial new construction program.
[30] Energy Center of Wisconsin, 2013. *Peoples Gas Light and Coke Company Energy Efficiency Potential Study: Program Years 4, 5 and 6*.

Table 26
Annual Therms Subject to Boiler Tune Up
(therms-millions)

Segment	Therms Used In Boilers	Percentage Not Practicing Maintenance	Adjusted Therms
Small office	3.5	53%	1.8
Large office	30.5	53%	16.2
Food service	1.5	53%	0.8
Private education	6.5	53%	3.5
Religious	8.0	53%	4.2
Other health care	1.0	53%	0.5
Service	2.9	53%	1.5
Lodging	21.0	53%	11.1
Retail	0.0	NA	0.0
Food sales	0.0	NA	0.0
Total	**74.8**		**39.6**

Using the TRM's estimate of 2 percent savings achieved from a boiler tune-up,[31] we determine that the customers who are not performing regular boiler tune-ups could achieve an annual total savings of 0.79 million therms, as shown in the following table.

Table 27
Annual Savings From Boiler Maintenance
(therms-millions)

Segment	Available Therms	Savings Factor	Savings
Small office	1.8	2%	0.04
Large office	16.2	2%	0.32
Food service	0.8	2%	0.02
Private education	3.5	2%	0.07
Religious	4.2	2%	0.08
Other health care	0.5	2%	0.01
Service	1.5	2%	0.03
Lodging	11.1	2%	0.22
Retail	0.0	2%	0.00
Food sales	0.0	2%	0.00
Total	**39.6**		**0.79**

[31] Illinois Energy Efficiency Stakeholder Advisory Group, 2014. *Illinois Statewide Technical Reference Manual for Energy Efficiency: Version 3.0*.

Adjusting for the technological measures reduces the savings estimate to 0.40 million therms per year.

Table 28
Annual Savings From Boiler Maintenance
After Technology Measures Installed
(therms-millions)

Segment	Savings	Savings From Technologies	Adjusted Savings
Small office	0.04	63.7%	0.01
Large office	0.32	65.9%	0.11
Food service	0.02	57.8%	0.01
Private education	0.07	39.9%	0.04
Religious	0.08	35.2%	0.05
Other health care	0.01	57.1%	0.00
Service	0.03	46.9%	0.02
Lodging	0.22	31.8%	0.15
Retail	0.00	33.9%	0.00
Food sales	0.00	58.6%	0.00
Total	**0.79**		**0.40**

CHAPTER 4: CONCLUSION

There clearly are opportunities to reduce energy waste in the Peoples Gas service area. The most promising areas are increased use of thermostat setback practices in both the residential and commercial sectors. Encouraging customers to wash laundry in cold water is another area where substantial savings could be garnered.

The following table provides the energy-savings potential in rank order based on the magnitude of savings.

Table 29
Annual Therm Savings
(millions)

Waste-Reducing Behavior	Before Technology Measures Installed	Before Technology Measures Installed
Residential: set back thermostat	16.1	9.9
Residential: wash in cold water	6.5	4.8
Commercial: set back thermostat	6.4	3.3
Residential: reduce water heater temperature	1.4	1.0
Residential: maintain heating system	0.9	0.5
Commercial: maintain heating system	0.8	0.4
Total	**31.1**	**19.9**

These numbers are large relative to savings estimates from other studies, and care must be taken not to assume that these represent achievable levels. Rather they represent upper-bound estimates, savings that could be achieved if all customers not practicing the stated behaviors would adopt them. In reality, only a fraction of the customers would be willing to do so, which means that the achievable levels are noticeably lower than those shown here.

SELECTED REFERENCES

The Cadmus Group, Inc., 2012. *Wi-Fi Programmable Controllable Thermostat Pilot Program Evaluation: Part of the Massachusetts 2011 Residential Retrofit and Low Income Program Area Evaluation*.

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APPENDIX

RESPONSES TO QUESTIONS AND COMMENTS RECEIVED AT THE OCTOBER 28, 2014 MEETING OF THE ILLINOIS STAKEHOLDER ADVISORY GROUP

- *In the Massachusetts smart thermostat study, how many degrees on average did people set back when they received the Ecobee device?*
  The study estimated the space heating energy savings implicitly using billing analysis, not explicitly based on observed temperature setbacks.

- *For the fast food restaurant discussed in the presentation, the open/close data on the graph appeared to refer to temperature settings, which is confusing.*
  We replaced the chart with a table to eliminate the confusion.

- *Why did the Energy Center assume that the typical family washes only 4 loads of laundry per week?*
  That was our original estimate based on discussions with energy efficiency experts. Further review of the data suggests that this figure is too low. In the final report, we used 6 loads per week. See report body for further discussion.

- *The ComEd baseline study provides local data on the proportion of customers who wash laundry in hot, warm and cold water.*
  We reviewed the study and considered that information in our analysis.

- *Did the Energy Center look at overall industrial heating system maintenance, such as leak detection in hot water heating lines?*
  We did not. We focused on areas where there is potential for an educational campaign to save energy. The sort of maintenance this question refers to is more closely related to industrial process management.

- *The assumed two-degree setback in the residential sector seems too low.*
  We did not assume a two-degree temperature setback, but rather a two-degree reduction in average daily temperature. A person setting back 8 degrees at night would cause the average daily temperature to decline by only 2.7 degrees. See body of the report for further discussion.

- *What was the setback behavior (degrees set back) observed in the commercial site visits?*
  We do not estimate degrees set back, but rather reduction in average daily temperature. The average daily temperature for commercial customers that show no setback behavior is 70.4 degrees; for those that do setback, the average daily temperature is 65.6 degrees. The temperature difference in the commercial sector is therefore about 5 degrees in contrast to the 2 degree difference in the residential sector. There could be some upward bias in the commercial data, however, since it is reported rather than measured.

- *In the commercial energy model, does the temperature setback occur independently of ventilation reduction, or are the two linked?*
  The thermostat setback occurs whenever we assumed that the building was unoccupied. The ventilation was also reduced at those times. More advanced modeling could be performed to allow for independent operation of those functions. We did not conduct such an analysis.

- *The achievable potential for Peoples Gas is about 6 million therms per year. What percentage is that of total sales?*
  The potential study shows that the target efficiency savings level for Plan Year 4 was 0.8%, or 11.2 million therms. This suggests that the total therm sales are 11.2 million / 0.008 = 1.4 billion therms. Therefore the achievable potential is 6.0 million / 1.4 billion = 0.4% of total sales.

ALTERNATIVE PRESENTATION OF WASTED ENERGY RESULTS

The following table converts the analysis in this report to that used by Opinion Dynamics for the ComEd wasted energy analysis.

Table A-1
Peoples Gas
Wasted Energy Estimates

PEOPLES GAS RESIDENTIAL SECTOR	Space Heating	Water Heating
% of residential usage	76%	18%
end-use penetration	99%	97%
therms per household (with end-use)	1,270	316
therms per household (all households)	1,259	306
total annual therms (millions)	624.3	152.0
% efficient usage	61%	67%
% technical waste (before behavioral waste)	37%	29%
% behavioral waste (after technical waste)	2%	4%
% behavioral waste (before technical waste)	3%	5%
% technical waste (after behavioral waste)	36%	28%
technical waste (before behavioral waste)-therms (millions)	233.2	44.8
behavioral waste (after technical waste)-therms (millions)	10.4	5.8
behavioral waste (before technical waste) (millions)	16.9	7.9
technical waste (after behavioral waste) (millions)	226.7	42.7